Digital Education Content in the EU – state of play and policy options

Final report: 22 September 2023

Request for Services EAC/02/2022

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Executive summary

In June 2022, the European Commission appointed Ecorys to carry out the study: '**Digital education content in the EU – state of play and policy options**' (EAC/02/2022). The work aimed to assist preparations for an EU Digital Education Content (DEC) Framework as foreseen within the Digital Education Action Plan 2021-27. This summary gives an overview of key messages and findings from the main research report.

Study context

Digital content has long been used in education, but came under the spotlight with the shift to emergency online learning during the COVID-19 pandemic. These developments, along with the ongoing digital transformation, have seen **rapid increases in production and consumption of DEC**. Digital content has become **increasingly adaptable and diverse**, ranging from digital textbooks to educational games, immersive Virtual Reality (VR) or Extended Reality (XR) experiences and Artificial Intelligence (AI) generated content. At the same time, **key stakeholders and their roles are also changing**, with the emergence of new actors and rise of user-generated content. These changes have technological, legal, economic and pedagogical dimensions.

The 2021 Council Recommendation (CR) on blended learning, the accelerating developments of Generative AI, including the development of ethical guidelines on the use of AI and data in teaching and learning, have all drawn attention to the need to better understand the challenges and opportunities presented for DEC.

Aims and approach

The study aimed to understand the current **state of play for digital education content across Europe**, and to assist the European Commission with identifying possible areas for EU intervention. The scope included Early Childhood Education and Care (ECEC), Primary and Secondary Education, including Vocational Education and Training (VET), and Higher Education (HE). The **specific objectives** were to:

a) Produce an in-depth analysis of the supply and demand of digital educational content.
b) Develop up-to-date definitions and related terminology that can be shared and used by stakeholders.
c) Identify and define technological, legal and any other relevant contextual bottlenecks.
d) Identify key challenges for the development of a robust digital education content framework at EU level.

The study was carried out between July 2022 and September 2023 and involved mixed methods, combining desk research with an EU27 country mapping, case studies and a market analysis[1]. The work was informed by ongoing dialogue with a Stakeholder Consultation Group (SCG). This group was recruited specifically for the study, with representation from both the supply and demand side within Europe's Digital Education Ecosystem[2].

Key findings

Definitions of Digital Education Content (DEC)

The study conducted an in-depth review of the literature, both academic and grey literature, in relation to the existing definitions and descriptions of DEC and consulted with the stakeholders. This work concluded that:

- There is a **myriad of terminology currently associated with digital education**, and this is also true for DEC. Terms such as digital education content, digital learning materials, digital learning resources, digital teaching aids and digital learning objects are often used interchangeably and need to be explained through the use of examples. This **inconsistency and complexity has hindered a shared understanding of DEC**, which remains under-theorised and under-researched relative to other aspects of digital education.

[1] The study aimed to adopt a 360° approach, exploring pedagogical, technical, regulatory and ethical, economic and financial considerations of DEC. While remaining systematic, adjustments were required to take into account data gaps and non-standardisation, differences in terminology, and the diffuse range of strategies, tools and frameworks within which DEC is located but not always clearly defined at national, regional and local levels.
[2] In total, 322 key stakeholders registered with the Stakeholder Consultation Group. 272 were EU-based and 50 international.

- With the more widespread use of VR/XR, mobile applications, AI and learning management systems (LMS), **an understanding of digital education "content" is expanding** to include the means by which content is embedded, as well as the tools or the channels through which the content is delivered or accessed. Content is mediated by the choice of digital tool or platform and how it is used to support learning, and has become more medium-independent, multi-output ready, and granular. These developments require established definitions to be continuously updated to reflect new and emerging forms of DEC.
- To address the issues presented within the literature, the study team worked with key stakeholders and drew upon a country mapping exercise to **prepare a broad and overarching definition** of ''digital education content'' (DEC). The resulting definition aims to reflect the complexity of the terms, the objective(s), and the scope for multiple formats, depending on the purpose for which it is created or used. This is presented below.

Box 1. Study definition of digital education content (DEC)

The over-arching study **definition** is as follows:

""Digital education content is data that is produced, structured, distributed and presented in a way that aims to meet an educational objective, made available in various formats and styles by digital tools. [3]"

DEC is a subset of digital content. Digital content is created from 'chunks' of digital data (i.e. text, images, video, audio, etc.) and combined to create digital content (i.e. webpages, digital texts, movies, etc.). DEC is used to **facilitate the learning process** (e.g. by making it easier for students to recall material), and to enable the widest possible number of learners to interact successfully with the content, by adopting inclusive design approaches, i.e. adhering to universal design principles (UDL);and to ensure that it can be easily retrieved and adapted, where needed, by utilising the appropriated semantic and metadata tagging.

When considering DEC, a number of **key principles** apply:

1. Digital education content is distinct from but related to and intertwined with; a) **the environment(s) within which it is used,** and b) **the pedagogical contexts, techniques and learning scenarios** within which the content is or becomes used for educational purposes.

2. Digital education content is **defined by its purpose (educational use)**. This encompasses both content *created* with the intention of supporting educational activities (''core digital education content'') and pre-existing content, *repurposed, re-animated or re-applied* to support educational models ('auxiliary digital education content''). The latter is not a primary focus of efforts to produce a DEC framework.

3. **In formal education (e.g. in school settings)**, which is the focus of this study, digital content can be used in a way to support the teaching of various curricula, learning pathways and other educational goals. Formal digital education content may **originate from or be reused in non-formal education contexts** (e.g., adult learning or informal learning, or for training/information provision).

Quality criteria for DEC

There has long been a practice of **evaluating print materials for education and training purposes** and these tools and frameworks have evolved to incorporate educational software and online materials. Across Europe, national and regional governments (e.g. Lithuania, Poland) and commercial actors have aspired to develop and apply objective criteria to identify "high-quality" resources that can be used in education and training settings. The literature on such approaches, triangulated with evidence from practice, shows that:

[3] Dedicated to teaching, learn and assess, or adapted or used by the teacher / student or trainer into a learning scenario, it means software, programs, applications, platforms, and (online or offline) resources that can be used with computers, mobile phones or other electronic devices, e.g. a website, app, Learning Management System, or Virtual Reality world.

- While objective criteria are important in making judgements, **it is as important to make a context-specific evaluation of how content supports learners to achieve a set of specific learning aims/intended learning outcomes**. Educators, who are crucial to this process, need to possess the necessary digital and pedagogical competences to make such informed judgements.
- **Training and guidance is necessary for teachers to make such decisions**, so they can move beyond the intrinsic properties of a particular piece of DEC and consider the wider context[4]. For example, teachers across education levels were struggling to select and use "high-quality" DEC during the COVID-19 crisis.[5] Training and professional development has also emerged as a priority, to support teachers and school leaders in their efforts to use DEC while navigating copyright, licensing and Intellectual Property (IP) issues.
- Quality criteria can **support users to make more informed choices**, and **providers to create better content**. As such, quality criteria should not be considered in isolation from the key stakeholders and the stage in the DEC cycle of creation, facilitation and use. It is important to ask for whom, in which contexts and for what purposes quality criteria are needed. The table below outlines some of these considerations.

Table 1. Key stakeholder groups and purpose of quality criteria

Stakeholder group	Purpose of quality criteria
Creators Content creators and providers (producers and distributors)	• To support and guide them in developing quality DEC to meet the educational needs of users, and the minimum technical, legal and contractual requirements to reach a wide range of school populations.
Facilitators Purchasers of content and assigners	• To procure/commission/aggregate quality DEC for content users - in particular for learner success and the development of digital skills for all - and achieve value for money.
Content Users Content users/evaluators (teachers, students, trainers, inspectors, researchers)	• To select and use quality DEC that will enhance teaching, learning and assessment experiences. • To contribute to an objective qualification of DECs based on common criteria and a description of the context of use.

Quality criteria should support each of the key stakeholder groups and be **adaptable for different types of content and learning aims**. They must address both the content itself, and how it is deployed (scenarios). There is also a need for future criteria to address **utility and usability issues**, from both the technical and pedagogical side, and enable **sense-checking**, to establish whether certain DEC are relevant for different stakeholders, levels of education and for use within different education systems.

Understanding the marketplace

Europe's education technology (EdTech) sector experienced unprecedented growth in the wake of the Covid-19 crisis. EdTech Venture Capital (VC) increased threefold from 2020-21 to over $2.5bn, while the European share of global ed tech funding rose from 6% in 2020 to 22% by 2022[6]**.** This high demand for digital tools and services disrupted well-established supply chains[7] and allowed start-ups to gain market exposure[8].

Key trends include the following:

- While emergency distance learning called for video-enabled content, the ongoing adoption of blended learning and personalisation within Europe's education systems has demanded solutions to enrich digital education content with AI or gamification, combined with online assessment and tutoring[9]. These

[4] OECD CERI, https://www.oecd.org/digital/learningtochangeictinschools.htm or OECD Web Archive
[5] Kundu, A., Bej, T., & Rice, M. (2021). Time to engage: Implementing math and literacy blended learning routines in an Indian elementary classroom. Education and Information Technologies, 26, 1201–1220.
[6] Brighteye Ventures (2023) The European Edtech Funding Report 2022.
[7] Andersson, P., and Mattsson, L-G (2019) Future digitalization of education after Covid-19. Available online: https://www.hhs.se/contentassets/419c7b2f06a94ee183bf52ca748c98b5/a54.pdf [Viewed 12.01.23]
[8] Learnetic (2023): The Future of Educational Publishers. Available online: https://www.learnetic.com/future-of-educational-publishers/
[9] In DE, FI and NL, for example, large-scale platforms exist to provide a cost-effective space for digital content.

adaptive learning solutions have required greater supply chain sophistication; and led to new EdTech partnerships, along with mergers and acquisitions – many of which are international in scope.

- Europe's publishers also diversified their digital offers. The shift online during the Covid-19 crisis helped to demonstrate the cost-effectiveness of digital textbooks compared with print, prompting buyers to switch to digital content libraries[10]. DEC has moved further away from an edition/revision model towards increased adaptability; harnessing Big Data within educational offers; more interactivity and personalisation (e.g. via course authoring tools); and re-packaging digital offers, blurring traditional publisher / ed tech boundaries.
- At the same time, the EU marketplace has been characterised by the expansion in user and teacher-generated content, produced, shared and (re) used on collaborative platforms. This is often, although not always, developed at arms' length from official public procurement channels, and available free of charge. It contrasts with the trend for in-demand Ed Tech providers to create exclusivity and prestige around their products and communities via relatively high joining costs or selective entry criteria.[11]
- While estimates are available for different education technologies, sizing the DEC market within these categories is not an easy task. In addition to the absence of a commonly agreed definition for DEC, common statistical data – both for the supply and demand side – are also lacking[12]. In addition, in market studies and forecasts, many similar, yet potentially slightly different and overlapping and imprecisely defined notions are used: online education, digital education, or e-learning among others.
- Within those studies which do refer to the DEC market, the estimates of market size vary significantly. At a global level, these market studies elicit estimates ranging from USD 14,14 billion to USD 200 billion (or almost USD 400 billion). Such variations signal a need for extreme caution. As a consequence, it is unclear how the relevant markets for these different areas relate to a single 'DEC marketplace'.
- From a market perspective, the report indicates that better data would help with an assessment of the sufficiency and sustainability of funding allocated to DEC. A collaborative effort is needed between public authorities and partner organisations, to determine what proportionate data collection arrangements might look like. Without this, there is no obvious means of understanding market dynamics at an EU level.

State of play across EU Member States

There are **wide differences between Member States in policy and governance arrangements** to oversee the **production, distribution and use of DEC**. These issues concern:

- The degree to which DEC is made explicit within national and local educational plans and strategies;
- Whether or not funding is ring-fenced for DEC within special projects and core educational budgets; and
- The composition of partnerships governing how DEC is developed and used, and their inclusiveness and representativeness of diverse stakeholders including public authorities, suppliers, educators and learners.

DEC policies are shaped by a number of factors, including:

- **Structural differences between national education systems** – DEC availability, choice and the organisation of public procurements reflects the relative centralisation of public education and the autonomies afforded to municipalities and schools to set budgets, and select resources.

[10] By 2021, European publishers were estimated to hold 3 million titles in digital format, buoyed not only by the growth of digital publishing, but also the digitisation of back catalogues and growth in print-on-demand and self-publication. Federation of European Publishers (2022). Available online: https://fep-fee.eu/European-Book-Publishing-1467 [Viewed: 12.01.23]
[11] Brighteye Ventures (2023) The European Edtech Funding Report 2022.
[12] Market size is defined by the maximum total number of sales and the resulting revenue. Considering that a large share of the DEC is acquired through public-sector procurement, the national budgets foreseen for DEC offer a proxy. However, this excludes the revenue generated from DEC sold directly to consumers (i.e. parents, students, learners), which requires data on the revenue from Business to Consumer (B2C) sales.

- **Geographical distribution of education technology markets** – Western, Central and Northern Europe continue to dominate the marketplace in the EdTech and publishing sectors, with Covid-19 gains reinforcing these regional divides. This landscape influences how and where DEC is created and monetised.
- **Educational value propositions** - market engagement ranges from privileging free or freemium content and open data policy (promotion and facilitation of access to OERs, e.g. Germany), to active market engagement (public-private partnerships, shared procurement with commercial providers, e.g. France[13]).

These variations are reflected in the role of public authorities in **curating and updating DEC**. In the most widespread model, public DEC platforms exist alongside products and services on the open market[14]. In contrast, some Member States utilise public platforms as the primary channel[15], or not at all.[16] These models have relative advantages and drawbacks. Centralisation of content on public platforms widens access, but may narrow choice for end users. Proprietary platforms reflect the market but risk biases from commercial algorithms.

Taken together, these factors show that one size does not fit all. Member States are at varying stages and trajectories with DEC, with a wide range of policy goals. This landscape presents fragmentation, with different laws, traditions, regulations, while also offering **strength in diversity**. The study found numerous examples of effective practices that may be adapted in other country contexts, and opportunities for "policy learning".

Demand side considerations

On the demand side, the desk research and mapping shows a priority among school leaders for **safe and affordable digital education content** that can be **easily employed by teaching staff**. Factors that prevent the integration of DEC in classrooms include inadequate resources, lack of pedagogical digital competences, restrictive language formats, interoperability issues and low educator confidence. Support in demand among surveyed educators included practice examples (learning scenarios, demonstrations); advice from digital instructional designers or pedagogues; more relevant CPD, and access to professional communities.

Challenges and bottlenecks

The desk research and consultations highlighted ten main challenges with a shared EU dimension, which fall under four main themes as follows. Each area is subject to a more detailed assessment in the full report.

Table 2. Overview of key areas for action and specific challenges / problems

Area for action	Challenge or problem
• **Standardisation and EU dimension** - the EU DEC ecosystem is characterised by low levels of technical standardisation. There are many proprietary tools and platforms with paywalls and algorithms, organisationally-specific standards and data models. This can result in poor levels of interoperability and inhibits the movement, transfer and scaling of DEC across countries and settings. New challenges are presented by advanced AI, its data complexity, and its impact on how DEC is shared and used.	**1.** Consistency of definitions, guiding principles and quality criteria **2.** Interoperability and minimum standards for metadata **3.** Complexity within Europe's DEC ecosystem
• **Smart and sustainable investment** – both operational and R&D budgets are needed to test and embed DEC. However, the study indicates problems with sufficiency, value for money and sustainability. Under investment in DEC relative to hardware; time-limited funding, unclear procurement practices, and lack of	**4.** Sufficiency and sustainability of funding for DEC **5.** Fitness of procurement models and processes

[13] The regional geography of Europe's ed tech and ed pub markets also exerts an influence on how and where DEC is created and monetised. Western and Northern Europe continue to dominate the ed tech marketplace, with Covid-19 gains reinforcing these divides.
[14] AT; BE; BG; CZ; DE; DK; EE; ES; HR; FR; IE; LT; LV; NL; MT; PT; PL; RO; SI
[15] CY; EL; SK; HU
[16] FI; IT; SE; LU

Area for action	Challenge or problem
inter-ministerial coordination can combine to yield a poor return on investment. Better data is needed to quantify these issues.	**6.** Minimum data collection and benchmarking for DEC investments
• **Access, equity and inclusion** - governance arrangements for DEC are not always fit for purpose, resulting in a lack of accountability, while educators and learners are often under-represented in how DEC is designed and used. Legal and ethical challenges are presented by the unsolicited use of data and GDPR breaches. Equity issues are presented by a lack of multilingual content, and barriers relating to disability or IT access.	**7.** Inclusive governance, teacher and learner agency **8.** Secure and ethical data processing, observing fundamental rights **9.** Access and inclusion for learners experiencing disadvantage
• **Fair and responsible use** – copyright, IP and licensing for DEC are complex, as they relate to authors' rights, exploitation rights of the product, and copyrights relating to individual digital assets. This complexity is multiplied by AI-generated content. Fear of litigation can disincentivise the use of DEC, while educators and learners often feel under supported. There has been an uptick in legal challenges, and documented infringements of rights.	**10.** Meeting obligations for copyright and intellectual property

Possible areas for intervention and EU Added Value

EU Added value

The study concludes that there is good case for EU action to support Member States in the creation, distribution and use of high-quality DEC. While countries have distinct needs and characteristics, there are many shared challenges, including those with a transnational dimension, reflecting the operation of the EU Single Market, EU regulatory frameworks (such as the Digital Services Act and Digital Markets Act), and EU common values.

With its competence, the EU has a role to play in:

- **a)** setting direction for DEC at a European policy level ('strategic vision').
- **b)** incentivising EU Member States to adopt a collective response to the challenges and issues at stake.
- **c)** providing guidance to support common EU standards, principles and quality criteria.
- **d)** providing an infrastructure for transnational collaboration and peer learning.
- **e)** supporting innovation, evidence generation, and addressing research gaps.

The study recommends that the EU support collective action, while respecting the competences of Member States for education as defined by Article 165.1 of the TFEU. The EU should support adoption of guidance and quality standards by Member States on a voluntary basis; respect the principles of healthy competition within the Single Market, and take into account the legacy of pre-existing country-level standards or tools for DEC.

Appraisal of policy options

The study team considered the range of policy instruments at the disposal of the EU, and formulated a more specific set of options for action. These were scored according to six criteria:1) importance (to addressing the DEC problem); 2) case for EU action; 3) potential impact; 4) cost; 5) feasibility, and 6) existing action. The Stakeholder Consultation Group (SCG) provided feedback and reflections on the options and their acceptability.

The appraisal concludes that the option of 'no action' is non-viable, given the need for support and guidance at an EU level, and the stated policy commitment under the DEAP. It also concludes that there is no reasonable grounds for market intervention, new legal instruments, or a new Council Recommendation (CR).

A strategic approach should combine **EU-level guidelines and tools** to improve coherence with **research and evaluation** to address evidence gaps, while leveraging EU funds to incentivise action and stimulate innovation. **EU networks and exchanges** should be engaged to scale and embed these policy actions, including the DELTA Expert Group and EU Digital Education Hub, while making DigiCompEdu and SELFIE a focal point for

rolling out new DEC standards and guidelines to accelerate take-up. Looking ahead, EAC should track and connect with other EU policy initiatives so that the framework remains agile and responsive to emerging trends.

Potential scenarios for EU action

The study outlines three potential scenarios for EU action, combining the recommended policy measures to maximise their impact and offering EAC a sliding scale of ambition, cost and complexity.

Box 2. Potential scenarios for EU action

- In the **first scenario** (moderate ambition), EAC develops a set of EU guidelines and a toolkit, working with experts to provide a common vocabulary, quality criteria, case studies and sample protocols. EU funds would be used to support cross-sectoral and transnational partnerships and policy experimentation, and to initiate studies and evaluations to strengthen the evidence base. EAC could launch a feasibility study on standardisation in financial monitoring and reporting on DEC, gathering statistics that may be helpful in understanding DEC expenditure in public education, alongside other key indicators of DEC maturity.
- The **second scenario** (high ambition) is a suitable point at which to initiate a feasibility study for a new EU-wide DEC tagging and labelling data infrastructure, encompassing educational, pedagogical, technological, and legal structures. Subject to feasibility, this option would perform a specific function in presenting, discovering, disseminating and sharing DEC. As the CEN TC 353 framework is already in play as a mirror of the national commissions and ISO, there is good potential to explore the production and use of metadata in the guidelines, and to build on this work. The actions outlined in the first scenario would also apply.
- In the **third scenario** (stretch ambition), EAC builds on the feasibility study and Impact Assessment to proceed with the development of a new DEC tagging and labelling data infrastructure. This would represent a high profile and ambitious IT project, aspiring towards a shared data language for DEC in Europe, and connecting local and global data systems to widen access to high quality, multilingual DEC for schools, educators and learners. EAC might also go beyond using the existing EU programmes to consider a new DEC Creation Fund as a catalyst for innovative DEC solutions led by Member States and their partners. This would require higher levels of investment than scenarios 1 and 2, offset with stronger leverage.

EAC might choose which scenario to adopt, subject to available resources and strategic prioritisation. The study encourages EAC to set in place robust monitoring and evaluation, to ensure accountability for the development of the framework and the selected policy measures and to measure progress, implementation and outcomes.

Recommendations for EU Member States

The study also proposes DEC system-strengthening for consideration by EU Member States and partners, while acknowledging that national aims and trajectories for DEC are different, and that further research is needed to determine the properties of a ‘mature’ DEC ecosystem. Suggested actions for voluntary adoption include:

a) **Action on educational governance** - a strategic vision for DEC, inclusive multi-agency partnerships; extensive consultation with supply and demand-side actors to establish roles, rights and responsibilities.
b) **Quality assurance and accountability** - implementing national and EU frameworks for interoperability, metadata, rights statements, OERs; robust management of public procurement exercises.
c) **Financial stability and sustainability** - reviewing sufficiency and stability of budgets; prioritising high quality validated resources; target funds for under-served populations (adaptive and multilingual DEC).
d) **Pedagogical alignment, recognition and validation** - evaluate to ensure high quality DEC, connected with related certifications; guide schools and educators on copyright and IP; invest in teacher education.
e) **Democratisation, freedoms and choice** – empower educational institutions to set and monitor DEC strategies and spend that meets educator and learner needs, framed by clear standards and expectations; support end users to participate at all stages in the content cycle; nurture DEC networks.

1.0 Introduction

This report presents the findings from the study: ***'Digital Education Content in the EU – state of play and policy options'*** (EAC/02/202), carried out by Ecorys Europe on behalf of the European Commission Directorate-General for Education, Youth, Sport and Culture[17]. The study aimed to provide a solid basis of knowledge and analysis about digital education content in the EU, and to gather evidence to support the development of an EU Digital Education Content Framework, as foreseen within the updated Digital Education Action Plan 2021-27.

In this chapter, we introduce the background policy and research context, set out the aims and objectives to be addressed and give an overview of the research methodology. We then explain the structure for the remaining chapters and appendices. It should be noted that this report is based on an analysis of data collected between July 2022 and September 2023, and the findings are current at the time of writing.

1.1 Study orientation

Over the past decades, technology has seen a shift away from traditional chalk and board teaching and learning environments towards schools and Higher Education Institutions as multi-media learning centres. This shift rapidly accelerated during the COVID-19 crisis, as homes became classrooms and teachers found new ways to connect with their students through digital education infrastructure and content. Against this backdrop, many EU Member States, guided by the Digital Education Action Plan 2021 – 27[18], allocated a significant portion of Recovery and Resilience Facility funds towards national digital education transformation plans[19].

While in-classroom learning is now re-established in schools, the importance of continuing to build on the momentum – and evidence base – developed preceding and during the crisis is imperative. This is not only to support hybrid learning practices, but also to ensure that students are equipped with the tools and skills that set them up for success in a rapidly digitising labour market. The latter is particularly pressing when noting that accessing the world of work in the future, even for low skilled positions, will require at least basic use of ICT[20]. There is also a growing recognition of the importance of the transversal nature of digital competences, extending beyond the purely educational to encompass child rights and wellbeing[21].

1.1.1 Unlocking the potential of digital education content

Beyond the need to equip learners with digital skills, the effective use of technology has the potential to complement traditional forms of teaching and learning, and to play a central role in removing barriers in access to learning, facilitating personalised learning, as well as improving education quality through better data analysis and foresight[22]. Within this context, the array of digital education opportunities in formal education are overwhelming; spanning from e-books to personalised learning environments, virtual and augmented reality (VAR) to mobile applications, Artificial Intelligence (AI) to learning management systems (LMS)[23].

With these changes to tools and platforms, an understanding of digital education "content" (DEC) is expanding to include the means *where* the content is embedded, as well as the tools or the channels through which the

[17] Directorate C – Innovation, Digital Education and International Cooperation, Unit C.4 —Digital Education
[18] Digital Education Action Plan (2021-2027). Available at: https://ec.europa.eu/education/education-in-the-eu/digital-education-action-plan_en
[19] The Recovery and Resilience Facility. Available at: https://ec.europa.eu/info/business-economy-euro/recovery-coronavirus/recovery-and-resilience-facility_en
[20] Nania, J., Bonella, H., Restuccia, D., and Taska, B. (2019). *No Longer Optional: Employer Demand for Digital Skills.* London: Burning Glass Technologies.
[21] Livingstone, S.; Kardefelt, W., D. and Saeed, M. (2019). *Global Kids Online Comparative Report, Innocenti Research Report*. Florence: UNICEF.
[22] European Commission. (2018). *Digital Learning and the EC*. Luxembourg: Publications Office of the European Union.
[23] Tuomi, I. (2018). *The impact of artificial intelligence on learning, teaching, and education*. Luxembourg: Publications Office of the European Union.

content is delivered to or accessed. Content is mediated by the choice of digital tool or platform and how it is used to support learning. The growing platformisation of education[24] across all levels has been underway for almost a decade, was accelerated during COVID-19, and is characterised by "combined evolutionary content systems, student management and learning assessments[25]."

Due to the ongoing digital transformation and the rapidly evolving ways in which educators and learners interact with and consume educational content, DEC has also become more and more:

- Medium-independent (or 'medium agnostic', following the content-as-data-principle);
- Multi-output ready (created once will be used in multiple contexts, and on multiple devices);
- Granular (dividable into smaller pieces, to facilitate personalised learning paths as well as specific information/instruction needs); and
- Designed according to universal principles to adequately support highly diverse cohorts of teachers and learners.

This new world of digital content is very different from previous stages which were dominated by software, digital textbooks and learning objects.

Teachers thus need a clear understanding of the affordances and limits of different technologies, and they can be used to support learning aims and activities. Different technologies support different types of learning within different types of learning environments. Ideally, teachers use a mix of digital tools and approaches, including those that involve active, student-directed learning and collaboration (i.e. based on web 2.0 technologies where students add and edit their own multi-media content), and those that integrate AI and help to personalise learning experiences by adapting content according to learners' interaction with the programme or platform. The rise of generative AI was at the forefront of debates on technology and education at the time of writing this report.

At the same time, the literature indicates that a strategic approach is needed to fully leverage this wide array of digital possibilities in the classroom, involving adapted pedagogical practice, appropriate curricula, teacher training and strategic frameworks[26]. What works in pre-school settings is somewhat different to pedagogical needs within general education or VET, while there is evidence that ICT can create more harm than good where classroom technologies are poorly integrated[27]. As a result, a measured approach to the development, procurement, use and scaling-up of pedagogically appropriate digital education content is a fundamental part of the challenge to delivering quality digital education across the EU, alongside other key considerations like connectivity, infrastructure, platforms, and the development of digital skills and competences.

1.1.2 A changing marketplace for DEC in Europe

The study was commissioned against the backdrop of a changing marketplace for educational technologies. Recent years have seen rapid growth in global educational technologies market, buoyed by the demand created by the Covid-19 crisis, and reflecting the growing attractiveness of public education systems to investors. The European Ed Tech market has thrived during this period. Traditionally associated with high quality public education but slower to embrace educational technologies, Europe experienced accelerated growth in the wake of the Covid-19 crisis. European EdTech VC increased threefold from 2020-21 to over $2.5bn by the end of the year, while the European share of global EdTech funding rose from 6% in 2020 to 22% by 2022[28].

The unprecedented demand for digital tools and services during the pandemic had a silver lining, in creating opportunities for smaller, less established players to sell-in specialist services to established buyer

[24] Rivas, A. (2023). The platformization of education: A framework to map the new directions of hybrid education systems 1. In *The New Digital Education Policy Landscape* (pp. 191-209). Routledge.
[25] Ibid.
[26] McKnight, K., O'Malley, K., Ruzic, R., Horsley, M. K., Franey, J. J., & Bassett, K. (2016). Teaching in a digital age: How educators use technology to improve student learning. *Journal of research on technology in education*, 48(3), 194-211.
[27] Denoël, E., Et. al. (2017) Drivers of student performance: Insights from Europe. New York: McKinsey & Company
[28] Brighteye Ventures (2023) The European Edtech Funding Report 2022.

relationships[29]. This demand also incentivised horizontal collaboration, in many cases supported at Member State level by the European Edtech Alliance[30]. The result was that the new, specialised start-ups gained market exposure[31]. Some public authorities led the way by taking action to facilitate procurement (e.g. Swedish Edtech developed common templates and instructions to de-mystify purchasing processes[32]), although such models have evolved to a variable degree across the EU.

As Europe's digital education content needs have evolved, so have the corresponding provider offers. While emergency distance learning called for video-enabled content, the more widespread adoption of blended learning and personalisation within Europe's education systems have demanded solutions to enrich digital education content with AI or gamification, combined with online assessment and tutoring[33]. These adaptive learning solutions have required greater supply chain sophistication, with new EdTech partnerships, along with mergers and acquisitions, many of which are international in scope.

The period has seen the accelerated diversification of educational offers from Europe's publishers. The shift online during the Covid-19 crisis helped to demonstrate the relative cost effectiveness of digital textbooks compared with print, prompting educational institutions and public authorities to switch investments to digital content libraries[34]. The evolution of content, which started before the Covid-19 crisis, has moved further away from an edition/revision model towards: increased adaptability; harnessing Big Data within educational offers; more interactivity and personalisation (e.g. via course authoring tools); and re-packaging digital offers, blurring traditional publisher and ed tech boundaries.

At the same time, the EU marketplace has been characterised by the expansion in user and teacher-generated content, produced, shared and (re) used on collaborative platforms. This is often developed at arms' length from official public procurement channels, and available free of charge. It contrast with the trend for in-demand Ed Tech providers to create exclusivity and prestige around their products and communities via relatively high joining costs or selective entry criteria.[35]

1.2 Aims and objectives

The Digital Education Action Plan 2021-27 contains 14 Actions to support the adaptation of the education and training systems of EU Member States to the digital age, of which the creation of a **European Digital Education Content Framework** is one (Action 3)[36]. The Framework aims to build on European cultural and creative diversity and include guiding principles for specific sectors and their needs, including high quality instructional design, accessibility, recognition and multilingualism while reflecting the need for interoperability, certification, verification, and transferability of content. It further aims to identify and respond to pressing digital education challenges such as navigating ethical and privacy issues, while quality assuring a myriad of digital content.

The purpose of the study was to guide the European Commission in its decision-making regarding policy options and potential areas for EU Added Value, in preparation for the framework. It has aimed to establish key definitions and guiding principles to frame and assess digital education content, understand the factors influencing supply and demand. It has explored how existing bottlenecks might be addressed, identifying solutions where the EU, within its competences, is best placed to act to help Member States and their partners to overcome bottlenecks and to boost the quality of digital education content.

[29] Andersson, P., and Mattsson, L-G (2019) Future digitalization of education after Covid-19. Available online: https://www.hhs.se/contentassets/419c7b2f06a94ee183bf52ca748c98b5/a54.pdf [Viewed 12.01.23]
[30] https://www.edtecheurope.org/
[31] Learnetic (2023): The Future of Educational Publishers. Available online: https://www.learnetic.com/future-of-educational-publishers/
[32] Andersson, P. and Mattsson, L.G. (2018). "Digital Transformation Supporting Public Service Innovation – Business Model Challenges and Sustainable Development Opportunities", (Chapter 11) in Andersson, P. et al. (eds), *Managing Digital Transformation*. The Stockholm School of Economics Institute for Research (SIR), Stockholm School of Economics: Stockholm.
[33] In DE, FI and NL, for example, large-scale platforms exist to provide a cost-effective space for digital content.
[34] Federation of European Publishers (2022) European Book Publishing Statistics 2021. Available online: https://fep-fee.eu/European-Book-Publishing-1467 [Viewed: 12.01.23]
[35] Brighteye Ventures (2022), *op. cit.*
[36] Ibid. (European Commission, 2021)

It should be noted that digital educational content does not mean the content of curricula, the content to be taught, or the content of examinations, which is the competence of Member States under the Treaties[37]. It relates to the pedagogical materials used in learning and curricula, with their associated or non-associated tools and services in their implementation, and the pedagogical modalities deployed. A full working definition is provided and explained in Chapter 2 of this report.

1.2.1 Specific objectives

The specific objectives of the study were as follows:

- To produce an in-depth analysis of the **supply and demand of digital educational content** with the lessons learnt from the COVID-19 period (1), from the ongoing digital transformation (2) (covering in particular technology drivers such as AI, blockchain, cloud computing etc.) and new trends of creation, adoption and use of digital education content (3).
- To develop an **up-to-date definition of digital education content and related terminology** that can be shared and used by stakeholders; prepare a categorisation of relevant quality criteria for digital education content; and develop a stakeholder matrix.
- **To identify and define technological, legal and any other relevant contextual bottlenecks** that impede the digital transformation in the area of digital education content and which may result in insufficient quality of education provision.
- **To Identify key challenges for the development of a robust digital education content framework** at EU level. Identify and evaluate solutions and interventions where the EU, within its competences, would have an added value, either to overcome the bottlenecks or to boost quality of education from the perspective of digital education content.
- To involve stakeholders from both the supply and demand side in the co-creation of those solutions by **setting up and running a Stakeholder Consultation Group (SCG)**, which will run alongside the data collection and ensure timely exchanges of views and expertise.

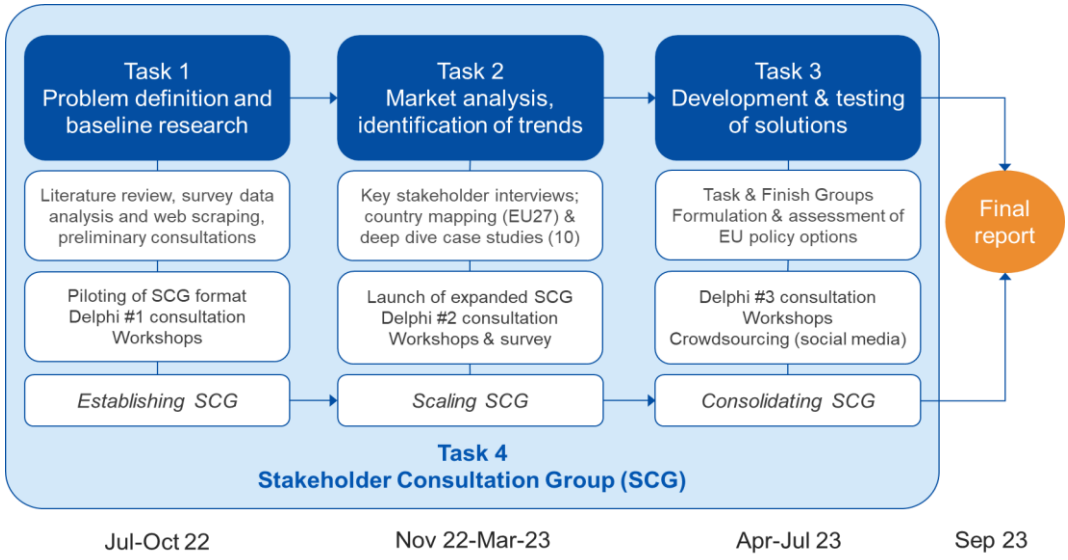
The study scope included Early Childhood Education and Care (ECEC), Primary and Secondary Education, including Vocational Education and Training (VET), and Higher Education (HE). It focussed on digital education content systems and practices designed with formal education objectives in mind. Lifelong learning and informal learning were out of scope. The geographical focus centred on the EU27, although the research also attended to international examples, insofar as these are relevant to the EU context.

1.3 Methodology

A mixed methods design was deployed for the study. This comprised of four main tasks (work packages), which were mapped closely to the objectives. They included: problem definition and baseline research; market analysis, development and testing of solutions, and setting-up and managing a Stakeholder Consultative Group (SCG) as a reference group to test and reflect on emerging themes and findings. The establishment and management of the SCG constituted a Task in its own right, and a means to realising the other tasks via ongoing engagement and co-production with key stakeholders. Figure 1 provides a visual overview.

[37] Consolidated versions of the Treaty on European Union and the Treaty on the Functioning of the European Union. Available online: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A12016ME%2FTXT

Figure 1: Study work programme – phasing and work done



Source: Ecorys, 2023.

The study Tasks and their scope are further summarised below:

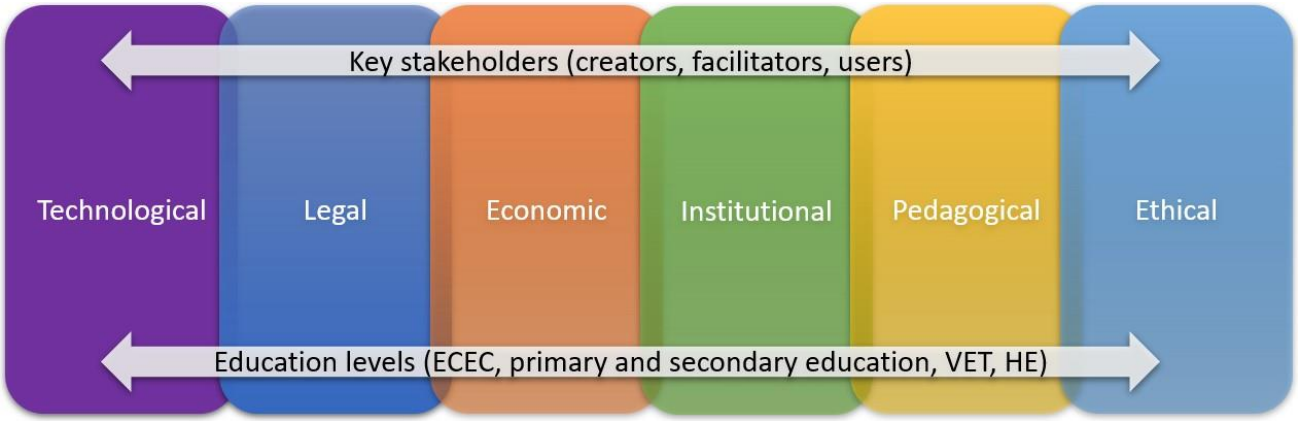
- **Task 1: Problem definition and baseline research (Jul to Oct 2022)**. This task involved an inception stage to scope the available data sources, and desk research including a literature review[38], web scraping[39] and review of databases, and analysis of consultation evidence undertaken by DG EAC in preparation for Action 3. The findings informed a first interim report and the strategy for Task 2.
- **Task 2: Market analysis and identification of trends (Nov 2022 to Mar 2023)**. This task comprised: desk research; key stakeholder interviews; a mapping of policy and practice arrangements across the EU 27[40]; selection of ten Member States for case studies; exploring the DEC lifecycle in further depth from supply and demand side perspectives[41]; and a survey of DEC providers[42]. The data facilitated comparative analyses and a market analysis, with the findings informing a second interim report.
- **Task 3: Development and testing of solutions (Apr to Jul 2023)**. The evidence gathered from tasks 1 and 2 was compiled, coded and analysed using a set of tools and frameworks, prior to the synthesis for the final report. A set of expert 'Task and Finish Groups' was conducted to refine the policy options[43], prior to the appraisal of the options with close consideration given to EU Added Value. These sets of analysis formed the basis of the draft final report, prepared by the study team with the external experts.
- **Task 4: Management of a Stakeholder Consultation Group (SCG) (Jan to Sep 2023)**. The purpose of the SCG was to provide a forum for the engagement and participation of professionals involved in the creation, facilitation and use of DEC in Europe, covering early childhood education and care (ECEC), primary and secondary education (including VET) and higher education. The SCG format was piloted in autumn 2022 with a restricted membership, prior to a public call to action in January 2023[44]. The group

[38] The review was conducted using a Rapid Evidence Assessment (REA) protocol. Systematic searches (and search criteria) were deployed, with the up to 50 most relevant and best quality items for each REA question, post screening stage.
[39] The web and database scraping was performed using the *Parsehub* web scraping tool. Initial data extraction was followed by manual thematic analysis of sources from selected public databases and websites. The findings were presented in a stand-alone technical report.
[40] A data collection template was populated with key information extracted from policy and research reports, public databases and stakeholder feedback in all 27 EU Member States. The work was conducted by validated researchers with native language expertise.
[41] Each case study comprised of a collaborative SWOT analysis, and online workshops with supply and demand-side stakeholders.
[42] The survey was conducted online using the EU Survey Tool, and publicised via the European Commission official social channels. In total, valid responses were received from 108 organisations, including a wide range of provider types.
[43] The groups included invited experts, and key stakeholders from the SCG. The six themes included: 1) Marketplace, 2) Quality; 3) Data governance and ethics; 4) Sustainable and inclusive procurement; 5) Teacher and learner agency, and 6) Technology-driven innovation.
[44] In total, 322 key stakeholders registered with the Stakeholder Consultation Group, of whom 272 were EU-based and 50 international.

supported two rounds of Delphi consultations[45], two sets of thematic workshops, and ad hoc inputs via a Teams channel.

The analysis of the evidence and feedback gathered through Tasks 1 to 4 was based on a 360 approach, which aimed to systematically identify and explore the technological, legal, economic, institutional, pedagogical, and ethical impact of DEC. The 360 analysis was carried out, to the extent possible based on available data and evidence, for each main stakeholder group (i.e. DEC creators, facilitators, and users), and main educational levels within the scope of the study (i.e. ECEC, primary and secondary education, VET, and HE).

Figure 2: Overview of the 360 approach to the analysis



Source: Ecorys, 2023.

1.3.1 Study data considerations

The study drew upon the best available data sources to inform the analyses and conclusions. Key challenges encountered and addressed included:

- **The dispersed nature and limited availability of data on DEC funding and expenditure**. The study encountered variable data collection and reporting by public authorities, and commercial restrictions on data regarding private business operations. This challenge was mitigated to some extent with an ad hoc survey of DEC providers. However, the study points towards a need for improved monitoring and reporting arrangements with regard to how funds are utilised for DEC and more consistent definitions.
- **The breadth and scope of the study parameters**. The coverage included ECEC, Primary and Secondary, VET and Higher Education; all types of technology markets intersecting with DEC, the full spectrum of content types, tools and services, and all 27 EU Member States, including legal, pedagogical, economic and technological, considerations. As with any study, careful balancing was required between scope and depth of inquiry within available resources. The study findings do not claim to be exhaustive, and have signposted to a need for future research and updating the evidence in view of the rapid evolution of educational technologies (Generative AI being foremost at the time of writing).

[45] The Delphi technique, a widely applied methodological tool in applied social research, involves a series of rounds of structured consultation. The approach is designed to examine stakeholder's perceptions of a policy issue, through an iterative process.

1.4 Report structure

The remainder of this report is structured as follows:

- **Chapter two** presents the definition of digital education content (DEC) and examines key stakeholders and their roles within the creation, facilitation and use of DEC in Europe. It goes on to consider how 'quality' is defined and measured and presents a set of criteria for the new Framework.
- **Chapter three** details the results from the market analysis. It starts by examining the feasibility of sizing the market(s) for DEC in Europe, and the supply and demand side characteristics. It goes on to assess market drivers and trends and to appraise enablers and obstacles to market development.
- **Chapter four** gives a comparative analysis of regulatory and governance arrangements across EU Member States and their advantages and drawbacks. It goes on to consider how DEC is funded and to examine procurement models and how responsibilities are organised.
- **Chapter five** considers how DEC has been integrated within relevant policies and curricula at Member State level, and its use in teaching, learning and assessment. It examines current and potential future pedagogical challenges and opportunities, including those presented by emerging technologies.
- **Chapter six** considers possible areas of EU intervention to address these shared challenges and maximise the opportunities presented by Europe's DEC Ecosystem. It starts with a problem analysis, addressing the main bottlenecks. It then considers the case for EU level action. Finally, it proposes a strategic approach to the development of the Framework, and scores and ranks the policy options.
- **Chapter seven** presents overall conclusions and reflections from the study.

The report also includes a Technical Appendix, with supporting information on the methods, data collected, and additional mapping information to complement the core chapters, and a stand-alone Executive Summary.

2.0 Definitions and quality criteria

This chapter aims to provide the building blocks to analyse the current Digital Education Content (DEC) landscape across Europe. In the following sections, we provide a shared understanding and definition of what is understood by DEC. Furthermore, we examine key stakeholder groups, as well as their roles and responsibilities across the DEC lifecycle. Lastly, we conclude the chapter with an analysis of what quality criteria should be considered in the creation, procurement and use of DEC.

More specifically, the sections below examine:

- **Defining Digital Education Content:** Section 2.1 develops a common definition for DEC, an informed by process that has included an extensive review of the relevant literature and by multiple consultations with key stakeholder groups over the course of the study.
- **DEC stakeholders:** Section 2.2 analyses the main stakeholder groups, their role and responsibilities, in the context of the three main stages of the DEC lifecycle – content creation and distribution; acquisition and assignment; use and evaluation.
- **Quality criteria:** Section 2.3 considers the notion of quality DEC, in terms of what constitutes quality DEC, and in particular what criteria should be considered in the creation, procurement and use of DEC. This section also reviews some existing practices across Member States.
- **Operationalising the criteria:** Section 2.4 propose an emerging set of quality criteria across relevant domains.

2.1 Defining Digital Education Content

2.1.1 Setting the Context

Digital education content (DEC) has been defined as follows in this study.

> *"Digital education content is data that is produced, structured, distributed and presented in a way that aims to meet an educational objective, made available in various formats and styles by digital tools.* [46]*"*

To arrive at this definition the study initially conducted an in-depth review of the literature, both academic and grey literature, in relation to the existing definitions and these descriptions of DEC were then deliberated with stakeholders over the course of the study. The deliberations and discussions provided multiple opportunities for all the stakeholders to check the completeness and appropriateness of the emerging definition, and to share comments and observations during the process. We will conclude this section by providing an explanation of the definition and how it can be applied to a range of educational contexts.

There is a myriad of terminology and buzzwords currently associated with digital education, with many of these terms often used inconsistently and interchangeably within the research literature. There are many umbrella or suitcase terms[47] in use in relation to digital education (such as digital education, blended learning, technology-enhanced learning) and these often need to be unpacked and explained through the use of examples. This is also true for DEC, and a review of the literature found that terms such as digital education content, digital learning materials, digital learning resources, digital teaching aids and digital learning objects, are often employed interchangeably. There are even examples of digital education research studies using the term digital

[46] Dedicated to teaching, learn and assess, or adapted or used by the teacher / student or trainer into a learning scenario, it means software, programs, applications, platforms, and (online or offline) resources that can be used with computers, mobile phones or other electronic devices, e.g. a website, app, Learning Management System, or Virtual Reality world.

[47] 'Minsky observed that a suitcase word "means nothing by itself, but holds a bunch of things inside that you have to unpack."' (Slocum, n.d.)

content[48], when discussing the use of DEC. Thus, there are a range of terms in use and they are often used interchangeably in the literature, with no or only minor differences detected in how they are defined. While there do not appear to be any deep contradictions or tensions across definitions of digital education content and related terms in the literature, there does appear to be a lack of specificity and uncertainty of scope present in many of the existing definitions, with little or no attempts to frame clear ''in/out'' criteria, as captured in the Box below.

Box 3. Existing definitions

Definitions of digital education content:

- Digital education content refers to resources in a digital format mobilised with the aim of supporting studying, learning and instruction. It comprises a wide variety of i) *materials*, such as e-books; ii) *activities or teaching methods*, such as serious games and digital storytelling; and iii) *tools, software, and programmes*.[49]
- Digital education content refers to ''digital technologies in the context of a pedagogical activity'' and encompasses a wide range of resources, tools, environments and computer practices that we use to support teaching and learning, including communication and collaboration, expression, creation, etc..[50]
- Digital education content encompasses all digitally supported educational materials, and thus has broad application across everything from snippets of video to full-year textbooks in a digital format along with all the video, audio, text, animation, simulations, and assessments in between. Digital content can consist of smaller "chunks," such as individual chapters or lessons, allowing for flexibility in creation, purchasing, distribution, and usage. It blurs the traditional division between "adopted" or "core" content and supplemental content.[51]
- Digital education content is a single learning object or lesson *created* in a digital format.[52]
- Digital education content constitutes the intellectual property and knowledge to be imparted through a digital medium. Different formats include text, audio, video, animation, and simulation content.[53]

Terms used interchangeably in the literature:

- Digital learning/educational/instructional material:
  - Digital learning materials can be defined as the digitised materials that support teachers' and students' education activities in order to achieve a learning objective.[54]

[48] https://unesdoc.unesco.org/ark:/48223/pf0000385723

[49] See M.Pinto & C. Leite (2020). Digital technologies in support of students learning in Higher Education. Digital Education Review - Number 37, June 2020; Selwyn, N., Henderson, M., Finger, G., Larkin, K., Smart, V., and Chao, S. (2016). What works and Why? Understanding successful technology enabled learning within institutional contexts Part B Appendices. Canberra, ACT: Australian Government Office for Learning and Teaching.;

[50] See Porubčinová, M (2019). The use of digital teaching aids in primary education with emphasis on students from socially disadvantaged backgrounds. https://www.casopispedagogika.sk/rocnik-10/cislo-4/studia-porubcinova.pdf ; KALAŠ, I. a kol. 2013. Premeny školy v digitálnom veku. Bratislava: Slovenské pedagogické nakladateľstvo – Mladé letá. 256 s. ISBN 9788010024094.

[51] Fletcher, G., Schaffhauser, D, & Levin, D. (2012). Out of Print: Reimagining the K-12 Textbook in a Digital Age. Washington, DC: State Educational Technology Directors Association (SETDA).

[52] Center for Digital Education, Consortium for School Networking & the International Society for Technology in Education, 2016.

[53] Kaplan-Leiserson, E. (2021). E-learning Glossary. The Polish Virtual University (PUW). https://www.puw.pl/sites/default/files/content_files/zasob_do_pobrania/355/elearn-gloss-learncircuits.pdf

[54] Sariyatun., Suryani, N., Sutimin, L. A., Abidin, N. F., & Akmal, A. (2021). The Effect of Digital Learning Material on Students' Social Skills in Social Studies Learning. International Journal of Instruction, 14(3), 417-432. https://doi.org/10.29333/iji.2021.14324a; Antoun, J., Nasr, R., & Zgheib, N. K. (2015). Use of technology in the readiness assurance process of Team Based Learning: paper, Automated Response System, or Computer Based Testing. Computers in Human Behavior, 46(6), 38-44. https://doi.org/10.1016/j.chb.2015.01.003;

- Digital instructional material includes all digitally supported learning materials from snippets of video to full-year textbooks in a digital format along with all the video, audio, text, animation, simulations, and assessments in-between.[55]
- Digital learning materials are study materials published in digital format. These encompass different formats from e-textbooks and e-workbooks to educational videos and e-tests.[56]

- Digital learning/teaching resources:
  - Digital learning resources are instructional materials in digital format created to assist students and teachers in the teaching and learning process. Often these materials reside in an electronic repository or digital library for access by educators.[57]
  - Digital learning resources include any digital resource that is actually used by teachers and learners for the purpose of learning.[58]
  - Digital learning/teaching objects (DLOs/DTOs):
  - A digital learning/teaching object is a digital resource used with an educational purpose in mind. Students might use DLOs in class, face-to-face, online or in blended learning. Digital resources can include a camera, photographs online, a text, slideshows, podcasts, videos of lectures, TED talks, games or simulations.
- Digital teaching aids (DTAs)
  - Digital teaching aids are online tools that can be used in educational work, and which have been *developed with the intention* of supporting learning activities.[59]

Source: Ecorys, 2023.

All the definitions presented in Box 3 for DEC see it as including **''all digitally supported materials employed with an educational purpose in mind''.** The definitions largely incorporate everything from **e-materials** (video clips, e-books) to sophisticated **software, programmes and tools facilitating interactive and immersive learning activities or teaching methods** such as educational games, simulations and digital storytelling. While the types of materials and approaches included within these definitions remain highly open-ended (so long as they assume a digital format), **the consideration of the ''intention'' of the user of such content (i.e. to support studying, learning, and/or instruction) constitutes a decisive element across all highlighted terms**.

This is an important consideration, when differentiating DEC from regular Digital Content (DC), which has been defined at EU level as follows: "digital content' means data which are produced and supplied in digital form"[60]. Thus DEC has a purpose and it is typically designed to support studying, learning, and/or instruction/assessment practices.

Dlouhá, J., & Pospíšilová, M. (2018). Education for sustainable development goals in public debate: the importance of participatory research in reflecting and supporting the consultation process in developing a vision for czech education. Journal of Cleaner Production, 172(1), 4314-4327. https://doi.org/10.1016/j.jclepro.2017.06.145

[55] Fletcher, G., Schaffhauser, D, & Levin, D. (2012). Out of Print: Reimagining the K-12 Textbook in a Digital Age. Washington, DC: State Educational Technology Directors Association (SETDA).

[56] Education and Youth Authority Estonia

[57] SETDA (2019). Digital Instructional Materials Acquisition Policies for States. https://dmaps.setda.org/glossary/

[58] OECD (2009). Beyond Textbooks: Digital Learning Resources as Systemic Innovation in the Nordic Countries, Educational Research and Innovation, OECD Publishing, Paris, https://doi.org/10.1787/9789264067813-en.

[59] Porubčinová, M (2019). The use of digital teaching aids in primary education with emphasis on students from socially disadvantaged backgrounds. https://www.casopispedagogika.sk/rocnik-10/cislo-4/studia-porubcinova.pdf;

[60] https://eur-lex.europa.eu/legal-content/en/ALL/?uri=CELEX%3A32019L0770

The definitions of DEC presented in Box 3, particularly those terms that can be used interchangeably with DEC, capture this key idea of purpose and specifically supporting the learning process. Furthermore, they note that the term has a "broad application across everything from snippets of video to full-year textbooks in a digital format along with all the video, audio, text, animation, simulations, and assessments in between".[61] The definition used by Fletcher et al. (2012)[62], presented above in Box 3 above, introduces the notion of DEC consisting of "chunks" and states that DEC "can consist of smaller "chunks," such as individual chapters or lessons, allowing for flexibility in creation, purchasing, distribution, and usage". This is a key concept as it introduces the idea that DEC can be of any size and it also introduces the idea of "core" and "auxiliary" DEC.

Many of the definitions listed in Box 3 contain this idea that DEC consists of smaller units (which Fletcher et al. describe as chunks) and these are assembled with a purpose in mind. This notion of chunks is important as it can assist producers to make their content more available (i.e. through the use of metadata) and it can also allow producers and users to swap different chunks, depending on the context. This has a myriad of implications for how producers use and reuse DEC.

When considering this idea of chunking, we could consider an e-textbook as being core DEC, as it provides a structured programme or curriculum for teachers and students to follow, and it was designed for the purpose of supporting learning. In contrast, a video on the geography of France which was created for tourism purposes (i.e. by the Tourist Board of France), that is used by a teacher in a class presentation could be classed as auxiliary DEC. Furthermore, an e-textbook consists of "chunks" of DEC, in the form of chapters, and these chapters in turn consist of a mix of video, audio, text, animation, simulations, and assessments. Thus, digital education content can be understood to encompass everything from small "chunks" of learning, such as an online learning game, to an entire online learning course.

While some of the definitions in Box 3 reference tools, the majority reference DEC that is developed for the purpose of supporting learning. Tools, can be considered in two ways. First, there are digital content free tools, such as word processors, presentation software, learning managements systems and/or generative AI tools[63]. These tools provide the user with a blank canvas which they can then use to create content for educational purposes. When used in this way these tools can be classified as DEC, because they are used to meet an educational objective, that of creating user generated content.

Second, digital tools can also include technologies, such as computers, mobile phones or other electronic devices, e.g. websites, apps, or online virtual worlds. These tools, in an of themselves cannot be classified as DEC, but when they are used to host or mediate content that is designed for an educational purpose, they then become DEC. For example, if a publisher or a user creates a website for an educational purpose (i.e. to share videos on how to solve mathematics problems), then the website can be classified as DEC.

2.1.2 Types of digital education content

Thus **digital education content is an umbrella term, that covers a wide range of digital content that is designed to support teaching, learning and assessment activities.** Often this content is designed and developed for a particular purpose and it is possible to classify different types of digital education content in this way. For example, you can further classify DEC using the following criteria, and we provide a short description of each below:

[61] Fletcher, G., Schaffhauser, D, & Levin, D. (2012). Out of Print: Reimagining the K-12 Textbook in a Digital Age. Washington, DC: State Educational Technology Directors Association (SETDA).
[62].Fletcher, G., Schaffhauser, D, & Levin, D. (2012). Out of Print: Reimagining the K-12 Textbook in a Digital Age. Washington, DC: State Educational Technology Directors Association (SETDA).
[63] https://buffer.com/resources/content-creator-tools/

- Types of digital tools;
- Pedagogical purpose;
- Level of accessibility/adaptability; and
- Level of proximity to formal curricula.

Criterion I: Types of digital tools

Historically there have been a number of classification models for digital education content tools[64][65] and many of these share common classification criteria. One particular model,[66] classifies digital education according to 11 primary types of software[67]. These include; 1) **Authoring Systems** to support teachers to develop their own instructional software; 2) **Graphic Software** (which captures, creates, and changes images that are available on the web, e.g. for the purpose of presentations); 3) **Reference Software** which provides access to resources such as thesauruses, encyclopaedias, atlases, and/or dictionaries; 4) **Desktop Publishing**; 5) **Tutorial Software**; 6) **Educational Games**; 7) **Simulations**; 8) **Drill and Practice Software**; 9) **Math Problem Solving Software**; 10) **Utility Software**, and; 11) **Special Needs Software**.

In considering this classification system against our new DEC definition the following types of software would be included, as they are assembled from chunks of content that are designed for a specific educational objective: Reference Software, Tutorial Software, Education Games, Simulations, Drill and Practice Software, Math Problem Solving Software and Specials Needs Software. The other types of software in this classification, namely: Authoring Systems, Graphic Software, Desktop Publishing and Utility Software could be classed as digital content free tools and in and of themselves are not DEC. However, when they are used to create user-generated DEC they do fit with our definition of DEC.

Criterion II: Pedagogical purpose

Others,[68] have classified DEC by pedagogical purpose. For example, a proposed classification based on methodological purpose of the tools is: 1) **learning**, the purpose of which is to provide knowledge and develop skills through educational and (or) practical activities; 2) **simulations to practice skills**, including educational activities and self-training; 3) **monitoring** and control activities associated with assessment; 4) **content** for information and retrieval purposes; 5) **imitation**, representing a certain aspect of reality to study its main characteristics; 6) **modelling** tools; 7) **demonstrative** tools; 8) **educational** games; and 9) **content** for recreational use.[69]

Criterion III: Accessibility and adaptation

Frameworks that structure digital education content according to accessibility and adaptability have also been identified, for instance separating **open educational resources** from **semi-open resources.** The latter is understood as open teaching, learning and research resources available to a limited group of persons[70], while the former makes these resources available to all. Distinctions can also be made between ***commercial* digital education resources**, which include resources for teaching, learning and research and are only available under

[64] Dimitracopoulou, A., (2001), Learning environments and Usability: Appropriateness and complementarity of evaluation methods. Available at: https://www.researchgate.net/publication/228950241_Learning_environments_and_Usability_Appropriateness_and_complementarity_of_evaluation_methods

[65] Jiayang Wang, Meng Han, Wanwan Wang (2019). Research on the Evolution and Classification of Digital Learning Resources. https://www.atlantis-press.com/proceedings/iceeim-19/125938437

[66] Nagata, S., (2017), What You Need to Know About Educational Software. ELearning Industry. Available at: https://elearningindustry.com/need-know-educational-software National Study of English Learners and Digital Learning Resources, Developer Toolkit: Creating Educational Technology for English Learners (2018), Washington, D.C

[67] Nagata, S., (2017), What You Need to Know About Educational Software. Available at: https://elearningindustry.com/need-know-educational-software National Study of English Learners and Digital Learning Resources, Developer Toolkit: Creating Educational Technology for English Learners (2018), Washington, D.C.

[68] See I. Robert, Modern information technologies in education: didactics problems, prospects of their using. Moscow: RAO, 2010, p. 169

[69] Ibid.

[70] National Study of English Learners and Digital Learning Resources, Developer Toolkit: Creating Educational Technology for English Learners, Washington, D.C., 2018, p. 22.

financial restrictions (i.e. availability to the general public against a fee and/or subscription) and **resources with *non-financial* restrictions (i.e. walled gardens only open to specific groups)**[71].

According to literature, a framework classifying digital education content across these dimensions can be depicted as in the Box below.

Box 4. Accessibility framework for categorising digital learning materials

Accessibility

- No restrictions (open access), for everyone.
- Non-financial restrictions, for everyone.
- Non-financial restrictions, not for everyone (walled garden).
- Financial restrictions.

Adaptation rights

- Adaptable (users have permission to adapt).
- Non-adaptable (users have no permission to adapt).

Source: Ecorys, adapted from Janssen, B., Schuwer, R (2021). A framework for categorizing digital learning materials.

Criterion IV: Proximity to formal curricula

The Swedish National Agency for Education has developed a framework which distinguishes between **digital content, digital teaching aids and digital tools**[72]. *Digital tools* include everything from digital hardware (e.g. computers, tablets) to online learning platforms and software. *Digital content* is understood as digital material that is not necessarily related to the school's curriculum, courses or subject plans, but which *becomes a* digital learning resource *when employed in the context of teaching*. An example is an entertainment game re-purposed for educational use. *Digital teaching aids* are seen as resources that are *specifically designed for teaching* and that, like a textbook, cover a larger area of knowledge or an entire subject.

Box 5. Digital education content genres

Genres identified:

- **Drill programmes**: various forms of self-correcting programs that can be used for the purpose of rehearsing and consolidating knowledge.
- **Digital learning games**: digital environments where the student takes part in an area of knowledge by, for example, solving various challenges and collecting points.
- **Interactive books**: learning resources where text is combined with multimodal and interactive functions.
- **Simulation programs**: programs that can be used to visualize a process or to build a model, for example.
- **Creative open-source software**: software where the user creates the content.
- **Digital media**: web-based products such as podcasts, film, apps, newspaper journalism and social media.

Source: Ecorys, 2023.

Thus, **DEC can take many forms, depending on the purpose for which it is designed and/or produced**. In developing a definition for DEC, the study distilled the existing definitions found during the literature review

[71] Ibid.
[72] Skolverket (2021). How to select and evaluate digital learning resources. https://www.skolverket.se/skolutveckling/inspiration-och-stod-i-arbetet/stod-i-arbetet/sa-valjer-och-varderar-du-digitala-larresurser#h-Digitalalarresurserettbrettsamlingsbegrepp

phase and presented these as a set of emerging principles to consulted stakeholders. The consultations revealed widespread agreement on these principles and they underpinned the study definition of DEC.

When considering DEC a number of **principles** apply:

- Digital education content is distinct from but related to and intertwined with; a**)** **the environment(s) within which it is used,** and b) **the pedagogical contexts, techniques and learning scenarios** within which the content is or becomes used for educational purposes.
- Digital education content is **defined by its purpose (educational use).** This encompasses both content *created* with the intention of supporting educational activities ("core digital education content'') and pre-existing content, *repurposed, re-animated or re-applied* to support educational models ("auxiliary digital education content''). For example, a chapter from a digital history textbook (e-textbook) discussing Roman gladiators can be considered core DEC while a video clip from Ben Hur or Gladiator that is used by the teacher or the learner in a presentation would be classed as auxiliary DEC.
- **In formal education (i.e. in school settings)**, which is the focus of this study, digital content can be used in a way to support the teaching of various curricula, learning pathways and other educational goals. This may include, but is not limited to:
    - Teaching, learning, and assessment.
    - Learner wellbeing and psychosocial development.
    - Parental engagement in children's learning.
    - It may include teacher education, and teacher peer education resources and information made available by digital media.
    - It may also include transversal competences such as critical thinking, digital skills, learning wellbeing and psychosocial development.
- Formal digital education content may originate from or be reused in non-formal education contexts (e.g., lifelong learning, or for training/information provision).

Therefore, **DEC is a subset of Digital Content and it has a very specific purpose**. Digital content is created from '*chunks'* of digital data (i.e. text, images, video, audio etc.) and they can be combined or '*chunked'* together to create digital content (i.e. webpages, digital texts, digital movies etc.). These chunks are the smallest meaningful units of content (i.e. an educational video, an OER, a chapter etc.) that can be combined to create larger units of content. These chunks typically chunked together (combined) to achieve the following objectives:

- To facilitate the learning process (for example by making it easier for students to recall some factful material;
- To enable the widest possible number of learners to interact successfully with the content by ensuring it is designed using inclusive design approaches (i.e. adhering to universal design principles (UDL));
- To ensure that it can be easily retrieved and adapted, where needed, by utilising the appropriated semantic and metadata tagging; and
- To enable producers to assemble content in formats and structures that meet the needs of specific educational contexts and markets.

Thus, as outlined earlier, **the definition of DEC evolved over the course of the study, informed by the literature review and multiple rounds of stakeholder consultation** and currently reads as follows:

> *Digital education content is data that is produced, structured, distributed and presented in a way that aims to meet an educational objective, made available in various formats and styles by digital tools."*[73]

The definition clearly states that DEC is developed and designed for a particular purpose, that of meeting an educational objective, and that it can take many formats depending on the purpose for which it is developed or used. DEC is always used in tandem with digital tools, and these are explained in the footnote below, and these tools typically require DEC in order to be used purposefully in many educational contexts. Furthermore, DEC is a subset of Digital Content, which is the umbrella term for all types of digital material.

Those that create DEC, such as publishers or teachers, typically make pedagogical decisions when designing the content. For example they might design DEC with particular pedagogical approaches in mind, such as drill and practice or exploratory approaches, or they may make decisions around how to pace the content and the order in which learners may interact with it. Thus, DEC is purposefully designed and created to support learning in a myriad of contexts, and it continues to evolve, as new technologies (for example Generative AI), to meet the needs of the education and training sector.

2.2 DEC stakeholders

The DEC ecosystem is characterised by a constellation of different stakeholders that play a key role at different stages of the DEC lifecycle, at different levels of governance, and within both the public and private sector.

This section provides a brief overview of who these stakeholders are, as well as their roles and responsibilities. A more detailed DEC stakeholder matrix and taxonomy can be found in Annex 3.

Stakeholders across the demand and supply side: overlapping and interchangeable roles

While a general distinction can be made between actors on the supply and demand sides, in practice, **roles across the DEC life cycle are often fluid and overlapping**, due to the myriad of education governance arrangements that exist within the EU Single Market and international supply chains. More specifically:

- On the **supply side**, multiple actors are involved in the production of DEC (DEC providers), as well as in its distribution and end use (infrastructure and service providers who can support end-users to become content providers themselves). However, the same actors can act both as publishers and infrastructure providers, depending on the specificities of the market they operate in.

- On the **demand side**, education institutions and other end users, as well as their representative structures (e.g. associations and networks) represent the main actors benefitting from DEC. End users can utilise DEC as it is or modify it to adapt it to their own context and needs, furthermore, they can generate their own digital resources, becoming content creators themselves.

- **Institutions at all levels of government play multiple roles across the demand-supply chain**, by buying DEC , tendering (particularly in the case of emerging technologies), or encouraging educators to produce content (particularly in the case of Open Educational Resources – OER); providing the necessary infrastructure for its fruition (supply), and determining the market structure and governance models through regulation. Furthermore, other stakeholders such as private and public investors) also play a role across the DEC life cycle by contributing to the production, distribution and use of high-quality DEC.

[73] Dedicated to teach, learn and assess, or adapted or used by the teacher / student or trainer into a learning scenario, it means software, programs, applications, platforms, and (online or offline) resources that can be used with computers, mobile phones or other electronic devices, e.g. a website, app, Learning Management System, or Virtual Reality world.

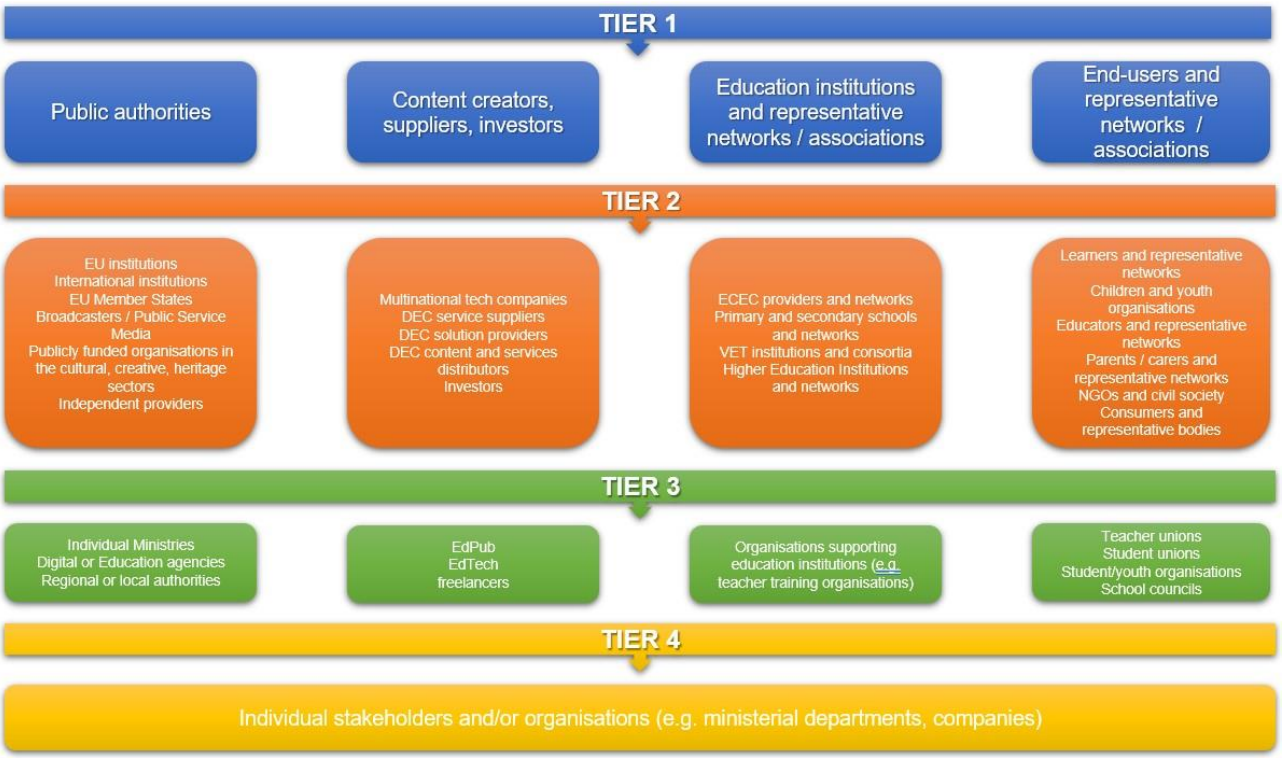
For the purpose of bringing more clarity to this complex landscape, our study proposes **a taxonomy as a means of classifying key stakeholders at different levels within the DEC ecosystem,** based on desk research and consultations. The taxonomy is articulated around **four tiers or levels progressively disaggregating categories and groups**, to provide a more granular understanding of the stakeholders that play an active role in the development and use of DEC, from policy making to the market. The four tiers are:

- **Tier 1** groups stakeholders according to **broad categories**: public authorities; content creators, suppliers, and investors; education institutions and their representative associations and networks; and end-users and their representative associations and networks.
    - **Public authorities:** They provide the governance and policy frameworks for education, skills and digitalisation at national, sub-national and transnational levels. Arrangements regarding the sub-division of responsibilities for budgets, policy and procurement vary across Member States, (see Chapters 3 and 4). Public authorities play a central role both on the supply and demand side by serving as providers of digital education, developing DEC at national, sub-national and transnational level, and providing the necessary infrastructure for its dissemination and fruition.
    - **Content creators, suppliers and investors:** A broad distinction can be made between EdPub (i.e. Educational Publishing) and EdTech (i.e. Educational Technology), while noting that the diversification of both sectors has created greater overlap and fusion of roles and expertise between these organisation types (e.g. EdTech Publishers, and partnerships or consortia with multi-provider input). These organisations may or may not also offer platforms, tools, consultancy as part of their offer, or subcontract these services to DEC providers. There is also scope for specialist and intermediary roles within this category.
    - **Education institutions:** This category includes education institutions across all stages and levels of education and the associated curricula: Early childhood education and care (ECEC), primary and secondary education, VET and higher education.
    - **End-users:** This broad category encompasses both educators and learners, as well as other education professionals (e.g. school leaders and their networks; as well as parents and carers and their representative organisations for younger students). End-users play a role in sourcing, appraising, selecting (and/or purchasing), adapting, applying and evaluating DEC within their everyday practice.
- **Tier 2** identifies **relevant groups within Tier 1-categories.** For example, public authorities are disaggregated by vertical (i.e. International, EU, national, regional, local) or horizonal (e.g. public service media; public organisations in the creative, cultural, and heritage sector) levels of governance; Content creators, suppliers, and investors, are split across areas of operation (e.g. DEC solution providers; distributors; service suppliers); education institutions are disaggregated by segment (e.g. ECEC; primary and secondary education; VET; Higher education); and end-users are disaggregated across types (e.g. learners; educators; parents and carers; as well as organisations representing their interests).
- **Tier 3** further **disaggregates Tier 2-groups by identifying sub-groups within these**. For example, public authorities at national level are disaggregated by type and areas of competence (e.g. Ministry of Education, Digital agencies; Managing Authorities for EU funds); DEC content providers are divided by type (e.g. EdPub; EdTech; freelancers); education institutions within each education type are further disaggregated to include agencies supporting their work (e.g. teacher training agencies). End-users and their representative organisations are also further split, for example to include individual learners/educators, student and youth organisations, school councils, teacher unions etc.
- **Tier 4** provides **further granularity** to the classification by **identifying individual stakeholders and/or organisations within Tier 3-sub-groups.** For example, for Ministries of Education, this means identifying specific departments responsible for digital education and/or content. For DEC content providers, Tier 4 disaggregates companies by size and includes concrete examples of market actors.

For organisations representing educators or learners, Tier 4 considers informal and formal groups (e.g. Facebook groups) where individual users might exchange ideas and experiences.

Figure 3 below provides an example of how stakeholders can be split across Tiers.

Figure 3: Example of stakeholders split across Tiers



Source: Ecorys, 2023

Overlapping roles across the supply-demand chain require further grouping according to functions within the DEC lifecycle

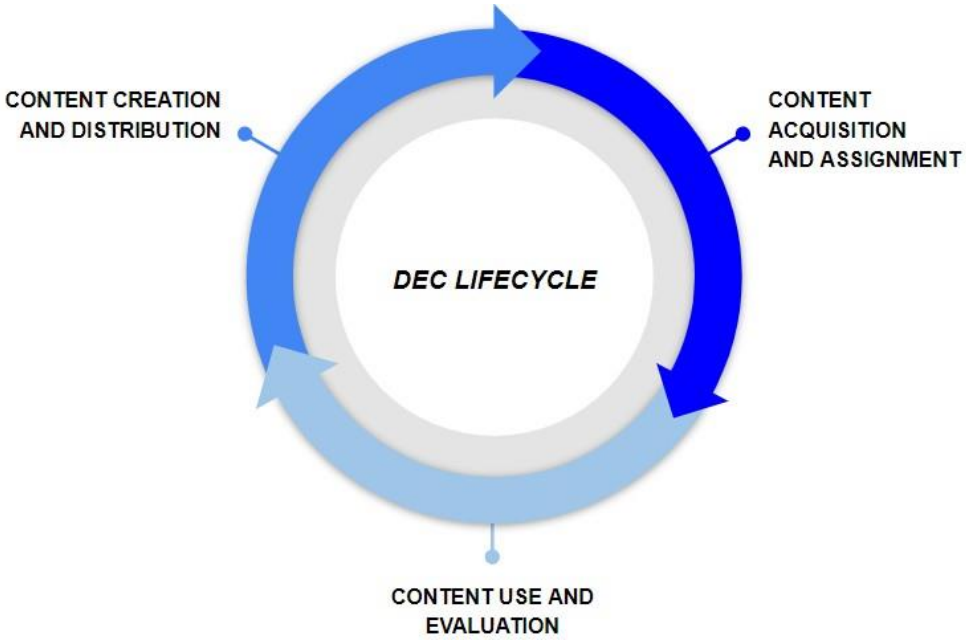
The above taxonomy is helpful to understand the multiplicity of levels and stakeholder categories that operate in the DEC ecosystem. However, **the taxonomy alone does not address the complex interlocking roles, relationships and networks between supply and demand**, or reflect how responsibilities are distributed in at EU, national and sub-national levels. This is why they need to be situated within the analysis of the DEC life cycle.

The DEC lifecycle is characterised by a multitude of sub-levels and variants, and involves various configurations of stakeholders. Our study identifies **three main stages**, which are used throughout the report to simplify the analysis. These are:

- Conent creation and distribution;
- Content acquisition and assignment; and
- Content use and evaluation

These three stages are understood as a circular process, in which the creation, acquisition and use of DEC lead to the iterative improvement and evolution of content, based on lessons learned throughout the lifecycle. They also make it possible to group together quality criteria, bottlenecks and solutions corresponding to each of the stages throughout the report.

Figure 4: Three main stages of the DEC lifecycle



Source: Ecorys, 2023

Each of the three main stages can be further disaggregated in sub-stages. This is further explained in Annex 3, where a **DEC stakeholder matrix** is provided, **mapping out key stakeholder roles by category, and corresponding top-tier tasks and areas of responsibility within each stage of the DEC lifecycle.** While the DEC stakeholder matrix in Annex 3 includes more details, the sub-sections below provide a brief overview of the main roles and responsibilities.

Stage 1 - Content creation and distribution

For what concerns this first stage, **public authorities** in charge of digital education play an important role in guiding the production and distribution of DEC, including by setting up supporting frameworks and enabling environments that promote meaningful design (e.g. by fostering closer cooperation between content developers and end users at international, national or regional scales), and making available public funding for the creation of testbeds or sandboxes to test and develop best approaches.

Furthermore, public institutions such as public broadcasting /media services, as well as cultural, heritage institutions (e.g. museums) that often produce their own digital material that can be used for educational purposes. Moreover, public authorities, through policy and investment in infrastructure, skills, and continuous professional development, can support educators and learners to become content-creators themselves.

However, content creation and distribution see a major role being played by **private sector actors**. Here, multinational DEC companies, as well as EdTech, EdPub and other DEC solution providers are accountable for the production and licensing of digital education content both for formal (i.e. education) and informal use (e.g. after school and home learning market). Alongside the production of DEC, these stakeholders also make available tools and services on the market with or without DEC, that can support the use and maintenance of digital content.

At this stage, content creators and suppliers may subcontract the development of single units of content (e.g. modules, chapters, complimentary materials), or specific digital assets (e.g. media, audio, video). Furthermore, at this stage broader partnerships and consortia can be set up, including through the support of private investments from third parties (e.g. Venture Capitalists, Angel investments; crowdfunding), which remain crucial for the production of DEC more broadly.

End users (educators, learners, parents and carers) often are consulted for the production of DEC (both for formal and informal use), by cooperating with the private sector or public institutions to ensure that DEC products

and services match their teaching, learning and assessment needs, as well as curricular objectives. Their involvement is also crucial in instances where public authorities take the lead in the provision of DEC through public platforms and repositories. Lastly, as outlined above, at this stage the role of users can be reversed, with educators and learners becoming content creators and distributors of user-generated content via dedicated platforms and/or informal channels.

Stage 2 - Content acquisition and assignment

For what concerns this second stage, the role of **public authorities**, particularly those at the national / regional / municipal level is mainly twofold. First, they are responsible and accountable for managing public budgets that can be invested for the development and use of digital education content. Beyond general education budgets, ring-fenced budgets for DEC (where these exist), and resources available through EU funding programmes, subsidies (e.g. for the acquisition of DEC by disadvantaged students and families; to support innovation – in particular those from smaller market players such as start-ups and SMEs) can also play an important role, ensuring fair and equitable access to digital education content.

Second, while the involvement of public authorities at different levels of governance, as well procurement models, vary (see Chapter 3), they consistently and directly influence acquisition of DEC through frameworks and criteria used for public procurement. In this stage, public authorities may be also responsible for establishing public-private partnerships, which bring together a wide range of stakeholders across the supply and demand side, for the implementation of joint solutions and often fostering innovation (see Chapter 4).

In terms of the role of **content creators, suppliers and investors in this second stage**, this is where DEC providers, from multinational companies to EdTech, EdPub and other organisations participate in public procurement and acquire specialised services (e.g. authoring, media editing and editorial services; sensory reading; translation services). This is the stage where DEC providers may change their role depending on the specific market(s) they operate in, with companies often producing content in one context, and providing auxiliary services in another.

Lastly, **education institutions** play a crucial role in this stage. Depending on the level of institutional autonomy afforded to schools at the national level, individual institutions can often be relatively independent in their spending decisions (see Chapter 4), and launch their own procurement processes for the acquisition of learning resources, including digital education content. This can happen through different modalities, depending on the role foreseen for public authorities at national / regional / municipal level in defining and managing school budgets, and the education level (e.g. Higher Education institutions are often more autonomous in their budgetary decisions – see Chapter 4).

Educators are the main decision makers within their institutions when it comes to selecting content, even though it is their institutions and school leaders that formally initiate the purchase. **Learners and parents** can be included in the loop of communication in relation to the acquisition of DEC, with different levels of involvement, depending on the national context (e.g. countries were learning resources, including digital, are provided for free by the State versus countries where educational materials are purchased by students and their families). Furthermore, depending on the national context where providers sell their products directly to users, educators, learners and parents are directly involved in the acquisition process.

Stage 3 - Content use and evaluation

For what concerns this third stage, **public authorities are** primarily involved in providing support to education and learners, as well as education institutions (e.g. through skills development and guidance), to ensure they can safely use content and include DEC in their teaching, learning and assessment practices. Furthermore, public authorities (e.g. Ministries of Education, digital agencies, education inspectorates) are responsible and accountable for creating quality assurance systems for digital education content (e.g. user experience, compliance with national curricula and legal standards).

In terms of the role of **education institutions and educators**, they take the lead in the allocation (after selection and acquisition) of digital education content and its use in classrooms across all levels of education. Furthermore, not only do educators integrate DEC in their teaching plans, determining its actual pedagogical

use and impact on learners, but they often also cooperate in formal or informal professional learning communities, and exchange on practices and lessons learned. As such they also influence the quality of DEC, which, far from being an intrinsic feature of content, is heavily impacted by its pedagogical use.

Lastly, in this third stage, **content creators, suppliers and investors** can play a role by contributing their expertise in advising on the use of content. They generally exploit data on the use of DECs (i.e. learning analytics) and the impact of success in order to further adapt their products and services, improve their offering and guarantee a better return on investment.

Throughout the three stages of the DEC lifecycle, favourable conditions for the development of meaningful content, including clear regulatory frameworks to support the development and use of DEC are needed. This sees a primary role of public authorities, both at the EU and national and sub-national levels, as regulation falls under their direct competence. In this role, they support or establish policies to promote the digital transformation (of education), guided by national curricula outlining objectives and priorities; draft and implement regulation around copyright, privacy and ethics, informed procurement to ensure the production and use of safe and high-quality; and make investment and budgetary decisions, influencing public spending on (digital) education and content.[74]

Content creators, suppliers and investors, as well as education institutions and users provide their contribution primarily in a consultative role, where participatory structures and processes allow for dialogue and exchanges between public authorities and key stakeholder groups. In this context, networks and associations representing users (i.e. educators, learners, parents and carers) as much as content creators and suppliers can take an active role in advocating and lobbying for the interests of their respective constituencies on the supply and demand side. However, content creators and suppliers, as well as education institutions and users remain responsible for complying with policy and regulatory standards (e.g. on copyright, data privacy, accessibility standards) in the development and use of DEC.

To facilitate the identification of quality criteria for DEC, the next sections build on the stakeholder classification and the stages of the DEC lifecycles outlined above, and outline quality standards relevant for key actors involved in the creation/distribution, facilitation, and use/evaluation of digital education content:

- **Creators** (i.e. these can range from an educator, to a commercial organisation);
- **Facilitators** (i.e. those that procure, order and arrange for the creation of DEC, they are in between the creators and the users);
- **Users** (i.e. those that use the content (educators, families, commercial organisations etc.) to achieve an educational outcome).

2.3 Quality criteria

2.3.1 Rationale for quality criteria

There has long been **a practice of 'evaluating' print materials for education and training purposes and these practices have been applied to DEC**, i.e. of educational software and online materials, for almost 25 years now[75]. There has also been a tradition in some Member States for central or regional governments to 'evaluate' textbooks and other educational material and these practices have been adapted for DEC as well (i.e. in Lithuania[76] and Poland[77]). The purpose of such evaluations is to identify "high-quality" resources that can be used in education and training settings, based on a set of objective criteria.

[74] For an overview of key EU policy instruments relevant for DEC, see Annex 2.
[75] Teachers get Teem spirit, https://www.theguardian.com/education/1999/nov/16/itforschools.news
[76] https://www.e-tar.lt/portal/lt/legalAct/cb34f0b0dbe911ec8d9390588bf2de65
39 Law 2022-10863 of 25 may Regarding the Minister of Education, Science and S
[77] https://www.prawo.pl/akty/dz-u-2019-2013,18903493.html

The literature on such approaches notes that **while objective criteria are important in making such judgements, it is as important to make a context-specific assessments of the impact the content has in supporting learners to achieve a set of specific learning aims/intended learning outcomes**. Thus, the role of the educator is an important component, and they need to possess the necessary digital and pedagogical competences to make such informed judgements. Teachers need to receive the necessary training and guidance to help them make such decisions, so they can move beyond the intrinsic properties of a particular piece of DEC and consider its impact in the wider context[78].

It came to light during COVID-19 that many teachers, at all levels, were struggling to select and use "high-quality" DEC and that teachers need support in this area.[79] Furthermore, the literature review conducted for this study identified a number of caveats, which are worth bearing in mind in relation to quality. These include:

- The *task of assuring quality* on the technical side (*quality assurance*) is distinct from measuring effectiveness and learning outcomes on the pedagogical side (*efficacy*). In other words; safe and reliable content may still be a poor choice in a given pedagogical context.;
- The *notion of quality is complex*, including both the content and how and by whom it is deployed;
- *What is high quality in one context is not necessarily high quality in another*. What matters is what the teacher and learner are doing with the content, the learning environments and scenarios that are deployed;
- *Quality frameworks should be efficacious without being too complex to apply for end-users*;
- There are *established EU and national regulations and laws, and multiple agencies accrediting DEC across Member States*. These efforts should be acknowledged and taken into consideration and where standards exist and are met, it should be possible to focus on certification of content and/or develop qualification approaches.

Furthermore, some organisations, such as UNESCO and the Broadband Commission Working Group on "School Connectivity", have gone a step further and introduced the idea of "high-quality" DEC, which go beyond the minimum requirements that all content should meet. In the case of UNESCO such content is seen as meaningful, inclusive and relevant education content and is defined as "*resources, tools, and applications, learning materials, solutions, platforms and OERs that **meet the needs of the learner alongside those of teachers and instructors, who also play an essential role in the achievement of learning outcomes**"*[80]. A subsequent UNESCO report[81] accentuating the diversity of digital content, states that high-quality digital education content, solutions, applications, and platforms, should all possess the characteristics stipulated in the Box below.

Box 6. Standards for high quality, meaningful, inclusive and relevant education content

Digital education content should:

- **Be developed by taking into account the local context and language** of the school and the surrounding community.
- **Be ambitious**, and provide learners with knowledge, skills, values, and attitudes that allow them to reach their highest potential, to protect themselves, and to thrive in society.

[78] OECD CERI, https://www.oecd.org/digital/learningtochangeictinschools.htm
[79] Kundu, A., Bej, T., & Rice, M. (2021). Time to engage: Implementing math and literacy blended learning routines in an Indian elementary classroom. Education and Information Technologies, 26, 1201–1220. https://link.springer.com/article/10.1007%2Fs10639-020-10306-0
[80] UNESCO, Broadband Commission for Sustainable Development, International Telecommunication Union, United Nations Children's Fund (2020). *The digital transformation of education: connecting schools, empowering learners.*
[81] UNESCO (2021). The platformization of education: a framework to map the new directions of hybrid education systems. Available at https://unesdoc.unesco.org/ark:/48223/pf0000377733.locale=en

- **Prepare learners for a faster, more connected, and uncertain world** by equipping them with core competencies in: communication, collaboration, critical thinking, creativity, problem solving, and appreciation of diversity, environmental consciousness, and learning to learn techniques.
- **Be built on the basis of open copyright and open source codes**, and under open ecosystem principles, so users are not thrust into others' walled gardens.
- Be made accessible online in formats that are also suitable to low connectivity contexts, and alternative analogue platforms if necessary.

And it must:

- **Be inclusive**, thereby addressing the needs of girls, children and youth belonging to minorities, indigenous and marginalized groups, as well as children with disabilities.
- **Be suitable and safe**, and must be developed and delivered according to principles that guarantee the online protection of children at all times.
- **Be deemed most appropriate by teachers** in order to advance the learning of their students. Efforts should be made to give teachers a wide selection of content; schools should work to obtain content recommended by teachers and, whenever possible, give teachers the ability to tailor content or make their own.
- **Be made available online to every child and young person** in the world and facilitate local ownership and decision making, while generating value for the local ecosystems creating and deploying these solutions.

Source: UNESCO (2021). The platformization of education: a framework to map the new directions of hybrid education systems.[82]

There are existing criteria for what constitutes high quality, meaningful, inclusive and relevant education content and these place and these go well beyond between technical, legal or contractual criteria, which are often viewed as minimal criteria.

Over the course of the study stakeholders (such as those working with teachers in various capacities), have called for the provision of catalogues or libraries of DEC (for example in the case of national DEC portals[83]) for teachers that have been reviewed or vetted, in order to provide access to a range of approved resources, while also saving teachers' time. There are multiple examples of such practices across Europe, for example:

- In Greece, called ''Quality Seals'' have been set up for digital education content that is made available via the Digital School platform and its repositories (see box below). Different types of ''Quality Seals''[84] exist to either certify that learning materials were created following a well-defined quality assurance process for their technical design, development, evaluation or approval; or that materials comply with specific quality criteria; or that content has been developed by a trustworthy/reliable source.
- In Hungary, the National Education Authority is responsible for overseeing quality assurance of the content available on the Nemzeti Köznevelési Portálon (NKP) portal[85]: this entails both ensuring that materials comply with the technical and accessibility requirements, and quality assuring the content through the involvement of external experts.

[82] Ibid.
[83] Examples include e Viki Platform in Slovakia, the Nemzeti Köznevelési Portál (NKP) in Hungary, the e-School project in Croatia, the Digital School platform in Greece and the EMU and Materialeplatforme portals in Denmark.
[84] Elina Megalou, Kostis Alexandris, Eugenia Oikonomidou, Christos Kaklamanis (2022). A Quality Assurance Framework for OERs based on Quality Seals and the Photodentro Seals Repository. Education and New Developments 2022. https://doi.org/10.36315/2022v2end036
[85] https://www.nkp.hu/

- In Germany, while broader quality assurance processes are in place for e-books, including by establishing lists of trusted publishers approved by each Land, public platforms have their own system of quality control for digital education content.

Furthermore, some Member States, such as Spain and Norway, have developed **guidelines and frameworks for teachers to help them make better informed judgements when selecting and using DEC**. In addition in some Member States there are a number of **commercial organisations**, such as EdTech Impact[86] and Education Alliance Finland[87], that **provide vetting services to DEC publishers** and then share these reviews and evaluations online to help teachers make better informed decisions. While other Member States, such as Lithuania, their **quality assurance arrangements for DEC are regulated by law**.[88]

Box 7. Inspiring practice on quality criteria

Quality criteria for DEC in Lithuania: In Lithuania, quality assurance arrangements for digital education content are regulated by law.[89] According to newly amended legislation in 2022, education content creators and publishers, including those creating and publishing digital education content, are responsible for quality assurance and validation. To this end, they have a legal obligation to ensure that at least three evaluators (i.e. subject specialists/specialists in digital education content) are involved in the assessment of the learning/teaching materials and resources before they are made available to users.

To facilitate this process, quality criteria for digital education content have been set up and enshrined in legislation[90]. These include:

- Digital education content is operational on personal laptops or mobile devices, via the operating systems and browsers officially supported by the manufacturers;
- Digital training tool complies with the official W3C standard tools, the texts are prepared using the UTF-8 encoding of the Unicode standard, no additional plug-ins or other technologies must be installed to view the digital textbook and the digital training tool;
- DEC fits together purposefully and is adapted to the didactics of teaching subject
- DEC is interactive, engaging students, stimulating their thinking and engagement;
- Purposeful animation, videos, text dubbing, texts, illustrations are used to convey the material;

The content of the tasks corresponds to the modern context, is focused on case and/or data analysis, problem solving, promotes educational methods more suitable for technology, and is adapted to learning both independently and in groups:

[86] https://edtechimpact.com/
[87] https://educationalliancefinland.com/
[88] Law 2022-10863 of 25 May Regarding the Minister of Education, Science and Sports in 2019 June 26 order no. V-755 "On the approval of the description of the procedure for assessing the compliance of textbooks and teaching materials with legal acts and approval of the description of the procedure for providing them" amendment ('Įsakymas 2022-05-25 Nr. 2022-10863 Dėl švietimo, mokslo ir sporto ministro 2019 m. birželio 26 d. įsakymo Nr. V-755 „Dėl Bendrojo ugdymo dalykų vadovėlių ir mokymo priemonių atitikties teisės aktams įvertinimo ir aprūpinimo jais tvarkos aprašo patvirtinimo" pakeitimo, TAR, 2022-05-25, Nr. 10863), available at :https://www.e-tar.lt/portal/lt/legalAct/cb34f0b0dbe911ec8d9390588bf2de65
[89] Law 2022-10863 of 25 May Regarding the Minister of Education, Science and Sports in 2019 June 26 order no. V-755 "On the approval of the description of the procedure for assessing the compliance of textbooks and teaching materials with legal acts and approval of the description of the procedure for providing them" amendment ('Įsakymas 2022-05-25 Nr. 2022-10863 Dėl švietimo, mokslo ir sporto ministro 2019 m. birželio 26 d. įsakymo Nr. V-755 „Dėl Bendrojo ugdymo dalykų vadovėlių ir mokymo priemonių atitikties teisės aktams įvertinimo ir aprūpinimo jais tvarkos aprašo patvirtinimo" pakeitimo, TAR, 2022-05-25, Nr. 10863), available at: https://www.e-tar.lt/portal/lt/legalAct/cb34f0b0dbe911ec8d9390588bf2de65
[90] Law 2022-10863 of 25 may Regarding the Minister of Education, Science and Sports in 2019 June 26 order no. V-755 "On the approval of the description of the procedure for assessing the compliance of textbooks and teaching materials with legal acts and approval of the description of the procedure for providing them" amendment, available at: https://www.e-tar.lt/portal/lt/legalAct/cb34f0b0dbe911ec8d9390588bf2de65

- If the use of the material requires several steps, explanations must be provided;
- Self-assessment, learning and support tools are installed in the digital textbook, and the possibility of seeing correct/incorrect answers is included;
- The user manual of the digital textbook and digital teaching tool must be detailed, drafted in Lithuanian and adapted to the characteristics of the students' age group;
- The digital textbook contains an information retrieval system, table of contents, index, keyword search, and may also include annotation, note-taking, tabs, highlighting tool, and interactive activity planning; and
- The digital textbook and digital training tool include technical support contacts and a working support system to ensure that problems are resolved in the shortest possible time.

Once digital education content is approved, the new material is uploaded on the official education information portal mokykla.lt. Each year, a selection of printed/digitalised textbooks and digital education content undergo a review process by the National Education Agency. Materials are selected based on the complaints received the previous year from the users, if a new version of the material has been published or there were any changes to the teaching curriculum. If any issues regarding the material are identified, the supplier is given a deadline to address them or the material is removed from the information portal.

Source: Ecorys, 2023.

Thus Member States are already providing a range of services to their teachers to assist them find 'high-quality' content easily and quickly.

Furthermore, quality frameworks have also been used in higher education to review OERs and digital learning platforms. These frameworks generally review a series of criteria that are, more or less, easy to measure (quantitative and qualitative), similar to those included in the UNESCO guidelines for Open Educational Resources (OER) in higher education[91].

- Rubric I. Content quality;
- Rubric II. Motivation;
- Rubric III. Presentation design;
- Rubric IV. Usability;
- Rubric V. Accessibility;
- Rubric VI. Educational value, and;
- Rubric VII. Overall rating.

Each rubric consists of several questions that the teacher or evaluator considers and then they give the resource an overall score. The research and feedback on such resources is that they should be efficacious without being too complex to remember and apply.[92]

[91] https://unesdoc.unesco.org/ark:/48223/pf0000213605

[92] Cheon, J., & Grant, M. (2008, March). A cognitive load approach to metaphorical interface design: Reconsidering theoretical frameworks. In Society for Information Technology & Teacher Education International Conference (pp. 1054–1059). Association for the Advancement of Computing in Education (AACE); Chiu, T. K., & Churchill, D. (2015). Exploring the characteristics of an optimal design of digital materials for concept learning in mathematics: Multimedia learning and variation theory. Computers & Education, 82, 280–291; Kim, M. K., Xie, K., & Cheng, S. L. (2017). Building teacher competency for digital content evaluation. Teaching and Teacher Education, 66, 309–324.

In addition to creating quality criteria for those involved in using DEC, **there is a need to assist Creators and Facilitators to make better decisions in relation to how they create, procure and compile "high-quality"** DEC. In the German state of Baden Württemberg[93], it has been recognised that educational institutions often need training and guidance in developing suitable digital content and thus they provide guidance to teachers in this regard, In addition. there are frameworks providing guidance for commercial creators to develop quality DEC[94]. Similarly, there is a need to support organisations, centrally, regionally or locally, to procure better quality DEC and again there are rubrics that can assist in this regard (for example the North Carolina NC Quality Rubric for Content[95]).

Furthermore, Member States, such as Croatia, France and Belgium (Flanders) have developed tender documentation and associated evaluation criteria to evaluate quality DEC, for specific purposes. There is an interest from ministries of education to have access to these documents and guidelines in relation to organising and selecting quality DEC that is commissioned or supported using public funds[96].

However, a word of caution is that **it is, in fact, typically not about judging ''high vs low quality'' digital content or tools, but rather identifying the most appropriate content and tool for the specific learning objectives at hand**.[97] This point was also made multiple times during the consultation phase and it was noted that teachers often want to learn how DEC was used in specific contexts (i.e. learning scenarios) and they want to hear how teachers have used the content in their own context. Thus, evaluation rubrics and frameworks, while in and of themselves are useful, are not enough and there is a need to capture and share how specific content is operationalised/mediated in real life teaching, learning and assessment settings. Teachers want examples that they can identify with and then try out the content in their context.

2.3.2 Guiding principles

The literature review conducted for this study identified the following **guiding principles for quality criteria** and these were then deliberated and fine-tuned during the subsequent stakeholder consultation activities:

- Avoid burden – save teachers' time so they can focus on pedagogical and didactic value and scientific quality of the content;
- Avoid censorship / Support diversity;
- Maximise choice; and
- Maximise equity and inclusion – so DEC can be used by all students in meaningful ways.

Quality criteria should support each of the key stakeholder groups and ensure that users have access to the widest possible set of "high-quality" DEC. There is a recognition that the criteria should address both the content itself and how it is deployed. In this regard the study has established that there is also a need for any future criteria should:

- Address **utility & usability issues**, from both the technical and pedagogical side; and
- Include **sense-check criteria** in terms of whether they are relevant for different stakeholders, different levels of education and within different education systems.

Thus, once again the context in which the content will be used is key and stakeholders, particularly ministries of education, have regularly referenced that Europe has diverse educational traditions and practices, and these

[93] Digital content in vocational education and training - Baden-Württemberg Stiftung (bwstiftung.de)
[94] https://www.researchgate.net/publication/236855764_An_Evaluation_Model_of_Digital_Educational_Resources
[95] Quality Review Tools for Digital Learning Resources. https://www.fi.ncsu.edu/resources/quality-review-tools-for-digital-learning-resources/
[96] DELTA WG Plenary, June 28 & 29th, 2023
[97] Damsa, a. Langford. M, Uehara, D., Scherer, R. (2021) Teachers' agency and online education in times of crisis. Computers in Human Behavior, Volume 121

need to be respected and supported. Thus, any quality criteria should support all the key stakeholders to develop, procure and use content that is appropriate for their setting, and they should not stray into areas that relate to the quality of curriculum or pedagogical approaches[98].

2.3.3 Quality criteria by key stakeholders

There is a range of key stakeholders involved in the DEC lifecycle, which includes the creation, procurement, and use of DEC, as was captured in section 2.2. **Different stakeholders will have different needs to consider in terms of quality criteria** and these are captured below.

Table 3 – Overview of key stakeholder groups and purpose of quality criteria

Stakeholder Group	Purpose of Quality Criteria	Key Questions to Consider
Creators Content creators and providers (producers and distributors)	To support and guide them in developing quality DEC to meet the educational needs of users, and the minimum technical, legal and contractual requirements to reach a wide range of school populations.	• *What kinds of DEC do content users require in particular contexts?* • *What quality components should this content ideally contain?* • *Who should the creators collaborate with to create such content? [and how?]*
Facilitators Purchasers of content and assigners	To procure/commission/aggregate quality DEC for content users - in particular for learner success and the development of digital skills for all - and achieve value for money.	• *Is the DEC fit for purpose and does it represent good value for money?* • *Is the DEC fit for various contexts and use?* • *Is the DEC a lever to adopt new teaching or learning methods, and develop basic digital skills?*
Content Users Content users/evaluators (teachers, students, trainers, inspectors, researchers)	To select and use quality DEC that will enhance teaching, learning and assessment experiences. Contribute to an objective qualification of DECs based on common criteria and a description of the context of use.	• *What kind of DEC is available to support my learning goals?* • *What does quality look like in DEC? Are there existing guidelines or approval ratings for content? Where can I find safe and legally approved DEC?* • *How can I use this content with my learners (i.e. share case-studies/learning scenarios of use) and will it impact effectively on learners' across a range of areas (i.e. efficiency, access, inclusion and equity)?* • *How can I contribute in an easy way to qualify DECs based on common criteria and approaches?*

[98] DELTA WG, Task and Finish Group, Stakeholder Consultations

Source: Ecorys, 2023

Typically, quality criteria are developed for end-users (for example, see Norway[99]), yet there is a growing realisation that each of the three stakeholder groups require a different set of supports that meet their specific needs, commitments and responsibilities.

Specific discussions on quality criteria held with key stakeholders throughout the study, with the aim to explore the applications of quality criteria, both on the supply and demand side, and to consider what added value the creation of such criteria might provide at EU level. Stakeholders comprised of publishers (public and private), and representatives from public authorities (such as teachers, research organisations, teacher support organisations, and teacher unions), and they considered specific DEC challenges and problems associated with the creation of DEC quality criteria, as part of a new EU framework.

Building on the core principles outlined at the outset of this section, the stakeholders suggested that any criteria should adhere to the following broad guidelines. These capture a range of issues that should underpin or inform the creation of any future quality criteria at the EU level:

- **Broad, Not Narrow Criteria Required**. Many existing frameworks reviewed in the study were deemed to be quite narrow and specific. It was noted that there is no one-size-fits all and whatever is created should enable the user to customise the criteria for their purpose. It was suggested that Member States and individual organisations could select the specific criteria that best fits with their context by providing them with broad guidelines and general criteria, which they could then customise for their own purposes. It was also noted that commissioning bodies (i.e. ministries of education, public bodies etc.) should not develop overly restrictive criteria for the creation of content when developing tender documentation, and should leave sufficient room for publishers/creators to showcase their creativity and maximise the affordances of digital technology in specific contexts[100].

- All criteria, where possible, should be **informed by relevant research** and conceptual frameworks[101].

- **Educational institutions should have access to the widest range of DEC**, including content that is not totally accurate, so as to develop learner digital literacy, and thus guidelines need to respect this purpose. It is essential that educators' professional judgement and competences are respected and that any criteria do not limit the type of content that they or the learners wish to use/interact with for specific educational purposes.

- **Prioritise interoperability of DEC**. At its most basic level interoperability means "the ability to work together with other systems or pieces of equipment"[102]. The term is also used in relation to the digital economy and here is it defined as "effective interoperability between networks, devices, applications, data repositories and services"[103] and it is now a major goal of the European Digital Agenda. However, for DEC, it has an even deeper meaning and can go so far as to include systems or approaches that can support the location and even the use and re-use of DEC across different platforms and devices.

- **Ensure safe use of data.** DEC is closely associated with the concept of data[104], in the sense that it is made up of data/information and that it itself generally generates data when users interact with it. These interactions typically can have associated technological, legal and ethical consequences. There is a need to ensure that stakeholders are compliant when collecting and using data and thus there is a need

[99] Quality Criteria for Digital Learning Resources, https://www.udir.no/globalassets/filer/tall-og-forskning/rapporter/2012/quality_criteria_dlr-eng.pdf
[100] This was noted by Katarina Lipovac's, from Profil Klett, a Croatian publisher and supported by the Croatian Academic and Research Network – CARNET
[101] European Union Digital Education quality standard framework and companion evaluation toolkit, https://www.tandfonline.com/doi/abs/10.1080/02680513.2021.1936476?journalCode=copl20
[102] https://dictionary.cambridge.org/dictionary/english/interoperability
[103] https://www.jipitec.eu/issues/jipitec-8-1-2017/4531
[104] https://en.wikipedia.org/wiki/Digital_data

for guidance or guidelines in this area. It was noted that existing guidelines, such as the Assessment List for Trustworthy Artificial Intelligence (ALTAI) for self-assessment[105] and the Ethical guidelines on the use of artificial intelligence and data in teaching and learning for educators[106], were referenced by stakeholders as examples of good practice.

- Ultimately users want to know how **DEC has been used in contexts similar to their own** and thus the creation and publication of learning scenarios or reviews is an important output. The practice of sharing user-generated reviews is not a new idea[107], and today there are organisations[108] that provide such a service. In turn, reviewers are seeking the development of taxonomies that will enable creators to map the reviews across multiple curricular areas and Member States. Currently this is quite challenging to achieve. In addition, the creation of such taxonomies would be quite challenging and time consuming.

- The issue of **competence** to use quality criteria was raised in relation to all three stakeholder groups (captured in Table 4 below). While the issue of teacher digital competencies (see DigCompEdu area 2, Digital Resources[109]) is often cited, it is also essential that creators and procurers have supports to further develop their competences in this area.

The above seven principles, which are broader than a set of quality criteria, were highlighted by stakeholders as being important to consider in the future creation of specific quality criteria for a range of contexts. However, the study also developed a list of 11 **areas that could be incorporated into any future quality criteria framework** or checklist:

- **Didactic relevance** - the compatibility of the content with the identified learning goals/needs. This could, for instance, include activity that promotes critical thinking, communication, collaboration, and/or creativity.
- **Information quality -** the information featured in the resource is accurate, i.e. free of errors and bias. The information is presented in a way that is clearly organised and logically structured, is easy to understand and appropriate for the level of education in question.
- **Technical functionalities -** the technical features work reliably (smoothly and quickly), and are purposeful, featuring interactivity, animation, automated feedback etc. as appropriate.
- **Accessibility -** the content is accessible to all students, especially those with disabilities.
- **Adaptability and differentiation -** the resource is suitable for different types of learners, can be adjusted for different learner cohorts, levels and learning styles, and exploits different pathways to achieve the learning objectives. Thus in this way it can be adapted for a specific learning context or specific goal.
- **Motivation and engagement -** the resource presents the content in an attractive and innovative way, increasing the student's engagement and effort based on research on behavioural, cognitive and emotional perspectives in the learning sciences.
- **Reusability -** the resource can be restructured to create new or adapted resources for use in different subjects and in different groupings of students.
- **Affordability –** the resource is financially sound.
- **Safety –** the resource must be developed and delivered according to principles that guarantee the online protection of user generally, and children in particular.

[105] https://digital-strategy.ec.europa.eu/en/library/assessment-list-trustworthy-artificial-intelligence-altai-self-assessment
[106] https://education.ec.europa.eu/news/ethical-guidelines-on-the-use-of-artificial-intelligence-and-data-in-teaching-and-learning-for-educators
[107] https://urldefense.com/v3/__https:/www.theguardian.com/education/1999/nov/16/itforschools.news__;!!DOxrgLBm!EQzj7Z-MQcKInJeemnzqDt7KBYff0__SdBZRIPRNHqimExhQvWynA0y2Sh2k8aMPWb3fjV-6yg1_fEMp2tvm7G9oKA$
[108] Two examples include https://educationalliancefinland.com/ and https://edtechimpact.com/
[109] https://op.europa.eu/en/publication-detail/-/publication/fcc33b68-d581-11e7-a5b9-01aa75ed71a1/language-en

- **Accountability -** materials share their origins and purposes, are based on standards or principles, abide by intellectual property rights, are open about personal information and user data collection processes.
- **Inclusion -** addresses whether diverse peoples are represented with contextual nuance, compassion, and respect.

As indicated earlier, these criteria can be operationalised to create a range of frameworks or checklists for each of the key stakeholder groups and for a range of purposes such as pedagogic, economic, legal, and technological as captured below:

- **Pedagogic:** e.g. promoting various teaching practices, enhancing learning outcomes, improve engagement factors;
- **Economic:** e.g. efficient use of production costs, innovative and sustainable business models;
- **Legal:** e.g. Compliance with existing legislation (i.e. privacy requirements, compliance with content description), fair remuneration for all resources used in the production, optimized copyright models, transnational exchange;
- **Technological:** e.g. Content parity for all users on all devices and in all contexts, optimised learner and user experience, supporting high levels of interoperability within educational ecosystems.

2.4 Operationalising the criteria

Desk research and stakeholder consultations identified that, while there are existing examples of DEC quality criteria/frameworks (i.e. tools) in use in many Member States, and in other parts of the world, this is an area that still requires further development. There is a need to assist all stakeholders in the DEC creation and use lifecycle in creating and operationalising quality criteria that are appropriate for their context. Thus, there is no one-size-fits-all tool but rather tools that are designed to fulfil specific functions, ranging from quality assurance at production level (with technical guidelines) to improving or modifying teaching practices. Table 4 below captures some of areas where criteria could assist stakeholders, but ultimately it is worth remembering that “usage is where quality is proven”.

The Table below captures five key domains that are relevant across a range of stakeholder contexts. The Table has been informed by combining the findings of the literature review and the stakeholder consultations. If we consider that there have been widespread calls for developing cataloguing systems that will help stakeholders find and use ‘appropriate’ digital education content, that meets their needs and that is financially viable for their context. While we have highlighted a number of examples of national platforms that catalogue and host, in the main free content, many stakeholders (i.e. those in teaching roles) are also seeking access to well-developed, well-organised, well-designed, and well-applied content, which comes at a cost.

Domain 1, **Discoverability, provenance and clarity of information** identifies a range of criteria that should be considered in relation to this domain. Similarly, there are a range of issues and associated criteria that need to be considered in relation to Domain 2, **Compliance and security guarantees**. During the consultation phase, there were multiple calls for identifying products and services that are compliant and ethical for use in education. Some have even suggested that such products and services have a quality mark to show they meet such criteria. Domain 3, **Usability of the content/resource**, is concerned with accessibility and design approaches, such Universal Design for Learning[110], to ensure all learners have access to quality digital education content.

Domain 4, **Relevance**, focuses on the relevance of a product or service to the needs of the educator or the learner. The criteria in this domain will vary depending on the specific context being addressed. Therefore, not all criteria may apply in all situations but users can customise the criteria to meet their specific needs. Finally,

[110] https://ec.europa.eu/programmes/erasmus-plus/project-result-content/fdf64e25-6e83-4315-83e4-e5f4cb21324c/2014-1-NO01-KA203-000426%20UDLL_BestPracticeGuidelines_WebVersion.pdf

the collection and sharing of Learning Usage Data to better understand the **User experience** (Domain 5), is an area that was referenced constantly by all stakeholders during the study. Publishers, in particular, better data on how their products and services are being used, as well as facilitators, and educators want to know how these products and services are being used in a range of education and training scenarios. Once again, depending on the context, the criteria will vary.

Table 4 – Proposed quality criteria for DEC

Possible Quality Criteria	
Domain	Criteria
Discoverability, provenance and clarity of information	• Easy to search, order and obtain. • Financial affordability. • Reliability and traceability of the source / confidence index. • Clarity of didactic and pedagogical objectives, level of education. • Clarity of technical, financial and legal requirements. • Clarity of conditions of use and re-use.
Compliance and security guarantees	• Pedagogical: compliance with curricula and reference systems. • Technical: standards used, interoperability, security, data storage and management. • Economic and financial: terms of sale and after-sales services, conditions of use, subscription exit and backward compatibility guarantees. • Regulatory and legal: RGPD and respect for rights enshrined in education codes (and human rights), accessibility (in the RGAA sense), etc.
Usability of the content/resource	• Ease of deployment and assignment. • Ease of access for users. • Ease of use for teachers/pupils (ergonomics, suitability for levels and ages, etc.)
Relevance	• Quality of the information contained. • Suitability for the proposed pedagogical and didactic objectives • Level of student participation and engagement. • Possibility of adjustment (modification, customisation, etc.) • Possibility of use in multiple teaching approaches/contexts. • Quality of feedback and support.
User experience	• Organisation of users' opinions. • Collection and sharing of usage indicators. • Sharing of scenarios for the pedagogical use of content.

Source: Ecorys, 2023

Based on the above, there is a need to customise quality criteria for specific purposes and to aim for a combination or combinations that can ensure the provision and use of high DEC quality. Criteria already exist in many contexts, particularly for end users (i.e. educators), but further work is needed to create modules that other stakeholders (i.e. the creators, the facilitators) can use and adapt to meet their priorities.

2.5 Key messages

This chapter has highlighted the complexity of defining digital education content, due to its multifaceted nature, broad scope, and the variety of stakeholders involved and roles undertaken within the DEC life cycle. This led to the identification of a possible definition, which was then used as a basis to outline a set of quality criteria for DEC, taking into account the needs of creators, facilitators, and users. In the Box below, we summarise some key messages and takeaways.

Box 8. Definitions and quality criteria - key messages

Key messages
• A **range of terms are in use for digital education content and are often used interchangeably in the literature**. While there does not appear to be any deep contradictions or tensions across existing definitions of DEC and related terms in the literature, there does appear to be **a lack of specificity and uncertainty of scope** present in many of the existing definitions. Thus there is a need to define digital education content in the context of a modern EU digital education ecosystem. • **DEC is an umbrella term** and it incorporates everything from e-materials (video clips, e-books) to sophisticated software, programmes and tools facilitating interactive and immersive learning activities or teaching methods such as educational games, simulations and digital storytelling. **What differentiates DEC from other kinds of Digital Content is the purpose** or the intention for which that content is created. It is created to supported an educational objective, such as to support studying, learning, and/or instruction). • **DEC typically consists of "chunks"** (i.e. a video, a chapter in an e-book, a digital assessment etc.) and these are assembled to support an education objective by a publisher, a teacher or a learner using a range of digital tools. In this way **DEC can take many forms**, depending on the purpose for which it was created. • There is a history of using quality criteria to evaluate print materials, particularly textbooks, in many EU Member States and this practice has been adapted for DEC using a set of criteria. While objective criteria are important in making such judgements, it is as **important to make a context-specific assessment of the impact the DEC has in supporting learners to achieve a set of specific learning aims/intended learning outcomes**. Thus the role of the educator and the context is important in making any judgements. • **EU Member States are already using a range of quality criteria in relation to DEC**. This ranges from evaluating digital education content that is hosted on national digital education content portals or libraries to judging the quality of e-textbooks. Some EU Member States, institutions and others have even produced criteria for teachers to make judgements in relation to digital education content they might use with their learners. Thus there are **a range of practices already in place across the EU in relation to the use of quality criteria for selecting DEC**. However, there are **gaps in relation to quality criteria for other stakeholder groups, such as content creators and facilitators**. • There is **no-one-size-fits-all set of quality criteria for producing, procuring or selecting and using DEC**. Criteria need to be developed for specific purposes (i.e. to create, to procure or to use) across a range of settings in formal education. However, a range of over-arching principles and guidelines should be taken into account when developing such specific quality criteria.

Source: Ecorys, 2023.

Chapter 3 goes on to explore to what extent a digital education content market already exists, and further investigates demand and supply dynamics, building on the stakeholder analysis.

3.0 Understanding the marketplace

This Chapter builds on the key definitions outlined in Chapter 2, as well as on the analysis of key stakeholders within the DEC lifecycle and aims to examine the current DEC marketplace in Europe. More specifically, the following sections focus on:

- **Sizing the market:** In section 3.1 we explore the feasibility of sizing the DEC marketplace in the EU, by comparing and contrasting global market estimates with available data from Member States.
- **Market characteristics:** In section 3.2 we provide a detailed description of the structure of the DEC market, with a focus on both the demand and supply side.
- **Key market enablers, drivers and trends:** In section 3.3. we outline some key considerations on market drivers and trends, to appraise enablers and obstacles to market development.

3.1 Sizing the market

Sizing the DEC market is not an easy task because, in addition to the absence of a commonly agreed definition for 'digital education content', the term itself is not widely used, hence, common statistical data – both for the supply and demand side – are also lacking. In addition, in market studies and forecasts, many similar, yet potentially slightly different and overlapping and imprecisely defined notions are used: online education, digital education, or e-learning among others. As a consequence, it is unclear how the relevant markets for these different areas relate to the DEC market as defined in this study.

3.1.1 Global DEC market estimates

Estimates of the global markets illustrate profoundly the above-mentioned conundrum. Many estimates and forecasts for various markets can be found (see a sample of the estimates in Table 5). We could find only two studies that referred directly to DEC market, but because they did not provide a definition of DEC, it is not clear to what extent their approaches correspond with the DEC definition developed as part of this study. We also included, for context and comparison, estimates for the 'digital education market', 'online education market' and the 'e-learning market'. However, it is unclear whether these different markets are synonymous, to what extent they might overlap, and how they relate to each other.

As the Table below shows, for those studies which do refer to the DEC market, the estimates of market size vary wildly, ranging from USD 14.14 billion to USD 200 billion (or almost USD 400 billion). The compound annual growth rate (CAGR) is estimated at a similarly wide range from 9.48% to 32.3%. Due to the unclear market definition and the lack of detailed knowledge of the studies' methodologies, it is not possible to explain such strong differences in the valuation.

At the same time, the companies listed in these studies as main players are largely the same. They include Adobe, Cengage Learning, Cisco, Coursera, Discovery Education, edX, Kahn Academy, LinkedIn Learning, Udacity, Udemy and others. This seems to indicate that some of the studies below do not distinguish between (digital) content itself, platforms, tools for creating of sharing content, and overall supporting technology for learning.

Going forward, future analyses and market estimates could benefit from adhering to a consistent definition, such as the one formulated in chapter 2 of this study.

Table 5 – Overview of estimates of global market size for DEC and similar markets

Denomination of the Market	Study by	Year	Estimated Market Size (in USD BN)	CAGR	Comments
DEC	FACT.MR[111]	2023	60	11.6%	The definition of the market is unclear. It includes segments of self-paced and instructor-led education, and segments of K-12 and higher education. Companies covered are Adobe, Cengage Learning, Discovery Education, etc.
DEC	Global Industry Analysts[112]	2022	71	11.4%	The definition of the market is unclear. It includes K-12 and higher education. Companies covered are Cisco, Cengage Learning, Discovery Education, Carnegie Learning, etc.
Online education	Statista[113]	2023	166.6	9.48%	The market is defined as “transfer of knowledge or skills, whether self-paced or instructor-led, through online platforms” and includes online learning platforms, online university education and professional certificates (B2B and B2C). Companies covered are Coursera, Udemy, edX, etc.
Online education	Markets & Markets[114]	2023	19.4	28%	The definition of the market is unclear. It includes segments of self-paced and instructor-led education, and segments of academic institutions and enterprise & public sector. Companies covered are Udacity, edX, LinkedIn Learning, Udemy, FutureLearn, Skillshare, Khan Academy, Ivercity, etc.
Digital education	Reports and Data[115]	2022	15.2	32.3%	No clear market definition but divides the market into following segments: online courses, educational apps, e-books. Companies covered are Coursera, Udacity, edX, LinkedIn Learning, Duolingo, Udemy, FutureLearn, SkillSoft Corp., etc.

[111] Digital Education Content Market Size Worth US$ 180 billion (globenewswire.com)
[112] Digital Education Content - Market Study by Global Industry Analysts, Inc. (strategyr.com)
[113] Online Education - Worldwide | Statista Market Forecast
[114] Global Digital Education Market Size, Share, Trends and Industry Analysis 2023 - 2028 (marketsandmarkets.com)
[115] Digital Education Market Size 2023, Forecast By 2032 (reportsanddata.com)

Denomination of the Market	Study by	Year	Estimated Market Size (in USD BN)	CAGR	Comments
e-learning	Global Market Insights[116]	2022	399.3 (of which 200 bn is content)	14%	The market is defined as "learning and acquiring knowledge using electronic technology, mostly on the internet". It includes "providing educational content, courses, and educational materials to distance learners using digital tools, resources, and platforms". Companies covered are Adobe, Baidu, Cisco, Citrix, Coursera, D2L Corporation, edX, FutureLearn, GitHub, Google, IBM, Kan Academy, Microsoft, Oracle, Pearson, SAP, Udemy, etc.
e-learning	SNS Insider[117]	2022	14.14	28.91%	E-learning or "technologically enhanced learning" has segments of "courses in entrepreneurship and business management and science and technology", self-paced or instructor-led. End-users are "government entities, businesses, and individual students and academic institutions". Companies covered are Coursera, Udacity, Udemy, Ivercity, Pluralsight, etc.

Source: Ecorys, 2023

3.1.2 Size of the EU market

Market size is defined by the maximum total number of sales and the resulting revenue. Considering that a large share of the DEC is acquired through public-sector procurement (which includes all levels of government and public schools), the national budgets foreseen for DEC (for a given year or over the course of several years) can be considered a good proxy for the DEC market size. However, this proxy does not include the revenue generated from DEC sold directly to consumers (i.e. parents, students, learners; B2C), and this gap remains in the estimate as there are no available data on the revenue from B2C sales. The reasons for this are: lack of the commonly accepted definition of DEC and related statistics; unclear relationship between DEC, online education, digital education, e-learning and other approaches; the large number of private companies active in the field.

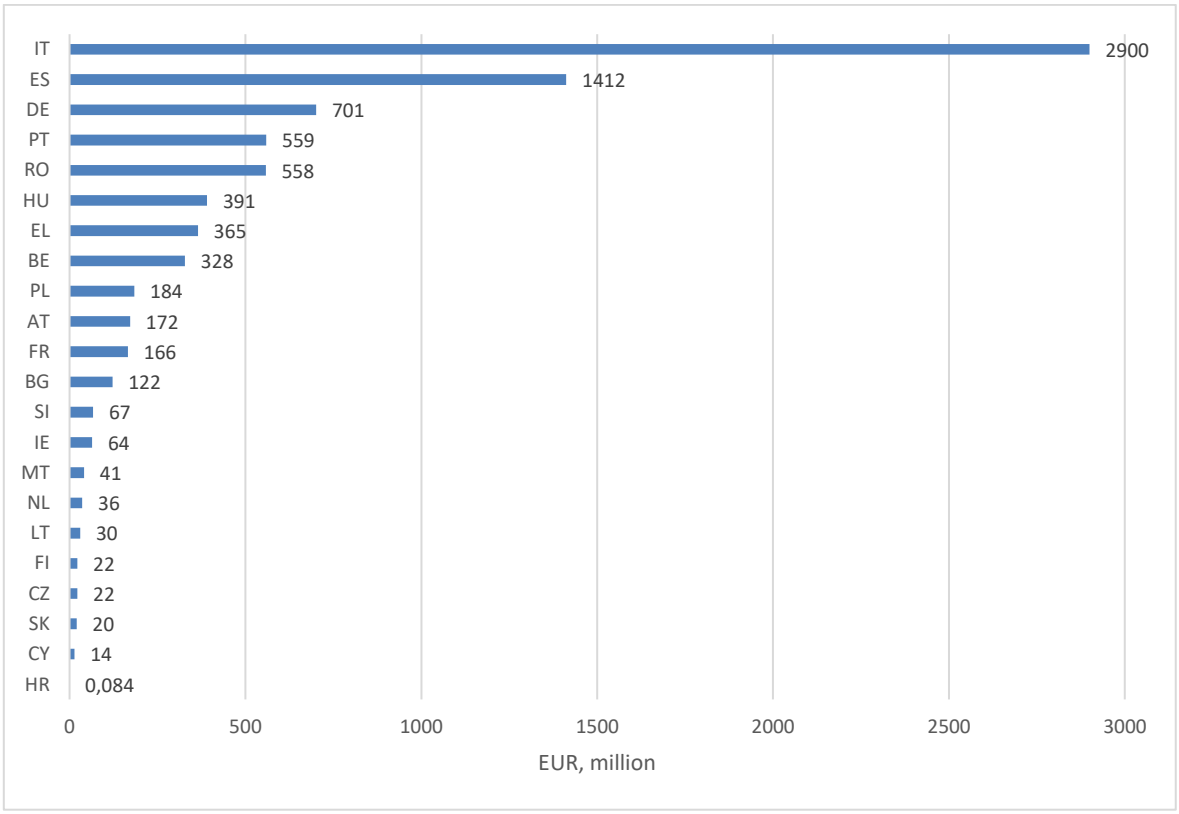
National education expenditure for DEC is not always specifically categorized in budgets. The reasons for this are manifold. DEC is often procured/purchased together with traditional education content, so that it is not possible to delimit the portion spent on DEC.[118] Some Member States (e.g. Finland, The Netherlands) purchase all education content under the same budget line. Others purchase it as part of the general expenditure for education (e.g. Slovakia) or bundled with digital infrastructure (Ireland). The differences in national approaches to budgeting also mean that the existing information is unlikely to be comparable. Because of this, further adjustments in the selection of a proxy are necessary to better estimate the DEC market size.

[116] E-learning Market Trends 2023 - 2032, Global Report (gminsights.com)
[117] https://www.snsinsider.com/reports/digital-education-market-1958
[118] As discussed by the stakeholders at the T&F Group on marketplace, it is often impossible to speak about the DEC market because there is a market for education content in general where DEC and traditional education content are often bundled together.

In an effort to overcome the problem of comparability, we considered the investments under the national Resilience and Recovery Plans (NRRPs) because, according to Article 16 (2) of the Recovery and Resilience Facility (RRF) Regulation,[119] Member States must devote at least 20% of their total allocations under the RRF to measures supporting digital transition,[120] of which DEC is one the potential spending components. Under the NRRPs, the relevant expenditure is social expenditure in education and childcare under the pillar "Digital transformation". Within this expenditure, we analysed NPPRs for the explicit mention of DEC or related terms.[121] The resulting proxy of the size of the DEC market for February 2021- 31 December 2026 is EUR 8174,084 million (see Figure 5 for the country-level data).

Even this proxy, however, has two major limitations. On the one hand, it is too broad as it includes at times expenditure beyond DEC. On the other hand, it does not cover expenditure on DEC by VET and HEI, as they are covered by a different pillar of NRRP entirely, and the DEC component there cannot be distinguished. In addition, it must be reminded that the fact some countries chose not to use NRRP to invest in DEC or decided for limited investment in DEC does not mean that they do not procure DEC from national budget.

Figure 5: Proxy calculation of the NRRP expenditure on DEC, per country[122]



Source: Ecorys' own calculations based on the ECA (2023). EU support for the digitalisation of schools: Significant investments, but a lack of strategic focus in the use of EU financing by member states.

While keeping in mind the above-mentioned limitations, Table 6 provides an overview of education and school expenditure in EU27 Member States, compared to the proxy for public funding directed to DEC under the RRF. It is to be noted that the funding under RRF covers the period 2021-2026. Values reported below are therefore an average over this period. In reality, however, the specific funding might be earmarked, for example for a

[119] Regulation (EU) 2021/241 of the European Parliament and of the Council of 12 February 2021 establishing the Recovery and Resilience Facility, OJ L 57 of 18.02.2021.
[120] See https://ec.europa.eu/economy_finance/recovery-and-resilience-scoreboard/digital.html
[121] Based on the ECA (2023). EU support for the digitalisation of schools: Significant investments, but a lack of strategic focus in the use of EU financing by member states: https://www.eca.europa.eu/Lists/ECADocuments/SR-2023-11/SR-2023-11_EN.pdf and on NRRPs.
[122] The relevant expenditure could not be identified in the NRRPs of Croatia, Denmark, Estonia, Latvia, Luxemburg and Sweden.

period of two years. The contribution of RRF varies greatly between Member States, with additional funding for DEC compared to the general government expenditure for schools ranging from 0% in Denmark, Estonia, Croatia, Luxembourg, Latvia, Sweden, up to 3.5% in Romania and 3.2% in Hungary. It shall be reminded that countries invest in DEC also from other sources beyond the NRRF.

European Commission

Table 6 – Expenditure on DEC in the context of other expenditure on education

Member State	Population (2022)	School Population (2021)	Education Expenditure (Total, Mln EUR, 2021)	Education Expenditure (% GDP, 2021)	Total Economy Expenditure - School (Mln EUR, 2020)	General Government Expenditure – School (Mln EUR, 2020)	Dec (Mln EUR, 2021-2026)	DEC as % of General Government Expenditure On School Per Year
AT	8978929	1044177	20100,8	4,9	8346	7905,5	172	0.36
BE	11617623	1950237	31558	6,3	12.629,10	11823,7	328	0.46
BG	6838937	713912	3049,3	4,3	935,3	1101,6	122	1.85
CY	904705	115257	1317	5,5	818,7	699,6	14	0.33
CZ	10516707	1434217	12038,8	5,1	4.997,50	4751	22	0.08
DE	83237124	9889941	163194	4,5	73608,6	69586,4	701	0.17
DK	5873420	982233	20337	6	9311,1	8884,1	0	0.00
EE	1331796	181514	1858,6	5,9	n/a	699,7	0	0.00
EL	10450782	1300384	7416	4,1	n/a	n/a	365	n/a
ES	47432893	6534031	55637	4,6	29526,4	24236,5	1412	0.97
FI	5548241	887789	14316	5,7	6181,9	6156,8	22	0.06
FR	67871925	10455058	131064	5,2	n/a	58130,4	166	0.05
HR	3862305	478091	3031,4	5,2	986,9	950,3	0,084	0.00
HU	9689010	1151360	7708,7	5	n/a	2040,6	391	3.19
IE	5060004	1006830	12722,8	3	6511,6	6153	64	0.17
IT	59030133	7320011	73341,2	4,1	32425,5	30634,8	2900	1.58

Member State	Population (2022)	School Population (2021)	Education Expenditure (Total, Mln EUR, 2021)	Education Expenditure (% GDP, 2021)	Total Economy Expenditure - School (Mln EUR, 2020)	General Government Expenditure – School (Mln EUR, 2020)	Dec (Mln EUR, 2021-2026)	DEC as % of General Government Expenditure On School Per Year
LT	2805998	344414	2682	4,8	1042,4	982,8	30	0.51
LU	645397	89987	3401,1	4,7	1343,8	1274,1	0	0.00
LV	1875757	240230	1873,6	5,6	638	590,8	0	0.00
MT	520971	58275	826,4	5,5	311,9	279,3	41	2.45
NL	17590672	2747992	43981	5,1	19403,9	18536,4	36	0.03
PL	37654247	4716597	28382,7	4,9	12821,6	10972,5	184	0.28
PT	10352042	1319731	9955,3	4,6	5689,3	5067,5	559	1.84
RO	19042455	2319778	7812,3	3,2	2656,7	2641,6	558	3.52
SE	10452326	1865214	35892,1	6,7	n/a	14064,1	0	0.00
SI	2107180	283636	2960	5,7	1242,3	1113,1	67	1.00
SK	5434712	682285	4270	4,3	2278,7	2064,5	20	0.16
EU27	446726291	60113181	700727,1	5,0	233707,2	291340,7	8174,084	0,73

Source: Ecorys' own calculations based on Eurostat, ECA, NRRPs.

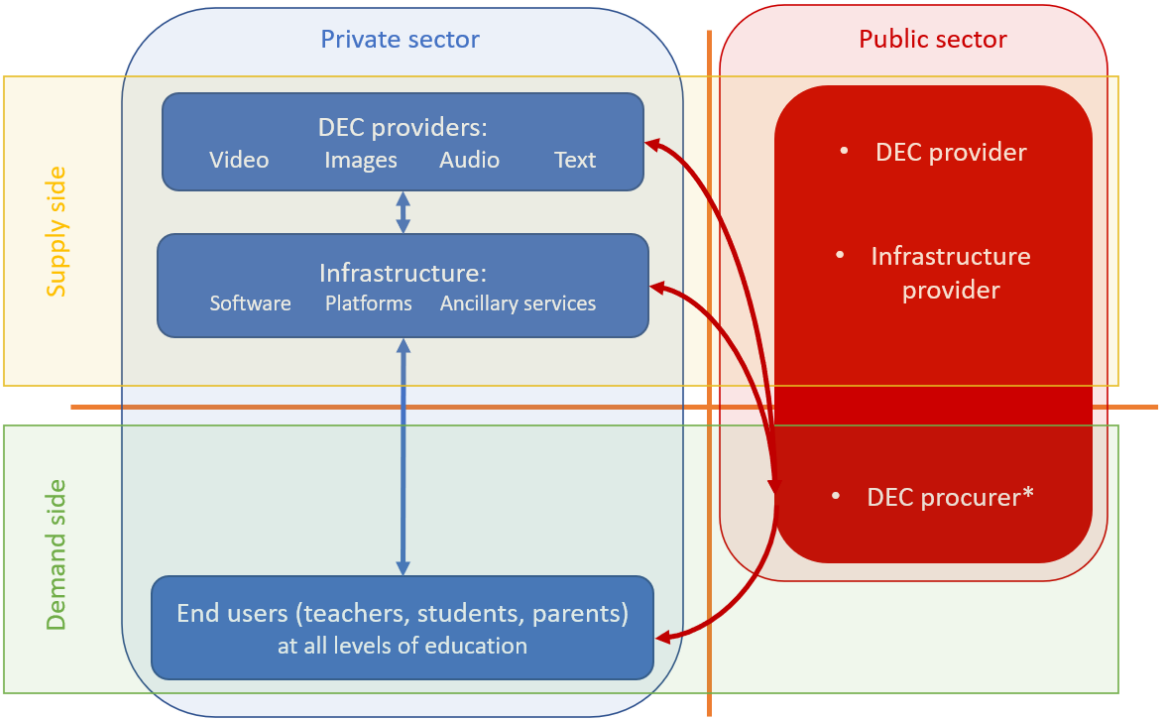
These numbers can be compared with the estimate of the overall EdTech market in Europe, which includes the sale of hardware and software. Through desk research only one study[123] could be found that provides an estimate of Europe's EdTech and Smart Classroom Market. It estimated the size of the EdTech market at USD 20,571 billion in 2019 and is expected to reach USD 61,251 billion by 2027. The geographical scope of this estimate is wider than EU27, as it includes Russia, Turkey, UK and some other non-EU Countries. Among companies, it covers such tech giants as Apple, Cisco, IBM, Microsoft, Oracle, SAP and some others. Based on available information, it is not clear what parts of the revenues of these companies were considered to account for the EdTech component, given that the estimate bundles these companies' hardware, software and cloud provision.[124]

3.2 Market characteristics

3.2.1 Structure of the DEC market

While the structure of the DEC market differs slightly from country to country, a generalised description can be provided for the EU market overall (see Figure 6). This allows us to establish working definitions. As we go on to report in this Chapter, the specific configurations of the supply and demand side are subject to greater complexity when viewed on a country-by-country basis.

Figure 6: Stylised structure of the DEC market[125]



Source: Ecorys, 2023

[123] Research & Markets (2020). Europe EdTech and Smart Classroom Market Forecast to 2027 - COVID-19 Impact and Regional Analysis by Component, Deployment Type, and End-User (researchandmarkets.com)

[124] Note that the net sales of these companies in Europe are enormous. For example, in 2022, Apple's net sales were USD 95 billion, and IBM's revenue was USD 17.95 billion.

[125] DEC procurers may also be private entities (e.g. private schools, universities or companies). However, we consider the share of the public sector procurement to be very significant and, hence, include procurement on the public sector side of the diagram.

The **supply side** consists of DEC providers and providers of infrastructure and ancillary services (hereafter – infrastructure providers for short)[126], while noting that one and the same company can be a DEC publisher and an infrastructure provider. As confirmed by the consulted stakeholders,[127] it is often difficult to draw the line between DEC and infrastructure for the purposes of the estimating the market size not only because many companies offer both packaged in one product, but also because often DEC is integrated in the software.

- **DEC providers** include a diverse range of organisations producing or augmenting digital education content and associated products and services. Many of them are publishers of traditional (i.e. printed) education content and have moved into the production of DEC. DEC offered by these publishers is typically a digital version of their printed materials (e.g. digital books, streamed audio lessons). EdTech companies can also provide a range of DEC offers, including educational games, interactive lessons and other materials, sometimes augmented with AI / XR. Many EdTech companies offer both digital and traditional (printed) content in parallel (including on the basis of "on demand" models).

  There are also specialised service providers to DEC producers such as freelance individuals or companies offering authoring, media editing, editorial services, pedagogical editing, sensitivity reading, and so forth. As shown in the stakeholder survey done for this study, these providers play an increasingly important role within supply chains as DEC offers become more sophisticated and diverse. End users are also sometimes producers and providers of DEC.

- **Infrastructure providers** are intermediaries between the DEC and the end user, i.e. they offer some type of an interface where the end user can consume DEC and ancillary services accompanying teaching and learning. For example, they can offer software that allows reading and engaging with DEC on a desktop or a mobile device. They can also offer platforms based on cloud technology with many supporting and ancillary services for all end users, such as storage, communication and collaboration environments, learning management and analytics, planning tools, examination and feedback solutions and many others.

The **demand side** consists of end users of DEC and procurers of DEC.

- **End users** include individual school leaders, teachers, and other education professionals and their networks, as well as learners, parents, carers and their representative organisations (see Chapter 2) – to a degree to which DEC and services of infrastructure providers are directed at them. End users sometimes but not always pay for DEC they use. The remuneration may be monetary (i.e. in money) or non-monetary (e.g. watching an advertisement). Often, however, DEC is acquired by a procurer and made available to the end user.

  Based on the education levels, the demand side is usually divided into at least four segments as the DEC needs to be specific for each of them: early childhood education, schools, vocational education and higher education. The segmentation is not a precise science as school education can be divided into primary and secondary education, or the segmentation can be also done by subjects (e.g. foreign language DEC, STEM DEC and so on). Thanks to recent technological developments, end users sometimes act as DEC producers.

- **DEC procurers** are those entities that acquire DEC and infrastructure and make them available to end users. The largest share of DEC is acquired through various procurement procedures by the public sector at various levels of government or dedicated private bodies (e.g. private schools, private universities, companies for VET). Although the data on the amounts of public and private DEC

[126] This term refers to platforms, services and tools to produce, distribute, and access digital content for teaching, learning and assessment. This should not be confused with general digital infrastructure, which refers to the necessary conditions (e.g. connectivity)ICT equipment; software and hardware) to be able to access the online environment, including digital learning resources. See Glossary in Annex 1.
[127] Stakeholders at the T&F Group on marketplace.

procurement are not available, we assume that public sector purchases a larger share because all EU Member States have large public education systems.

The state at different levels of government (i.e. central, regional, local), depending on its internal political organisation, would be responsible for procuring DEC and paying for it with public money (from a dedicated budget). The procured DEC is then distributed to the end users. As a procurer, the state (public sector) is in a unique position on the demand side. Firstly, the procurer determines what it wants to buy (e.g. by adopting educational policies and laws, and/or then by issuing a specific description of the intended purchase). Secondly, in some Member States, it may be the sole purchaser for a certain segment of education or for a regional or local market.

The position of the state is unparalleled because of how many roles the state plays in relation to the DEC market. The state can participate on the supply side (e.g. create its own DEC and infrastructure). However, more importantly, it also determines the market structure and sets the rules for the market activity (laws and regulations). The state defines the curriculum for several levels of education (usually, ECEC, schools and partially VET and HEI), thus deciding what DEC can be created at all and forming the market.

The sections below discuss in more detail the supply and demand sides of the DEC market, trends and developments in the near future and what factors impact them.

3.2.2 Demand side characteristics

3.2.2.1 Uptake and use of DEC

Comparable data on the uptake and use of DEC by end users are not available across all EU Member States and for all levels of education. Countries do not systematically collect these data; rather, data on ICT connectivity of education facilities or digital skills of students and/or teachers or other similar data are available. Such data do not provide us with a good indication of actual use of DEC in education.

Desk research revealed that countries that collect data on DEC use very different metrics. In particular, some countries report on the percentage of students using DEC, others – on the percentage of teachers using DEC, yet others – on the percentage of education facilities in which DEC is used. For some countries, only the number of users of one main platform is published (e.g. in countries with public online repositories). Because of this, a meaningful comparison of DEC use by country is impossible, and it is difficult to say how advanced EU Member States are in integrating DEC in their education system.

As shown in Table 7, the least data are available for ECEC. Even though data are lacking, there seems to be a tendency that the higher the education level is, the more DEC is used. A few countries stand out as having fully embraced DEC at all education levels, namely Belgium (Flanders), Denmark, Estonia, the Netherlands and Spain. By contrast, the available data on DEC use numbers show very low use. For more detailed information on data sources, see Annex 4.

Table 7 – Use of DEC at different levels of education, per country

Member State	ECEC	Primary and Secondary Education	HEI	VET
AT	Barely used	55% schools (2020)	72% students (2021)	94% schools (2020)
BE (Fl)	n/a	Nearly all (2020)	Nearly all	n/a
BG	n/a	n/a	n/a	n/a
CY	n/a	n/a	n/a	n/a

Member State	ECEC	Primary and Secondary Education	HEI	VET
CZ	n/a	81% teachers (2022)	n/a	n/a
DE	41% kindergartens (2019)	over 70% pupils (2020)	90% teachers (2017)	97% teachers (2016)
DK	n/a	Nearly all (2021)	99% HEIs (2021)	80% teachers (2019)
EE	85% kindergartens	99% schools	n/a	n/a
EL	n/a	over 40% pupils use the main DEC platform (2023)	n/a	n/a
ES	n/a	Nearly all	Nearly all	Nearly all
FI	n/a	83% schools (2019)	n/a	n/a
FR	n/a	n/a	2,5 mln FUN users (2021)	70% training sessions (2022)
HR	n/a	11% pupils use the main DEC platform (2023)	n/a	n/a
HU	n/a	33% teachers (2019)	13% students used digital library (2016)	n/a
IE	n/a	over 60% lessons (2020)	71% students and 69% teachers (2019)	n/a
IT	n/a	86% schools (2022)	Nearly all	n/a
LT	n/a	50% schools (2017-2018)	n/a	94% schools (2020)
LU	n/a	n/a	n/a	n/a
LV	72% kindergartens (2018)	n/a	n/a	n/a
MT	over 20% teachers (2022)	Nearly all (2022)	n/a	n/a
NL	n/a	Nearly all	Nearly all	n/a
PL	n/a	n/a	n/a	n/a
PT	n/a	n/a	n/a	n/a
RO	n/a	n/a	n/a	n/a
SE	n/a	70% teachers	n/a	50% teachers

Member State	ECEC	Primary and Secondary Education	HEI	VET
SI	n/a	n/a	n/a	n/a
SK	n/a	n/a	n/a	n/a

Source: Ecorys' own calculations based on country mapping for this study

3.2.2.2 Public procurement

This sub-section deals only with public procurement. This limitation is explained by two factors. First, the public procurement of educational content in general represents a larger share of all purchasing of educational content because all EU Member States have large public education systems. Second, no comprehensive information on private procurement of DEC is available. It goes without saying that private procurement of DEC by private ECEC, private schools, private universities and VET facilities and companies is widespread. Private procurement is by nature decentralised in all EU Member States.

Organisation of public procurement (i.e. large part of the demand side) is determined by the organisation of public procurement in any given EU Member State. There is no single model of how DEC public procurement is carried out, and the organisation of public procurement differs for different levels of education within a single country (see Annex 4 for details). In particular it seems that in the higher education sector, the participation of the government is the lowest, and HEIs and students are buyers of DEC. Most country-level procurement information available for this study relates to schools, and based on our analysis of country reports, three main models of public procurement of DEC can be distinguished[128];

- **Centralised procurement:** Under this model, the DEC and DEC infrastructure procurement is carried out at the national level by a single buyer, namely the Ministry of Education or other responsible government agency. This model seems to be very rare and is used only by a few countries. For example, Croatia and Hungary use it for primary schools, and Hungary uses it for VET. It is not clear whether DEC or DEC infrastructure are procured in this way or only to some degree.

- **Decentralised procurement:** Under this widespread model, public procurement of DEC is conducted at lower levels of government (e.g. regional or local education authorities) or even by educational facilities themselves (e.g. schools). Decentralised procurement varies greatly depending on the countries' internal organisations and constitutional traditions. In most countries, procurers vary also by level of education. Of particular interest is that in some countries not only public authorities, but schools and even educators can conduct public procurement of DEC (see Table 8 below).

Table 8 – EU Member States where educational facilities and educators may organise DEC procurement

	ECEC	Secondary education	Higher education	VET
Educational facilities can organise own DEC procurement	AT; BE; CZ; DK; DE; FR; LT; NL; PT	AT; BE; DE; FI; FR; IE; LT; NL; PT	AT; BE; DE; FI; FR; IE; NL; PT	AT; BE; DE; FI; NL; PT

[128] We note that this typology may be incomplete and/or imprecise because information on the organisation of DEC public procurement for Bulgaria, Croatia, Cyprus, Estonia, Greece, Hungary, Malta, Poland, Romania and Slovenia was incomplete or unavailable.

	ECEC	Secondary education	Higher education	VET
Educators can organise own DEC procurement	CZ; ES; IT; SK	CY; CZ; EL; ES; IT; LV; SK	CZ; EL; ES; IT; LV; SK	CZ; ES; IT; SK

Source: Ecorys' own elaborations based on country mapping for this study

In Austria and Poland, procurers are not entirely free to choose DEC, but must select from the content and/or providers approved by the Ministry of Education. In Latvia and Luxembourg, schools can select approved DEC and/or providers and then request the responsible municipality to procure them.

- **Mixed procurement:** Under this model, centralised and decentralised procurement is possible. This is also a popular model in Austria, Cyprus, Czechia, Finland, Greece, Latvia, Lithuania, Slovakia and Spain. From the available information, it is not clear how the delimitation is done between what is acquired centrally and what is acquired by regional or local authorities.

The available data are unclear with regard to what procurement rules are applicable (i.e. EU procurement rules or national) and what types of procurement (e.g. open tenders, competitive dialogues) are used for different purchases in what country. The procured DEC is usually distributed free of charge to teachers and students.

While we aimed to categorise Member States' public procurement under three typologies, there are certain **peculiarities and special features in some Member States worth** including:

- In Slovenia, parents and students have to buy educational materials, including DEC, but these are sold at reduced prices subsidised by the state. The available data is not sufficiently clear to describe how this subsidisation occurs (e.g. vouchers directly to end users, special agreements between the government and publishers).
- In Poland and Slovakia, the procured DEC can be complemented by DEC purchased privately by parents and students.
- In Croatia, Poland and Slovakia, schools can use their own budgets to purchase DEC that is not available via the government-owned DEC platform.
- In Malta, teachers can request permission from the Ministry to have the children install freely available software.
- In Romania, subscriptions to platforms have been purchased by teachers, from the local budgets or funds raised by parents' associations.

3.2.2.3 Spotlight on the demand side: mini-survey of educators and learners

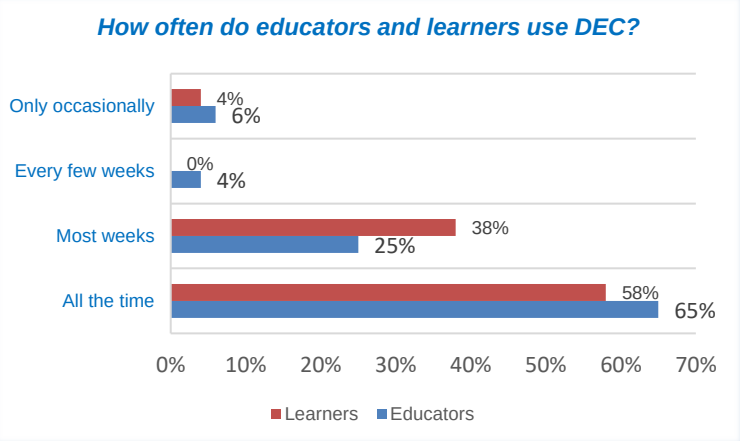
The box below presents a short overview of some of the key findings from a mini-survey carried out in May 2023 to gather educators and learners' views on DEC and its use in their teaching, learning and assessment practices. The survey received a total of 170 valid responses, 138 of which were from educators, and 32 from learners. While the survey is not representative of the perspective of all educators and leaners across Europe, the results provide helpful insights on existing challenges and opportunities.

Box 9. Spotlight on the demand side: education stakeholders

WHAT DOES THE DEMAND SIDE LOOK LIKE ACROSS THE EU?

Demand for DEC entails different needs and preferences, resulting in different user patterns

This stakeholder group comprises heads of schools, educators (teachers and trainers) and other school staff, as well as learners (pupils or students) across all education levels included within the study (ECEC, primary and secondary including VET, and HE). Each of these groups have their own user patterns, preferences, and concerns. While not representative of all stakeholders on the demand side, the mini-survey of educators and learners carried out as part of this study can offer some insights on their needs and behaviours in relation to digital education content.



When asked about **how often digital education content is employed** in their teaching and learning practices, the study's mini-survey showed that a majority of educators and learners use digital education content very frequently, with 65% of educators and 58% of learners indicating they use it 'all the time' and a subsequent 25% and 38% using it 'most weeks'. However, it should be noted that, while the mini-survey allowed for a zoom-in on a sub-set of learners and educators, data on use and uptake of DEC remains largely unavailable.

WHAT TYPES OF DEC DO EDUCATORS AND LEARNERS USE?

Engaging and interactive content that can be tailored to needs and lessons plans are the preferred choice of educators and learners

In terms of the **types of content preferred,** heads of schools prioritise sourcing and disseminating safe and affordable digital education content that can be easily employed by their teaching staff[129]. In the EU, school leaders have been reported to hold significantly more positive attitudes towards ICT use for learning and teaching than teachers do[130]. When it comes to learners, both desk research and survey evidence suggest that learners are primarily interested in stimulating and engaging digital content in their classrooms tailored to their individual learning needs and pace[131]. Emerging research also suggests that learners prefer digital learning in the blended or flipped format rather than solely online formats[132].

Educators have similar preferences, with the added caveat of placing a high-level of importance on access to digital content that aligns with their lesson plans, while remaining user-friendly and time-efficient[133]. These findings from the literature are mirrored in the findings from the crowd-sourcing survey, where interactivity, engagement, personalisation, collaboration, user-friendliness, customisation and scaffolding were cited as key considerations in selecting digital content. Moreover, tools that support assessment, particularly formative and peer-assessment, were cited as highly valued resources.

[129] Tołwińska, B. The Role of Principals in Learning Schools to Support Teachers' Use of Digital Technologies. Tech Know Learn 26, 917–930 (2021). https://doi.org/10.1007/s10758-021-09496-4

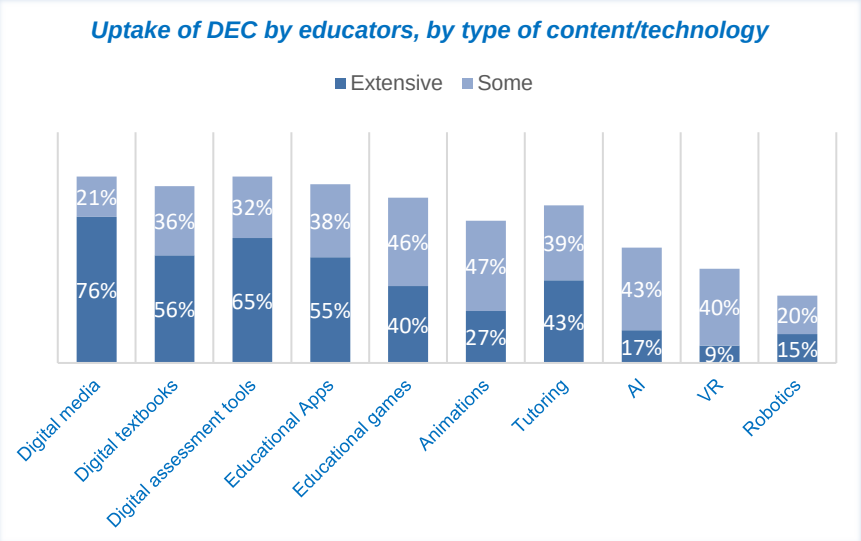
[130] 2nd Survey on Schools on ICT (European Commission, 2019).

[131] https://www.oecd-ilibrary.org/fr/education/oecd-digital-education-outlook_7fbfff45-en

[132] See for instance: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC10047520/

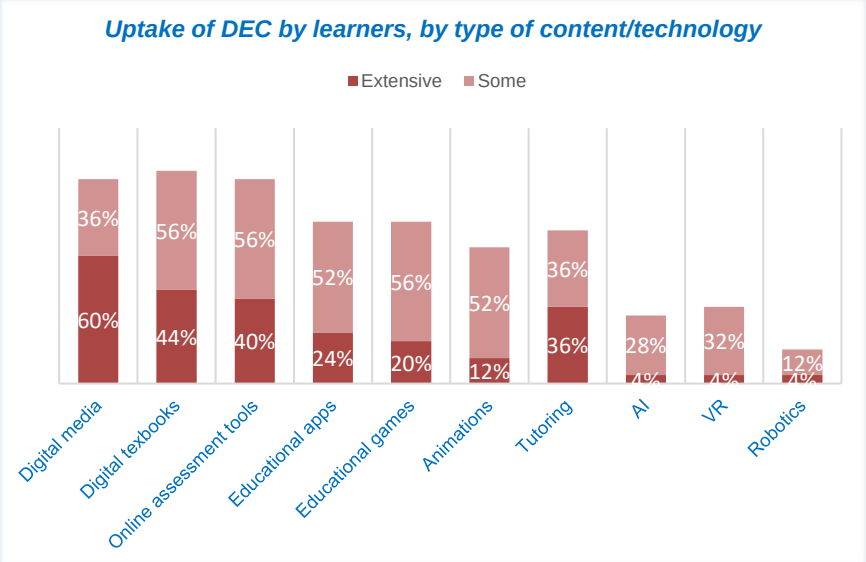
[133] Teig, N., Scherer, R., Nilsen, T. (2019) I Know I Can, but Do I Have the Time? The Role of Teachers' Self-Efficacy and Perceived Time Constraints in Implementing Cognitive-Activation Strategies in Science. Front Psychol. 2019 Aug 2;10:1697. doi: 10.3389/fpsyg.2019.01697. PMID: 31428011PMCID: PMC6687835.

These preferences are largely echoed in the actual uptake of different types of content teachers report using, which **favour content that teachers can readily identify as relevant and quickly incorporate into their lesson plans**. In particular, educators overwhelmingly reported having extensive experience with traditional content such as digital media[134], as well as digital textbooks[135].



Uptake in online assessment and tutoring tools is also reportedly high. Software that support engaging, interactive and collaborative learning also showed a notable uptake, including educational apps and online educational games. Content generated through emerging technologies, on the other hand, still has a more modest overall uptake, with AI (including ChatGPT), reported as most frequently used among these.

For what concerns learners, the mini-survey showed that they tend to rely on digital resources for practical exercises (e.g. quizzes and e-tests); access to additional resources to get information and ideas for their homework and exams; and course attendance.



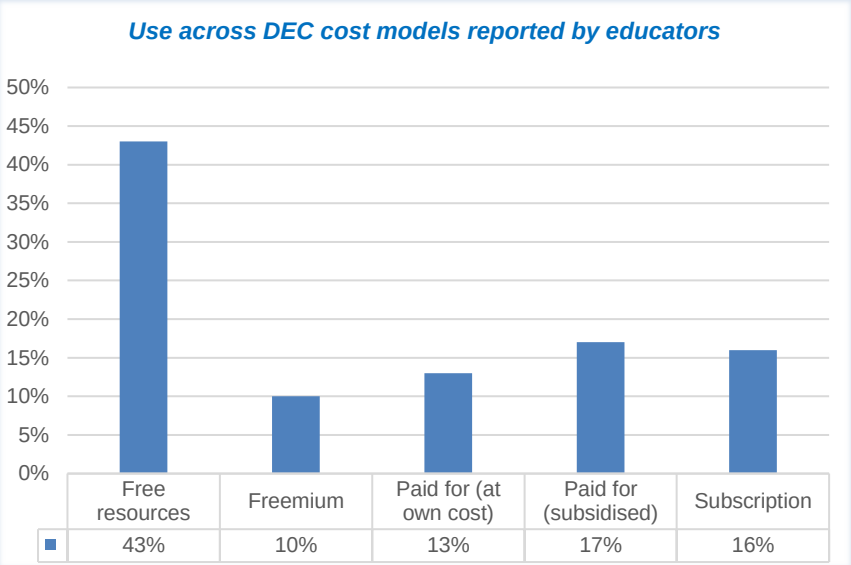
The survey results are comparable for educators in relation to the uptake of different types of DEC. Learners report slightly lower levels of usage compared to educators. Nonetheless, similar percentages of uptake may indicate that learners' use is linked to the extent to which their educators incorporate DEC in their teaching practices.

[134] Graphics, images, documents, audio and video.
[135] Also known as e-textbooks.

ACQUISITION PRACTICES

Broad reliance on free resources, with paid and subsidised resources representing a low share of DEC taken up by educators

A recent study reported that **two-thirds of teachers said that they faced barriers related to expenses connected with using digital materials**, such as the expense of buying computers or other electronic devices for school and the expense of students' home access to devices and the internet[136].



These barriers are even more common for teachers serving larger numbers of low-income students. Teachers of low-income students might be able to use free digital materials in a school-based setting, but these materials are **not necessarily available to all students when doing their homework, as many do not have access to devices and internet at home**[137].

As argued in the literature, a significant number of survey respondents suggested that educational resources should be subsidised by the state, particularly in view of equity concerns. As the figure shows, however, to date a majority of teachers surveyed still primarily resort to using free resources, with subsidised resources making up a modest share of digital education content employed.

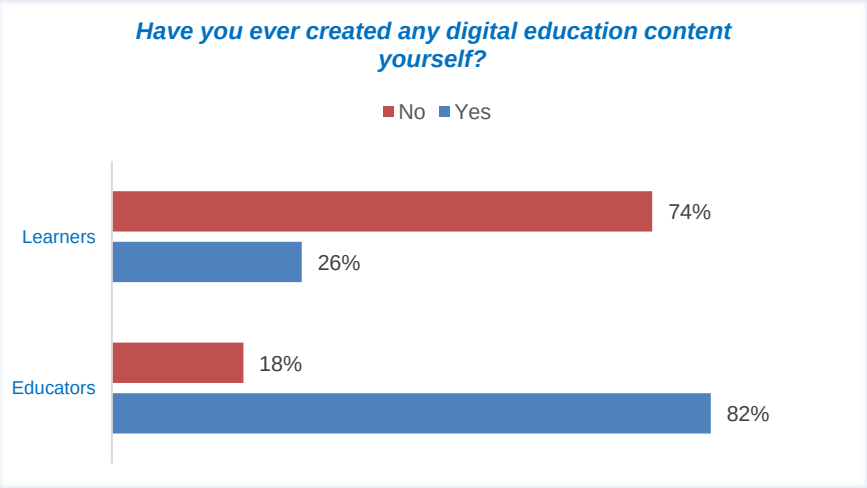
EDUCATORS AND LEARNERS AS DEC CREATORS

Educators are more involved than learners in the production of content, with a large variety of resources being created and shared with other teachers for re-use and feedback

While educators and learners can use DEC produced by professional organisations, they can also act as content creators themselves. For example, educators may become involved in digital education content production either by being asked by their own education administration to produce materials for their peers or students; or by collaborating with private or public publishers. Learners can also produce digital education content, for example in the context of their courses, and including by cooperating with their teachers. Last but not least, both learners and educators can use digital content not initially intended for to teaching and learning (i.e. peripheral digital education content)[138] into DEC by integrating it into the learning process.

[136] https://www.rand.org/pubs/research_reports/RRA134-3.html
[137] Ibid.
[138] See Chapter 2 and the definition of ''peripheral digital education content'' in the Glossary of terms in Annex 1.

The results of the mini-survey show that **educators are involved in the creation of content much more than learners**, with the vast majority of respondents among teachers indicating they have created DEC themselves, as opposed to less than a third of the students. Types of content produced by surveyed educators range from presentations to videos, podcasts, to educational games, online quizzes, online courses, digital storytelling and OER.



Respondents underline how these resources help making their lessons more interactive and appealing for the learners, and that they regularly share their own content with other educators, and re-use it across classes and courses, with some indicating that they ask other teachers and students for feedback to improve the material. Despite this, a generally heavy **workload, low levels of digital skills, and lack of adequate recognition act as barriers for educators** to engage in content creation.

CHALLENGES AND OPPORTUNITIES FOR EDUCATORS[139] AND LEARNERS[140]

- **Quality DEC is not always affordable**. While costs are seen as generally proportionate, educators insist that resources should be free/subsidised by the State.
- **DEC remains a low priority for education institutions**, mostly due to concerns related to costs/affordability and lack of trust (e.g. risk of disinformation and plagiarism).
- **DEC may worsen the digital divide** if adequate support is not provided to all schools and learners for its acquisition and use. This is also linked to access to hardware and software, as well as digital teaching and learning practices.
- **Learners' wellbeing is a concerns as** excessive screentime is seen as damaging, and digital resources could lead to overstimulation and become counterproductive.
- **Teacher-created content needs better recognition** (e.g. remuneration, career progression), **as well as investment in training** (e.g. to increase technical expertise and keep up with the pace of the digital transformation) **and guidance** (e.g. on copyright and legal implications).
- **More interactive and engaging lessons**, as well as customisable content, captivating the attention of learners and better responding to needs, with positive impact on their progress.
- **Opportunity to invest in guidance and sharing of good practices**, to provide concrete evidence of impact of digital content and avoid a ''digital is better by default'' logic.
- Opportunity for school management/school leaders to lead the digital transformation in education institutions through guidance to educators and budgeting.
- **Stronger formal and informal cooperation within the teaching community**, to share experiences and promote teacher training, tutoring and coaching.

[139] Icon made by Bert-Flint on flaticon.com
[140] Icon made by lutfix on flaticon.com

	• **Difficulties with navigating the DEC offer and identifying quality resources,** as learners do not always have the skills to filter the volume of information and identify trusted providers. • Online learning can lead to wellbeing issues due to excessive screentime, requiring self-discipline on the side of learners. • **Mental health is a concern due to increased isolation,** with a greater onus put on educators, parents and carers to monitor learners' psychological wellbeing.	• **Greater access to learning resources and opportunities**, beyond education institutions and libraries, leading to greater flexibility. • **More interactive, fun, and affordable education content,** making the learning process easier and more engaging.

Source: Ecorys, 2023

3.2.3 Supply side characteristics

Data collected and analysed support the initial finding that the supply of DEC in the European Union cannot be understood as monolithic. There is a great degree of variation across Member States with regards to both the supply of DEC infrastructure and of content itself. This fragmentation is a direct result of the heterogeneity of approaches to education across EU Member States, which represents a valuable feature showcasing the richness of European education systems, and allowing national DEC markets to evolve at their own pace, depending on the maturity of the system they operate in.

Another feature of DEC markets that contributes to fragmentation is the variety of actors involved and the multiple roles that specific stakeholders can take on within and across the supply and demand side (e.g. public authorities moving within the supply-demand chain depending on the level of centralisation of education systems; or the challenging role of DEC distributors, who ensure access to content produced by multiple providers and publishers; but represent an intermediary in the customer-provider relationships, which does not allow DEC providers to access client feedback and data directly).

In the following sections, we provide an overview of the supply of DEC infrastructure and content separately, given the different competitive landscape of the two segments.

3.2.3.1 Supply of infrastructure for DEC

With regards to the supply of infrastructure, different segments can be distinguished in the DEC market. They include:

- International platforms (that include multiple of tools or services, such as communication and collaboration) or course management systems (CMSs) such as Google Classroom or the open-source Moodle;
- Platforms for administrative tasks and teachers/parents exchanges and communications; such as Librus or E-Klaze – used in Poland and Latvia respectively for parents to have an overview of their children's grades – Magister and Sometoday – used in the Netherlands for communication between parents and teachers;
- Repositories of content, divided into 1) cloud repositories for the sharing of content at the individual level (e.g. Dropbox used by teachers to share DEC with students) and 2) platforms dedicated to storing and accessing DEC, such as YouTube for audio-visual or dedicated platforms where subscribers can access DEC developed by a publisher;

- Platforms incorporating a variety of the aforementioned functions and/or other ancillary services. Examples include Stuudium, e-Kool in Estonia – used for both exchanging information with parents and managing learning – VLE and ENT in France – used for both administrative and pedagogical aspects. Under this category, multiple ancillary services can be offered, spanning from online webshops for ordering DEC material – such as SURF in the Netherlands – to software to manage and organise DEC databases, e.g. ONIX metadata managers.

To provide comparable typologies across Member States, DEC infrastructure providers can be grouped as:

- **Public providers** that developed and ran the online platform or software in-house, procured a private company to develop and run the public service, or a private provider who has a public service delegation;
- **Private providers that require payment** for accessing their services.
- **Private providers who allow open access**.

It is not uncommon for both private and public infrastructure providers to also act as content providers.

Publicly available data is scarce and does not allow a segmentation by educational level for most Member States. Still, evidence substantiated by stakeholder consultations suggests that in most EU Member States, the **supply of platforms and infrastructure for DEC is very competitive.** Traditional publishers – both national and international – developed platforms for the use of the DEC they produce (blurring the line separating traditional and digital publishers), Edtech companies offer a variety of tools for teaching both domestically and internationally, while Big Tech companies offer competing products increasingly tailored for education, leading to the availability of multiple solutions with regard to the type of service offered and the educational level targeted by each supplier.

In some cases, e.g. Sweden, the market is too small for the number of competitors present, spurring Swedish EdTech companies to look outward and expand their offering across the Nordic countries. The EdTech sector is more developed in some Member States than in others, with countries such as Estonia, France, Germany, Italy, Spain, and Sweden spearheading the EdTech market in Europe, according to desk research.

While private DEC infrastructure providers compete across Member States, public authorities in most EU countries also provide their own infrastructure for DEC. In many cases, public platforms are repositories of content produced by teachers or public bodies. Information collected suggests that in at least 10 countries public platforms also supply infrastructure for DEC, such as registry, information sharing between teachers and parents, and creation of DEC (Austria, Bulgaria, Czech Republic, Demark, Estonia, France, Greece, Croatia [pilot project], Hungary, and Latvia). Information on the uptake and of such platforms is scarce and not easily comparable (see section above on uptake and use of DEC).[141]

In seven countries (Austria, Bulgaria, Estonia, Greece, Croatia, Hungary, and Latvia) a **unitary/single-access platform** has been developed by public authorities to provide access to DEC content, e-registers, grading tools, and ancillary tools. In Latvia, public authorities developed a platform to allow the **data integration between private and public platforms**, thus supporting the supply of private platforms in a market where the state's platform has a central role.

The **dual role of supplier and procurer of the public authority** appears to only have weakened the supply of DEC infrastructure providers in Denmark and Greece. In **Denmark** an **oligopolistic market** developed with only a handful of providers[142]; in the latter procurement rules were recently overhauled to incentivise the entry of private actors in a market until then dominated by public sector. **Greece** appears to be the **only EU country**

[141] During the T&G workshops on Marketplace, stakeholders noted that the lack of available data in this regard is worrying on two different levels. First, as these platforms were developed using public funding, accountability should be ensured to understand the impact of such investments. Second, this lack of data might hinder competition: private sector DEC providers are often challenged by public sector providers based on the lack of data, which often leads to the adoption of public platforms/ public DEC without having a clear understanding of competitiveness in this regard.

[142] Information gathered during the country mapping suggest only 4 providers exists at the moment.

where, until very recently, the **supply of infrastructure and content** (see below) for DEC has been **captured by the state**, where solutions produced in-house are procured.

In term of competitive landscapes, **outside of the main global players, a majority of infrastructure providers appear to be private companies.**

3.2.3.2 Supply of content

The supply of digital education content across the EU is diverse and complex, with each Member State having its own unique market characteristics. Multiple factors explain such diversity and complexity. First of all, (digital) education content has extremely wide scope, being designed and implemented for multiple educational objectives, such as to complement, replicate, or substitute in-person teaching or printed textbooks. For example, DEC can be designed to spur pupils' engagement at ECEC level, or to allow practice via simulation of complex or dangerous procedures at VET or HE level (think of machinery and surgery simulators).

These examples barely introduce the variety of materials and services that fall within the definition of DEC. Furthermore, factors such as linguistic differences, organisation of the educational systems, curricula – strictly defined at a national level or flexible frameworks where teachers tailor their offering – and procurement rules (see section 3.3.2.2 above), all contribute to notable differences across Member States.

The supply of content can potentially be separated into submarkets based on educational levels, types of products/services, or other meaningful categories. Nevertheless, overlaps between submarkets, or peculiarities falling outside a simple definition of submarkets reduce the power of such categorisation to better understand market complexities. Across the EU, DEC providers include the following actors:

- **Educational publishers:** traditional publishers who provide paper books, increasingly but unevenly moving into the supply of DEC and, in some cases, associated tools and services.
- **EdTech providers:** private companies developing innovative contents and sharing solutions, or tools without the content itself; specialised service providers to DEC producers such as freelance individuals or companies offering authoring, media editing, editorial services, pedagogical editing, sensitivity reading, etc.
- **Public broadcasters, ministries, and other public bodies:** public authorities, in addition to being the main procurers of DEC in the EU, are increasingly producing and sharing their own DEC on publicly controlled platforms. DEC shared on these platforms can be aligned with school curricula, but this is not always the case. This leads in certain cases to a strong capture of the market by the public sector, which set the rules for demands, steering supply, while also supplying its own content.
- **NGOs and associations:** e.g. in the provision of open access DEC for pupils with special needs of medical, linguistic, or cultural. Examples include DEC freely shared by associations focusing on the integration on migrant children.
- **Teachers, students, and learners (both as individuals and via professional or student associations):** Teachers are often directly involved in the production of DEC. This can happen, generally, through a request from the administration that employs them, via collaboration with publishers, via teachers' associations, or in a private capacity. Whether distribution is regulated, and how supply of this content takes place depends on the country and the educational level. For example, in higher education, DEC produced by professors is the most common format of learning material.

The lack of precise data remains a limitation of this exercise, as also flagged and recognised by consulted stakeholders. However, we have been able to gather some additional information for each category of providers.

- The **supply of DEC produced by traditional publishers** is, in the majority of Member States **competitive**, with a number of established providers offering their content. Business models can be grouped around the following typologies**:**

- **Publishers offering traditional and DEC as alternative products,** referring to publishers who supply the same content either as printed and digital format (Bulgaria[143], Czech Republic, Estonia[144], Spain, Finland[145], France, Croatia, Hungary, Lithuania, Luxemburg, Latvia, Malta[146], Netherlands, Portugal, Sweden, Slovakia[147]).
- **Publishers only offering DEC:** There are a few recorded instances of new providers established after the start of digitalisation of education that compete against traditional ones focusing solely on digital format of traditional education material.
- **Publishers offering DEC as add-on and not stand-alone products,** thus limiting the development of DEC as a self-standing segment of the market.

- The **supply of DEC produced by EdTech** companies varies greatly across Member States. At the current stage of the market analysis – given the current gaps in available information – EdTech markets can be grouped as follows:
  - **Mature:** where multiple companies compete for market shares against each other and against traditional publishers (Germany[148], Estonia[149], Spain, France, Lithuania[150], Netherlands[151], Sweden).
  - **Developing:** where companies are entering the market, but the quality of quantity of DEC offered is not yet mature (Poland[152]).
  - **Immature:** where few to no companies exists and the segment is captured by other providers, or non-existing (Flemish Belgium, Greece, Croatia, Malta, Portugal, Romania).
- **All Member States' public authorities currently produce and supply DEC.** DEC produced and supplied can vary from simple content bases, self-contained lessons, all the way to complete modules and courses including multiple modules. DEC can, in some cases, be supplied with supporting DEC infrastructure to tailor, or adapt content.

  The coverage across educational levels, the number of tools and services available, and the quality and quantity of content supplied by public authorities therefore varies between countries, with some pioneering the development of DEC, and other only recently developing their own offering. For example, in Malta a public repository has only been created as a response to the COVID-19 pandemic. Most Member States also offer their own intermediation platforms, supplying an integrated offering for free to student and educators.

[143] DEC from publishers is available in the single platform developed by public authorities. See previous section on supply of infrastructure.
[144] A 2019 publication by the Estonian Centre for Applied Research CentAR reports that obligation from 2015, stating that educational literature corresponding to the national curriculum of lower and upper secondary schools had to be made available digitally. Opiq, which is currently one of the most used platforms brings together the digital versions of (text)books of Estonia's largest educational publishers.
[145] In most cases, digital format also includes a varying degree of both audio and video material and interactive features.
[146] While the Maltese market is extremely small, supply of DEC from international publishers is very vast thanks to education taking place in English. The supply of DEC in Maltese is currently limited.
[147] DEC is integrated in the single platform developed by public authorities. See previous section on supply of infrastructure.
[148] Multiple EdTech companies exists and supply internationally as well. However, interviews suggests that smaller EdTechs are struggling to find distribution channels within the country, which is dominated by traditional publishers.
[149] EdTech holds a strong position in the market – especially after the shift to remote education due to COVID-19 pandemic. By the end of 2020, within one year, 43 EdTech companies were registered in Estonia.
[150] Based on desk research, digital education content is often offered by start-ups as an extracurricular activity for pupils to learn programming or coding and improve STEM skills. However, there are some examples of DEC that has been created for formal education, for example, game-based learning through Minecraft.
[151] Small and medium size enterprises are mostly driving the innovation in the Netherlands. They often are specialised niche market publishers. There also are some disruptors in the edtech market for higher education such as Feedback Fruits and Grasple. There are some start-ups in the edtech market such as leeruniek, misterchadd developing new services.
[152] The Foundation EdTech Poland (15 Members) gathers companies, providing innovative digital solutions and content. These are mainly small and medium companies or/ and start-ups.

- Ministries of Education are actives in most countries with the production and distribution of DEC specifically tailored for national curricula;
- Public broadcasting companies in certain countries also produce DEC and share it on their own platforms (examples include ORF in Austria, Yle in Finland, and RAI Scuola in Italy). Such content is often free to access but not necessarily to reuse during school activities;
- Museums, public libraries and other public institutions often produce DEC in their field of expertise. Such content is often free to access but not necessarily to reuse during school activities.

- Data concerning the **supply of DEC by associations and NGOs** is scarce and typically based on specific case studies. Because of this, its quantification and relevance for the market is impossible to determine.
- **Teachers' content** is shared following different models in different countries:
  - Certain countries established a **public platform** where teachers (individually or via teachers' associations) can upload their content, for other teachers and students to freely search, re-use, and adapt (Austria, Flemish Belgium, Estonia, Greece, Croatia, Malta);
  - In other countries, teachers' DEC is supplied via **private platforms** (Spain, France);
  - In a few countries the **supply of teachers' DEC is filtered by public authorities**, where a jury assesses the quality of the DEC before making it publicly available on its platforms (Bulgaria, Czech Republic, Slovakia);
  - In some cases, a public platform is also complemented by competing private repositories (Hungary, Ireland, Romania).

3.2.3.3 Spotlight on the supply side: DEC provider survey

The box below presents a short overview of some of the key findings from the DEC provider survey carried out in February-March 2023 to gather information on explore business models, provider offers and their characteristics, and current and future needs and priorities for a healthy marketplace in the EU.[153] The survey received valid responses from 108 organisations operating within Europe's DEC marketplace. As with the mini-survey of educators and learners, while the survey of providers should not be considered as representative of the perspective of all organisations on the supply side, it can offer insights on current challenges and opportunities.

[153] See DEC provider survey report.

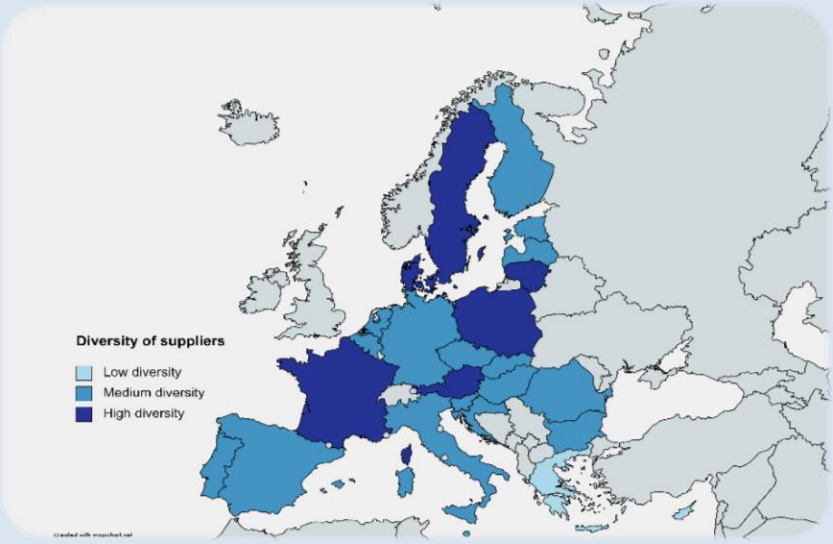
Box 10. Spotlight on the supply side: DEC provider survey

WHAT DOES THE SUPPLY SIDE LOOK LIKE ACROSS THE EU?

Varying levels of diversity within Member States'' supplier base

The **supplier base is largely homogeneous in the majority of countries** in the EU (BG, BEfl, CZ, DE, EE, ES, FI, HR, HU, IE, IT, LV, MT, NL, PT, RO, SI, SK), favouring large and established EdPub organisations as well as international EdTech and/or Big Tech providers.

A **mixed supplier landscape characterises a second group of countries** (AT, DE, DK, FR, SE), with a diverse provider base of native and international EdTech and EdPub of different sizes.

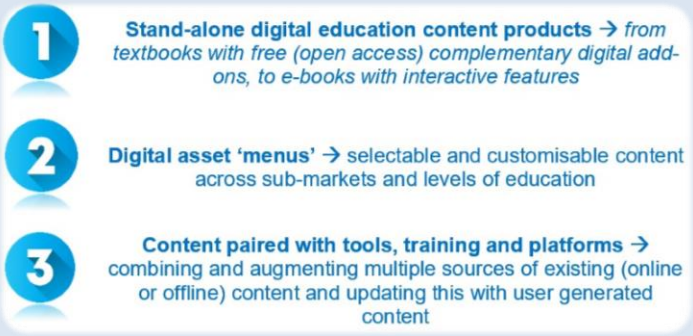


A small number of countries presents a fledgeling market with small number of providers, limited scale and diversity.

WHAT TYPES OF DEC ARE AVAILABLE ON THE MARKET IN THE EU?

The DEC offer includes a vast variety of products available to customers on their own, or through menus and packs of resources

Private suppliers provide a large variety of products and services to cater to users' needs. These range from learning scenarios that include digital resources, online courses (e.g. MOOCs), digital media (e.g. graphics, images, documents, audio and video), e-books, educational apps, online assessment tools (e.g. quizzes, question banks, e-tests); educational games; Open Educational Resources (OERs); and others. **DEC is made available on the market either as a standalone, or as part of a menu of customisable resources users can choose from depending on their needs, or as a package** with tools, training and platforms.



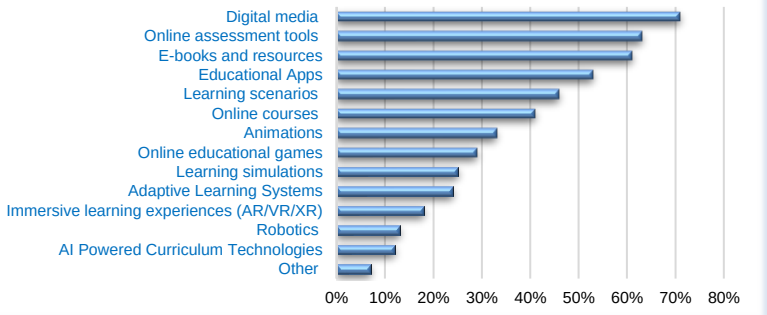
Based on feedback from consulted providers, while emerging technologies (e.g. AI, XR, VR) do not yet feature as part of the core DEC offer across providers offers, as one in five surveyed organisations reported using AR/VR/XR to offer immersive learning experience, and a lower share indicated offering robotics and AI, this data reflects a degree of market penetration for such technologies. Furthermore, with the recent take-up of AI in education and significance assigned to these technologies when looking to the future market, trends could soon see an increased integration of these solutions in the DEC market.

Not just products: the DEC offers include a wide range of tailored support and training services

DEC providers usually accompany their digital education products with a series of **additional services, to help customers to select, procure, use, evaluate DEC, as well as create digital materials themselves**.

Services range from technical support (e.g. maintenance), to the provision of hardware, data analytics and visualisation, or consultancy and editorial services. According to survey respondents, while not routinely offered, instructional materials is provided by the majority of organisations (65%). This is followed by training programmes targeting educators, to support them with using DEC in their day-to-day work.

Which of the following specific types of DEC does your organisation currently provide?



HOW DO SUPPLIERS ORGANISE AND FUND THEIR WORK?

Subcontracting, partnerships and consortia as key avenues for cooperation within the supply chain

SUBCONTRACTING

- Providers play multiple roles within content chains (design, creation, curation, dissemination).
- **Two thirds of surveyed providers subcontract to other supplliers**; and over half of surveyed providers offers their service to other suppliers.
- **Older companies are more likely to sucontract than younger providers**, but are less likely to provide their services to others.
- Subcontracting happens for a variety of reasons, including purchasing content (e.g. from freelance writers, or publishers); acquiring specialist knowledge (e.g. technical or pedagogical); translation or editorial services; platform development; licensing; and others.

PARTNERSHIPS AND CONSORTIA

- Partnerships allow providers to **access funding, participate in the governance of DEC, and engage with a broader range of stakeholders** with different technical and pedagogical expertise.
- The **majority of surveyed providers engages in partnerships** with other suppliers or consortia, either sometimes or often.
- Operating within partnerships and consortia helps providers to bid for public service contracts and projects, or for research grants; and take an active role in education governance arrangements, either through cross-sectoral partnerships with public authorities or participation in EU or national level networks and associations.

Own resources, national budgets and EU funds as the main source of financial support for suppliers

The survey reveals that **financial support can derive from fairly diverse sources** – from organisations' own resources to public (EU, national, regional) and private funds (e.g. Venture Capital, Angel investment), bank loans, and crowdfunding. However, **self-funding, and support from regional or national authorities and from the EU or associated agencies stand out as the main funding streams** for surveyed suppliers (52%, 42% and 29% respectively), with the high ranking of public funds being consistent with the reliance on partnership arrangements described above. However, **the extent to which and how sources of funding are utilised are affected by organisation's years of operation in the market**.

New(er) companies (0-9 years)	***They draw on self-funding (67%) and public funding from regional or national authorities (42%) and are the most likely to access Venture Capital and Angel investment, but less likely to access private capital from a parent company.***
Mid-range companies (10-19 years	***They are the most likely to draw on self-funding, with over three quarters (75%) reporting to do so, and take bank loans (24%). However, they very rarely access private funding from parent company.***
Established companies (20+ years)	***They are considerably less likely to draw on self-funding (33%). Their main funding streams comprise of public funding (46%) and private funding from a parent company (41%). None of them reported receiving Angel investment.***

REVENUE AND TURNOVER FROM DEC

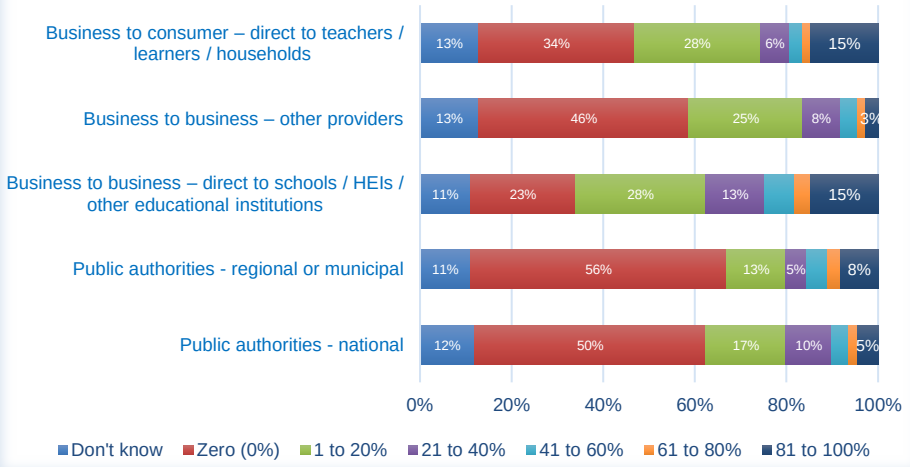
Suppliers' revenue is as diverse as their products and services portfolios

DEC represents only a portion of suppliers' revenue streams, with 67% of surveyed providers reporting that the sale of DEC generates revenue for them, and 46% of organisations, and also indicating non-digitalised content (e.g. textbooks, exercise books, equipment and sensors) as a source of income. As suppliers also include a wide range of DEC-related services in their offer, just under one third of survey respondents also generate revenue from their sale. Lastly, licensing fees, publication or distribution rights, freemium subscriptions, training and continuous professional development, were also indicated as a revenue stream (by 31%, 21% and 19% of respondents respectively).

Business to Business (B2B) and Business to Consumer (B2C) as the main markets models across suppliers in Europe

B2B represents as the most common business model among surveyed suppliers, with direct sales to schools, higher education institutions and other educational institutions representing the highest proportion of DEC sales among respondents, followed by direct sales to teachers, learners and households. Provider types come into play, with **EdPub attributing a higher proportion of their sales to the B2C category than EdTech**, while the latter reported higher volumes of B2B sales B2B than EdPub.

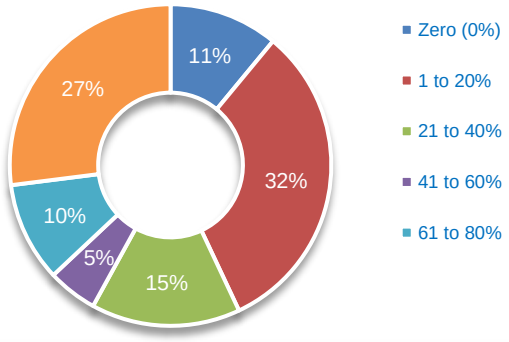
What proportion of your sales of digital education content and associated support and services correspond with the following customers?



This reflects the variety of roles within EdTech, with some providers seemingly acting as specialist subcontractors within supply chains.

The survey responses can also be useful proxies for **understanding trends in provider performance and market conditions**. Just over 35% of suppliers report an annual figure upwards of EUR 3 million. At the other end of the scale, 25% of providers report annual turnover between EUR 0 and 249k, with the remainder spread across the categories in-between. However, there are **wide variations in the proportion of annual turnover derived from DEC and related services**, with EdTech, on average, being more reliant on DEC and related services for a high proportion their annual turnover, compared to EdPub.

What proportion of your organisation's annual turnover concerned DEC and related services?



Overall findings show a **positive trend of steady year-on-year turnover growth from 2017-18 onwards** among surveyed providers, corresponding with a period of expansion for the DEC market in Europe. Many providers reported making initial gains prior to the COVID-19 crisis, assisted by rapid digitalisation in the publishing sector; the emergence of new partnerships, acquisitions and mergers, and access to markets outside of Europe.

Suppliers capitalised on opportunities presented by emergency distance learning during a period of high public investment in digital infrastructure; heightened demand for digitalised resources, and new opportunities for direct interaction with schools and learners to understand their needs. Looking ahead, the vast majority of **providers anticipate positive turnover growth into 2023-2024 and 2024-2025**.

CHALLENGES AND OPPORTUNITIES FOR DEC SUPPLIERS

FRAGMENTATION OF MARKETS AND REGULATORY APPROACHES[154]

- **Fragmentation means navigating multiple national markets** with different regulatory, pedagogical and infrastructural demands.
- **Pressure on providers to strengthen their sales** and offer an expanded array of services to be competitive.
- **Multilingualism** results in wide disparities in the availability of content in Europe's diverse languages.
- Differences in regulatory and policy frameworks across can hinder the market, particularly for suppliers operating transnationally (e.g. interoperability).

- **Culture of resilience and adaptation**, with the vast majority of surveyed providers tailoring their offers and operating multiple business models to reflect sub-markets and national frameworks.
- **Growing sophistication of DEC supply chains,** with significant use of subcontracting, and local suppliers to provide native language expertise and an understanding of sub-national markets.
- **Potential for coordinated action at EU level** to define standards and taxonomies on copyright, interoperability and use of data, and sharing of **good practices**.

PEDAGOGY[155]

- **Variety of pedagogical approaches**: indicted as high or moderate challenge by 74% of surveyed providers.
- **Lack of confidence and buy-in from schools and teachers** is a challenge for 61% of providers.
- **Support for SEND learners not routinely available** at scale, as often linked to specialist projects.
- **Different curricula and integration levels of digital tools and content** are barriers to realising economies of scale.

- **Diversity of DEC offers, with support provided to educators** to make the best use of resources and tools
- **Autonomy of educational institutions** to determine how funds are spent, and the pedagogical application of content and possibility for providers to work directly with schools.
- **Greater optimism by newer suppliers in general public's trust towards digital education** and in personalisation and curriculum flexibility.
- **Ongoing equality and accessibility** with two thirds of organisations reporting offering adaptive solutions for SEND learners.

FUNDING[156]

- **Dependence on public funding** and lower confidence levels the availability of public investment in general education, with newer companies being were less confident than their more established counterparts.
- **Sustainability and scalability of DEC** with a ''grants culture'' adding a layer of complexity by promoting time-limited special projects, rather than long-term, transferable solutions. This affects newer companies disproportionately.

- Despite adequacy concerns, confidence in **continuing investment in digital infrastructure and in digital** education, as well as confidence expressed in the availability of scientific research/evidence.
- **''Grants culture'' stimulates innovation** by acting as an important source of funding and a stimulus to R&D activities.
- **Opportunities for cooperation between suppliers through partnerships and**

[154] Icon for this section made by turkkub on flaticon.com
[155] Icon for this section made by Eucalypt on flaticon.com
[156] Icon for this section made by Kiranshastry on flaticon.com

	• **Disproportionate impact of unfavourable procurement conditions on newer companies**, while procurement-savvy providers can routinely engage in multiple bids for research, innovations and test beds.	**consortia** to bid for funding and access wider range of expertise. • **EU funding as opportunity** to prioritise transnational solutions to make digital tools and content accessible and adaptable across Europe
	TECHNOLOGICAL DEVELOPMENTS[157]	
	• **Fast pace of digital transformation requires ongoing adaptation** resulting in associated costs and higher-risks for providers to adapt business models and remain relevant. • **Revolution of 'disruptive' technologies (e.g. AI, VR/XR) still somewhat contained** to a relative minority of providers and provider offers, but change expected soon. • **Need for greater buy-in from educators and enhanced professional development**, as well as increased public investment in infrastructure.	• **Emerging technologies have potential to optimise content and improve usage performance**, with data analytics and AI standing out as having the most transformative potential. • **Adaptive technologies can be enabling factors for personalisation,** and vice versa, as increased demand for personalised content and stronger models of end user engagement in product design provide stimuli for technological solutions

Source: Ecorys, 2023

3.3 Key market enablers, drivers and trends

3.3.1 COVID-19 pandemic and recovery

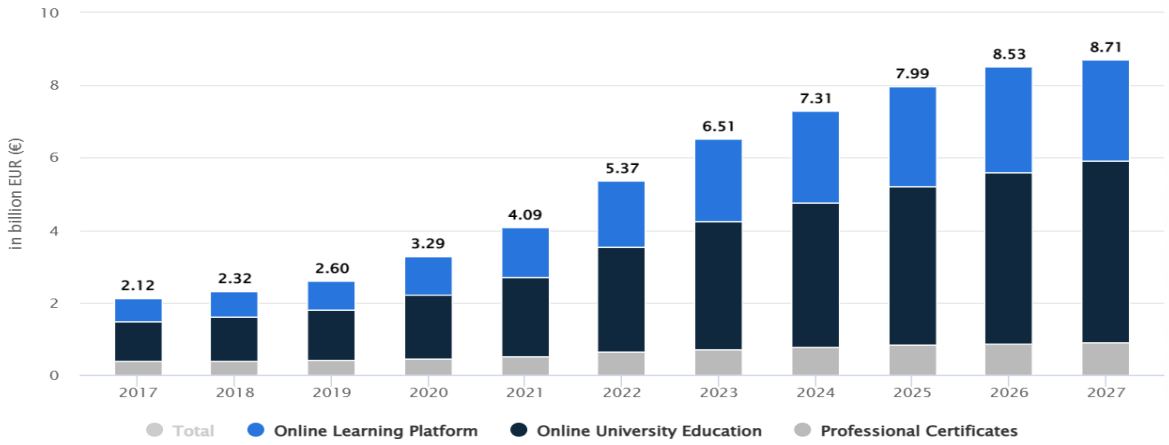
The online education market (which includes DEC)[158] in the EU has been growing steadily over the last few years (see Figure 7 for growth by revenue). The COVID-19 pandemic gave a strong push to this development (see nearly 25% increase in revenue from 2019 to 2020, Figure 8). As observed by the consulted stakeholders, the education content sector was forced to digitise, and there is no going back to traditional content. Market forecasts reflect this view and assume that the growth will remain at a similar level until 2026-2027. The regional forecast of growth of the DEC market is in line with the global forecasts.[159]

[157] Icon for this section made by Eucalypt on flaticon.com

[158] Based on the definition used by Statista for its data collection, the online education market includes university designed and delivered courses and credentials (public and private), online learning platform courses and credentials, and professional certification offered through institutes and study prep companies. The definition excludes learning management systems, virtual learning environments and exclusively B2B companies. Statista (2023). Online Education – Worldwide. While this definition leaves out ECEC and primary and secondary schools, there are no reasons to believe that trends in these segments would different than in HE and VET. In addition, schools are partially covered by the online learning platform element.

[159] Technavio (2023). Digital Education Content Market by End-user and Geography - Forecast and Analysis 2023-2027.

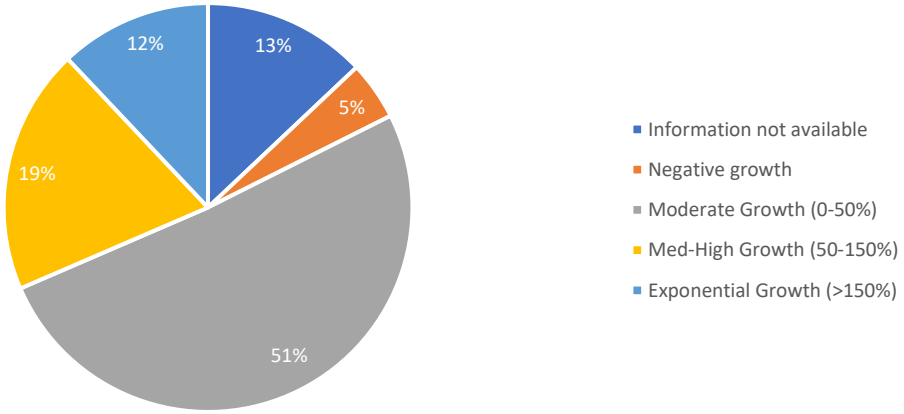
Figure 7: Development of the online education market by revenue (EU27)



Source: Statista, February 2023

The forecast of market growth was confirmed by the respondents to the DEC providers survey conducted for this study. Most of the respondents expect that their business will be grow in terms of turnover in the next two years (see Figure 8 below). Almost one-third of the respondents (31%) even expect medium-high or exponential growth in their turnover.

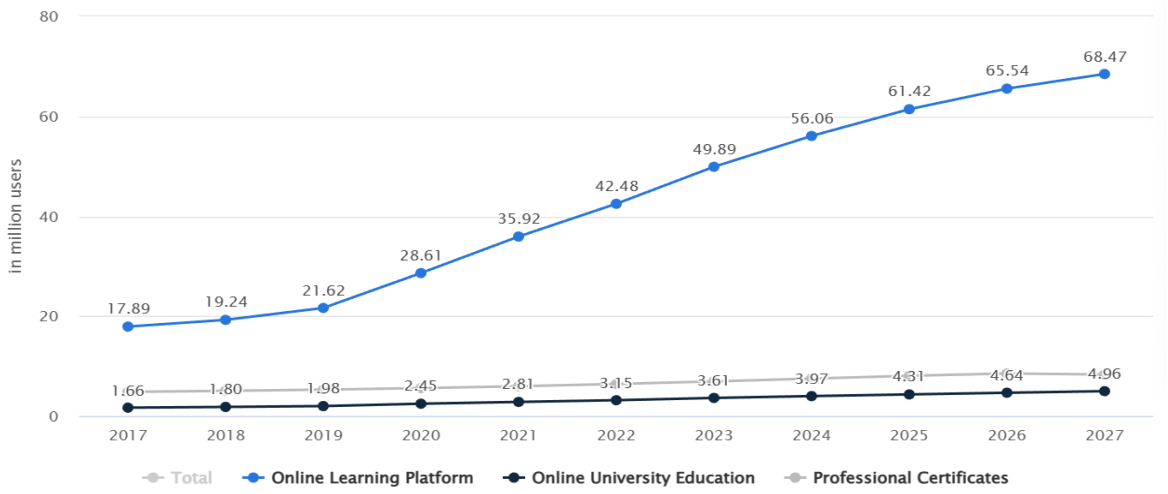
Figure 8: Expectations of DEC providers for turnover growth in the next two years



Source: Ecorys, DEC provider survey, 2023, N=108

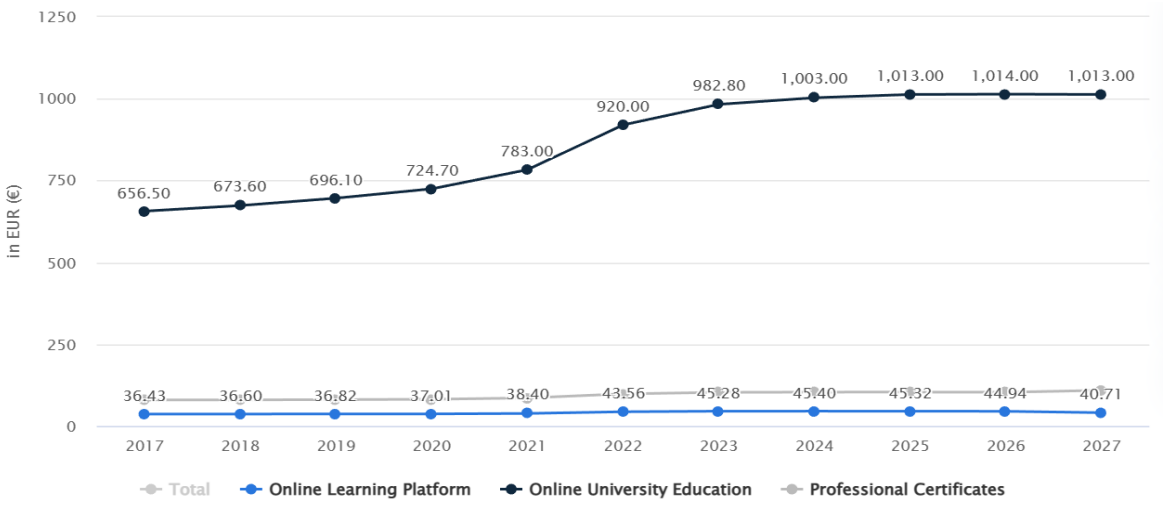
The growth seems to be expected mainly due to the increase in the user base (i.e. increase in the uptake of DEC). Figure 9 shows that between 2019 and 2022 the number of users in the EU grew annually by around 20%-30%, likely to connected to the impact of the COVID-19 pandemic. At the same time, the average revenue per user has increased much more slowly (between 4% and 8% annually, with only one significant increase of 17% between 2021 and 2022) and is expected to stay at about the same level from 2024 onwards (see Figure 10).

Figure 9: Development of the demand side by the number of users (EU27)



Source: Statista, February 2023

Figure 10: Development of the average revenue per user of online education (EU27)



Source: Statista, February 2023

The trend of the market growth needs to be seen through a demographic lens. On the demand side, due to declining birth rates, the number of potential end users in the lower educational levels could be stagnating and then decreasing. This may lead to a shrinking consumer base in the long run. At the same time, there are more new end users in the higher education and VET (e.g. for upskilling, reskilling).

The consulted stakeholders also cautioned that the projected numbers may not reflect the reality of DEC development entirely. This is because, as mentioned in Section 3.1, there is no clear market definition and, as mentioned in Section 3.2.1, DEC is often mixed with traditional education content and with DEC infrastructure. It is, therefore, difficult to say exactly where the growth is occurring (i.e. DEC or some other part of the market covered by the given forecast) and how strongly.[160] In addition, the numbers of potential users based on which market development predictions are made and the number of actual users vary.

[160] See for further details the T&F Group on marketplace output paper.

On the supply side, more companies are entering the market for DEC and DEC infrastructure. However, such companies do not have a potential to scale up considerably, according to the consulted stakeholders. Most companies are small and have fairly small turnover[161].

3.3.2 Emerging marketplace: technological, socio-economic and policy drivers

The drivers of the upward trend in the market and factors responsible for further change in the market are multifaceted. The technical and economic drivers discussed below have a global nature and are not specific to the EU. They are strongly responsible for making DEC more accessible and affordable, i.e. creating greater uptake while also keeping prices low. Policy-related drivers also cause a stronger uptake as well as ensure consumer choice of DEC. Policy-related drivers are EU-specific, and are expressions of the various policy and legislative developments at the EU and Member State levels.

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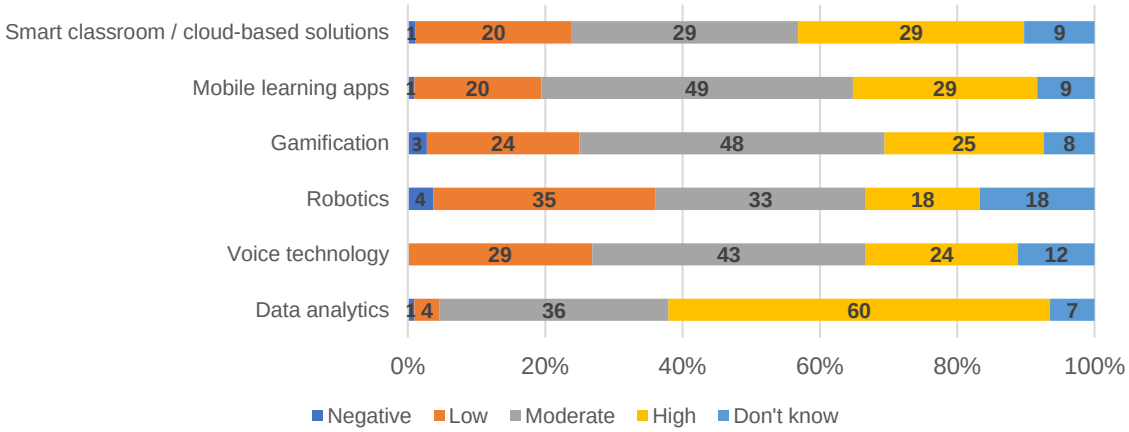
Technological drivers

Technological developments constitute some of the strongest drivers for the development of the DEC market. When asked about the impact of various technologies, the majority of the surveyed DEC providers expected moderate to high impacts in the near future (Figure 11). Although artificial intelligence (AI), virtual and augmented reality (jointly known as XR) were not included in the survey, a very large share of respondents mentioned these technologies as those that are likely to have a high impact on the market (30 respondents mentioned AI and 8 mentioned XR).

Figure 11: Impact anticipated on the market from the following technologies, over the next two years[162]



Source: Ecorys, DEC provider survey, 2023, N=108

Emerging technologies like **AI, machine learning, XR, big data analytics** are expected to revolutionise education. AI has the potential to offer inclusive, ubiquitous, personalised education for all, facilitate the management and delivery of education services and assist teachers in their various tasks[163]. VR/AR will

[161] Ibid.
[162] Please note that AI and XR were not included in the answer list in the survey.
[163] Fengchun Miao, Wayne Holmes, Ronghuai Huang, and Hui Zhang (2012). AI and education: guidance for policy-makers, UNESCO.

enhance learning experiences due to new ways of sharing and acquiring information and knowledge (i.e. immersive learning)[164].

In most EU countries, emerging disruptive technologies are not yet commonplace in classrooms. Only a few countries use them fairly often (e.g. XR in professional education in the Netherlands and in Czech Republic, or the use of XR and simulation in medical degrees in Czech Republic). In most countries, such technologies are subject to pilots and special projects. Therefore, there is an emerging market for these technologies in the field of education that will be growing in the years to come. It is impossible to predict how fast this growth will be as the technologies need to mature and use cases and applications need to be developed, tried and implemented. We are only at the beginning of the road in this context.

Other more established technologies are already used to some extent in education, but their potential has not yet been fully explored.

Social media (as also discussed in the section above on the supply of DEC) have been used for years by teachers and students for the creation and storage of DEC, sharing of DEC, management of the learning process and engagement with parents. In recent years, their usage for educational purposes, including for DEC, has grown significantly. One of the reasons is the COVID-19 pandemic when many education facilities shifted their operation online and had to rely on social media for various operations.[165] Another reason is the growth and evolution of social media.

Where used in a pedagogically appropriate ways, social media channels afford opportunities to utilise content that connects with cultural and social reference points. Many social media providers adjusted the offering of digital tools during the pandemic (e.g. providing more services for free, expanding some services, etc.), thus also increasing their use in education. Trends in the use of social media will likely continue as landscape evolves and grows; new uses of social media for DEC are likely to be found.

Mobile learning has increased due to the growing availability and affordability of mobile devices (i.e. smartphones, tablets), improved connectivity through mobile broadband and the increased number of educational apps.[166] The COVID-19 pandemic also played a role as mobile learning applications were used to support teaching and learning during lockdowns. It is expected that the market for mobile learning will continue to grow in the coming years as broadband connectivity further improves and 5G mobile standard becomes fully functioning everywhere allowing for immersive learning (VR/AR) via mobile devices. The developments in the mobile device capabilities and new applications will also contribute to further growth in mobile learning[167].

Socio-economic drivers

The **increased use of various DEC-related services offered by technology companies** during the COVID-19 pandemic facilitated the market entry and consolidation by of many Big Tech companies. Other technology companies also benefited from the gamification trend to enter the DEC market or were able to leverage their position in various adjacent markets (e.g. cloud services, social media, gaming, mobile apps) and superior technological expertise to strengthen their presence in the DEC market and/or disrupt it. This includes, for example, advancements in programming and STEM, and the use of cards like MicroBit or Scratch[168]. It is expected that these companies will use their capabilities to enhance and improve existing DEC as well as

[164] Hadi Ardiny and Esmaeel Khanmirza (2018). The Role of AR and VR Technologies in Education Developments: Opportunities and Challenges. In: 6th RSI International Conference on Robotics and Mechatronics (IcRoM), pp. 482-487. DOI: 10.1109/ICRoM.2018.8657615.

[165] For example, for Spain see Raquel Gil-Fernández, Alicia León-Gómez, Diego Calderón-Garrido (2021). Influence of COVID on the Educational Use of Social Media by Students of Teaching Degrees. In: Education in the Knowledge Society 22, pp. 1-10; for Cyprus see Christos Papademetriou, Sofia Anastasiadou, George Konteos and Stylianos Papalexandris (2022). COVID-19 Pandemic: The Impact of the Social Media Technology on Higher Education. In: Education Sciences 12. DOI: https://doi.org/10.3390/educsci12040261 .

[166] Hylén, Jan (2012). Turning on mobile learning in Europe: illustrative initiatives and policy implications, UNESCO; Matzavela V, Alepis E. (2021). M-learning in the COVID-19 era: physical vs digital class. Educ Inf Technol (Dordr) 26(6), pp. 7183-7203. DOI: 10.1007/s10639-021-10572-6 .

[167] EMR (2022). Europe Mobile E-learning Market Outlook.

[168] https://medevel.com/minecraft-alternatives/

(participate in) design of completely new types of DEC.[169] They are also likely to influence the market structure and business models of the incumbent publishers.

Public investments in the digital infrastructure, in education in general and digitalisation of education are an important driver for the use of DEC by end-users (i.e. teachers, students) as in most national systems they rely on the government for acquiring access to DEC. Public investments also incentivise the development of the supply side because different levels of government are the main procurer (i.e. demand side). The EU Recovery and Resilience Facility (RRF) and NextGenerationEU also play a large role as, according to Article 16 (2) of the RRF Regulation,[170] Member States must devote 20% of their total allocations to measures supporting digital transition. Digitisation of education is an important part of such digital transition, and Member States are investing heavily in it (see Section 3.1.2).

The **change in learning and teaching habits** is likely to increase the use of DEC and also bring new audiences of learners, thus increasing overall demand for and uptake of DEC. Digitisation of education in general has allowed for more flexible learning in terms of content, schedules and learning and teaching methods. This leads to more personalised education and adaptive learning,[171] away from the more standardised education offers that have existed up until recently for the majority of the population. Due to the increased demand, more companies will get involved and develop more DEC offers still.

Pedagogical advances for using DEC in education play a central role both in the creation of DEC (i.e. supply side) and its uptake and use (i.e. demand side). Teachers need to build their competences, access to professional learning networks for collective learning, and also support of experts (within or external to schools) to be able to integrate DEC in their teaching in a meaningful way, and there are dedicated programs and projects in many countries dedicated to this purpose (e.g. DigiSprong in Belgium-Flanders, CARNET in Croatia).

In some countries, there is still lack of understanding on whether and how to use DEC at certain levels of education (e.g. in Austria, for children under age of 6; in Germany, for children under age of 4; in Slovenia regarding ECEC; in Romania, there is lack of standards for open educational resources in general). Especially in relation to cutting edge technology (e.g. AI, XR), clear pedagogical guidance by public authorities could make it or break it in terms of the use of such technologies in education.

In many countries, sometimes to complement the offer by the market, the **public sector often creates its own DEC or organises private DEC content creators (especially teachers)** in some way. Often, the government provides an environment for and supports teacher-generated DEC, but checks the quality before it is allowed to the use in the classroom (e.g. BG, HR, FR). For example, in France, content created by teachers is evaluated by inspectors and then made available to teachers in the country or region.

New business models have emerged. For instance, **DEC and infrastructure providers more often target parents and pupils** or students rather than procurers because the former are an easier audience to sell products and services to and because companies avoid the complexity of public procurement rules when making their sales.

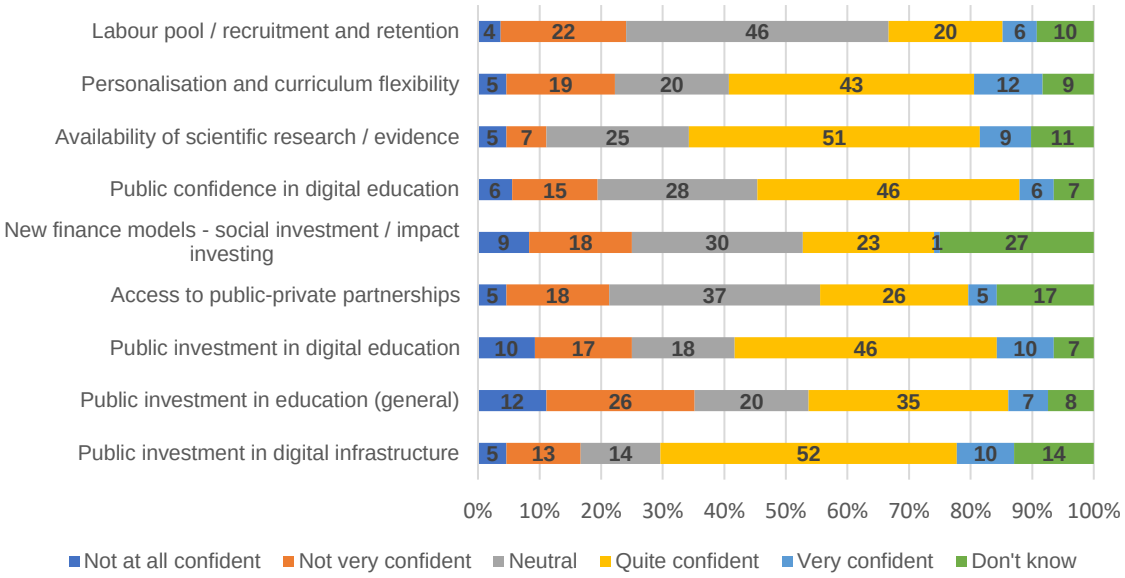
The responses of the DEC providers to the survey question about their confidence in market conditions (Figure 12) can be interpreted to signify how important they are for the further development of the DEC market.

[169] Özalp, H., Ozcan, P., Dinckol, D., Zachariadis, M., & Gawer, A. (2022). “Digital Colonization" of Highly Regulated Industries: An Analysis of Big Tech Platforms' Entry into Healthcare and Education. California Management Review, 64(4), pp. 99-100. DOI: https://doi.org/10.1177/00081256221094307

[170] Regulation (EU) 2021/241 of the European Parliament and of the Council of 12 February 2021 establishing the Recovery and Resilience Facility, OJ L 57 of 18.02.2021.

[171] Peng, H., Ma, S. & Spector, J.M. (2019). Personalized adaptive learning: an emerging pedagogical approach enabled by a smart learning environment. In: Smart Learn. Environ. 6:9. DOI: https://doi.org/10.1186/s40561-019-0089-y .

Figure 12: Confidence of DEC providers in the market conditions over the next two years



Source: Ecorys, DEC provider survey, 2023, N=108

Policy-related drivers

Digitalisation and education policies of the EU and its Member States are some of the most important drivers of the development of the DEC market. It would go beyond the scope of this study to enumerate all relevant policies, therefore just a few policy and policy initiatives at the EU level should be mentioned.

The EU 2030 Digital Compass[172] is a comprehensive policy to improve digital infrastructure and connectivity and digitise all spheres of life including education. It aims to foster the development of a "high-performing digital education ecosystem" (i.e. under the target of digitally skilled population and highly skilled digital professionals). The Digital Skills Agenda[173] and Digital Education Action Plan[174] support the upskilling and education of the EU population to achieve the twin goal of digital and green transition by developing digital skills and using digital tools (including DEC). Under the Digital Education Action Plan, Action 3 specifically aims to identify areas where EU-level activities could bring added value. In these areas, the EU are to cooperate with stakeholders to find the most effective solutions and bundle them in the European Framework for DEC.

Other EU-level policies are also relevant for the DEC market development. In particular, EU **competition policy** and measures related to digital economy and **regulation of platforms** (e.g. Digital Services Act,[175] Digital Market Act,[176] Platform-to-Business Regulation[177]) help keep the supply side competitive, ensuring the level playing field and curbing the market power of the big tech companies. They also guarantee the rights of users and provide instruments for their effective protection. The EU **procurement rules**[178] stimulate the supply side by providing a more harmonised regulatory environment for government procurement in the EU, and the

[172] European Commission (2021). 2030 Digital Compass: the European way for the Digital Decade, COM(2021) 118 of 09.03.2021.
[173] European Commission (2020). European Skills Agenda for sustainable competitiveness, social fairness and resilience. COM(2020) 274 of 01.07.2020.
[174] European Commission (2020). Digital Education Action Plan 2021-2027, COM(2020) 624 of 30.09.2020.
[175] Regulation (EU) 2022/2065 of the European Parliament and of the Council of 19 October 2022 on a Single Market For Digital Services and amending Directive 2000/31/EC, OJ L 277 of 27.10.2022.
[176] Regulation (EU) 2022/1925 of the European Parliament and of the Council of 14 September 2022 on contestable and fair markets in the digital sector and amending Directives (EU) 2019/1937 and (EU) 2020/1828, OJ L 265n of 12.10.2022.
[177] Regulation (EU) 2019/1150 of the European Parliament and of the Council of 20 June 2019 on promoting fairness and transparency for business users of online intermediation services, OJ L 186 of 11.07.2019.
[178] Directive 2014/24/EU of the European Parliament and of the Council of 26 February 2014 on public procurement and repealing Directive 2004/18/EC, OJ L 94, 28.3.2014.

Guidance on **Innovation Procurement**[179] incentivises the development and adoption of innovative DEC solutions. EU rules related to **intellectual property rights**[180] are key to ensure that copyright-protected materials, including DEC, can be used in royalty-free for educational purposes.

National policies follow the mentioned EU policies but adapt them to the national circumstances. Of particular importance in this context are **upskilling policies** directed at imparting knowledge and skills on teachers to use various forms of DEC as well as national policies that aim to increase or **improve high-speed connectivity** of educational facilities and to provide schools, teachers and pupils with **necessary digital equipment** (whiteboards, computers, laptops, etc.). These types of policies have a potential to significantly increase demand for and use of DEC, in the medium-term and to sustain it over the long term.

3.3.3 Obstacles to DEC market development

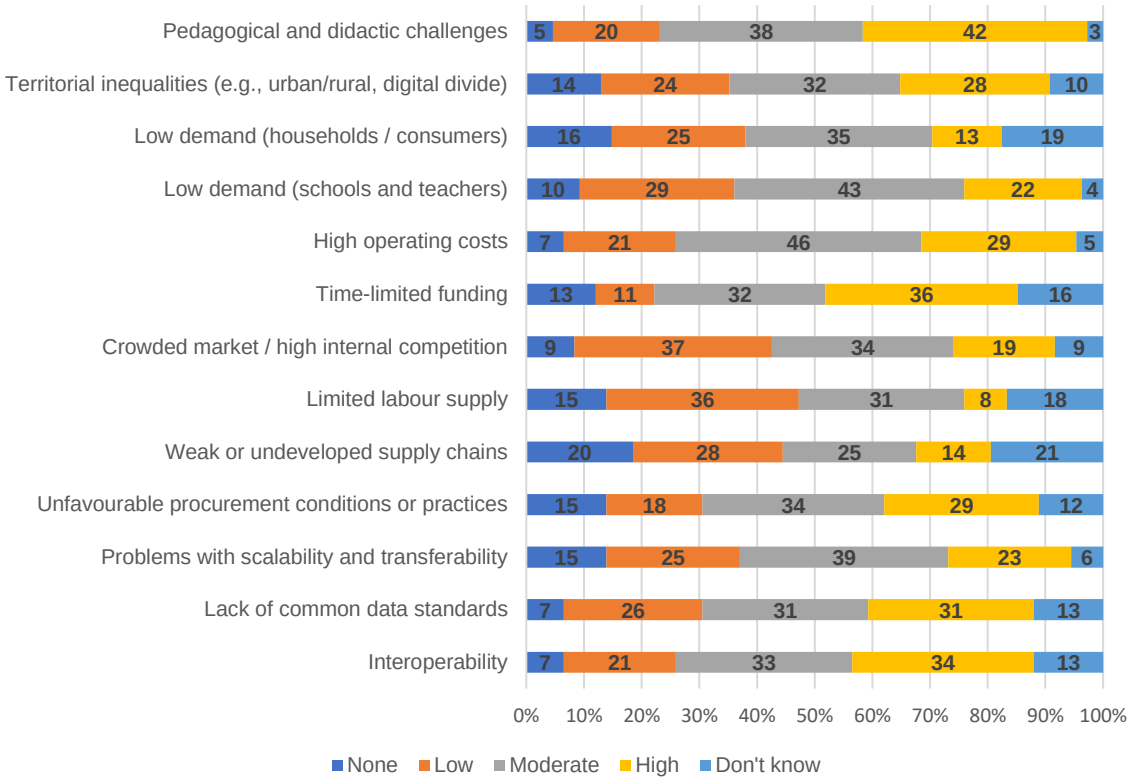
Before discussing the challenges to the DEC market development, the challenges related to the estimate of the market size, which are linked to the ability to monitor and describe the DEC market development must be reiterated. The **lack of a universally accepted definition of DEC** means that the DEC market cannot be clearly delimited and distinguished from other similar markets (e.g. online education, digital education). Without a clear definition, **collecting accurate data is also a challenge**, and it is reflected in the large data gaps identified by this study. Almost all countries lack data related specifically to DEC supply and demand.

Lack of disaggregated data on public expenditure on DEC also represents an obstacle to the further development of the DEC market. With no common metrics or parameters that can be measured across all Member States (e.g. percentage of students using DEC at each level of education), it is not possible to follow the development of the demand for and use of DEC. This is first an issue of transparency and accountability, particularly in the case of public education systems and platforms created (directly or indirectly) by the public sector, as it concerns how public funding is being spent. Second, it can represent a challenge for the private sector too: public expenditure levels can influence the extent to which providers decide to operate in a given market, particularly where public institutions drive the demand for DEC. Furthermore, lack of data on spending affects monitoring and evaluation of DEC, as it does not allow for measuring return on investment.

The development of the DEC market is hampered by a number of challenges. The DEC providers surveyed for this study indicated the following challenges as particularly relevant (i.e. a large share of respondents replied that it is a moderate or high challenge): pedagogical and didactical issues (74%), costs (69%), funding (63%), interoperability (62%), low uptake (about 60%), unfavourable procurement conditions or practices (58%) and lack of common data standards (57%) (Figure 13).

[179] Commission Notice — Guidance on Innovation Procurement, OJ C 267, 6.7.2021.
[180] Directive (EU) 2019/790 of the European Parliament and of the Council of 17 April 2019 on copyright and related rights in the Digital Single Market and amending Directives 96/9/EC and 2001/29/EC, OJ L 130 of 17.05.2019.

Figure 13: How much of a challenge is presented by the following, in the EU DEC marketplace?



Source: Ecorys, DEC provider survey, 2023, N=108

Some of the challenges are interconnected and can be explained by other problems that the study uncovered through country-level research.

Pedagogical and didactical issues in using DEC for teaching and instruction are partially responsible for the low uptake and use of DEC. These issues may result from the lack of digital skills of or support for teachers, lack of relevant didactical instructions and materials in some Member States or too rigid an approach to curriculum and pedagogy in some countries, regions or educational institutions.

Unfavourable public procurement conditions or practices make it more difficult for new market players and EdTech startups to obtain the necessary investments and reach the DEC procurers and end users. They skew the system in favour of incumbent providers due to their established relationship with ministries of education and other facilities responsible for public procurement of educational products, legacy presence in the market and knowledge of the procurer's requirements and processes. Considering that the **cost and risks for new players to enter the market is always high** (especially if they come from abroad), such situations related to procurement may discourage some new entrants as the chances to get a return on their upfront investment are very low.

In the context of the discussed public procurement issues, the **lack of common standards and interoperability** may provide a further tilt to favour incumbent providers. In such a situation, the procurer would be more inclined to get all products and services from one hand to make sure that they all work well together. Any new provider would need to make sure that it can interoperate with the existing system, which may be difficult, especially if the incumbent refuses to disclose some issues based on trade secrets or other intellectual rights protection. Alternatively, a new provider may need a licence, which would make its offer more expensive in comparison to the incumbent's offer.

Technological and legal obstacles also limit the deployment of new technologies. **Some technologies (e.g. AI) are not yet mature** enough to be used in education, in specific levels of education or in specific courses. More

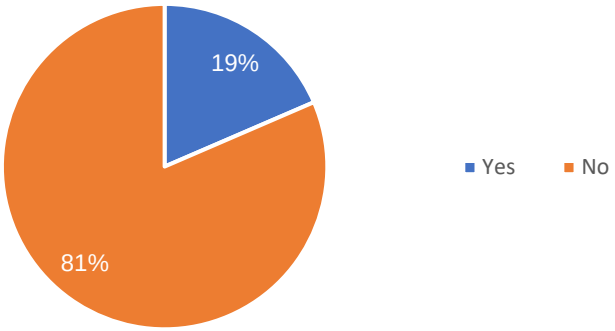
testing and piloting need to be conducted, and there might not be an adequate regulatory framework in the context of education. **Cybersecurity issues** related to the use of DEC in educational facilities and **to digital education more generally** have not been resolved, nor **standards related to cybersecurity in education** developed.

Legal frameworks for emerging technologies are also non-existent or immature. For instance, the **use of (personal) data in the context of AI** development and deployment and **copyright issues** on materials developed with the use of AI are some of the topics that are being intensely discussed in the context of higher education – with no solutions yet.

While the technologies and topics of the future await further action, some countries, regions and educational institutions (especially ECEC and schools) struggle with basic issues. In several countries, there is still **no adequate broadband connectivity and/or equipment** in the classrooms. In some cases, teachers and students do not have the necessary devices. Hence, DEC cannot be used at all or to a very limited extent.

Also, our research indicates that the EU does not yet has a common market for DEC, but rather many national markets. The majority of respondents to the DEC provider survey could not name regional or national markets in which they wish to expand (Figure 14). It shall be noted that these responses do not necessarily mean that there are no cross-border difficulties. Based on the country research on the structure of supply and demand, a more likely explanation is that most DEC providers are nationally oriented, and integrated into the national systems, and do not wish to move to other markets.

Figure 14: Are there national or regional geographical markets where you wish to operate but are unable to do so?



Source: Ecorys, DEC provider survey, 2023, N=108

Those respondents who experienced difficulties expanding to other markets named the following obstacles:

- Difficulty in entering the circle of incumbent DEC providers with existing links to the public procurer (including where DEC is publicly provided in specific countries or regions);
- Lack of infrastructure, equipment and digital skills in certain regions (e.g. rural);
- Language or cultural differences;
- Lack of interest from the buyers (procurers, end users). This is often further explained by language and cultural differences, lack of data/ understanding of the system of other countries and lack of digital skills; and
- Lack of funding/ investment.

3.4 Key messages

Drawing on the analysis of current characteristics, supply and demand dynamics, as well as key enablers, drivers and trends, the box below summarises key messages and takeaways on the DEC market.

Box 11. Understanding the market - key messages

Key messages
• **Sizing the DEC market is not an easy task** because, in addition to the absence of a commonly agreed definition for digital education content, common statistical data are also lacking. Within the EU, national education expenditure for DEC is not always specifically categorised in national budgets, making comparisons virtually impossible. • There is **great variation between EU Member States and levels of education** in terms of uptake of DEC, but there are examples of countries reaching almost 100% for all levels of education. • The **maturity of the supply of DEC in EU Member States varies greatly**, encompassing both mature and developing markets, in which the COVID-19 pandemic strongly pushed for the development of a DEC market. • **Emerging technologies such as AI, machine learning, XR, big data analytics are expected to revolutionise education**. AI has the potential to offer inclusive, ubiquitous, personalised education for all, facilitate the management and delivery of education services and assist teachers in their various tasks. VR/AR will enhance learning experiences due to new ways of sharing and acquiring information and knowledge (i.e. immersive learning). • The increased use of various DEC-related services offered **during the COVID-19 pandemic facilitated the market entry and consolidation by of many Big Tech companies**. Other technology companies also benefited from the gamification trend to enter the DEC market or were able to leverage their position in various adjacent markets (e.g. cloud services, social media, gaming, mobile apps) and superior technological expertise to strengthen their presence in the DEC market and/or disrupt it. • **Unfavourable public procurement conditions or practices make it more difficult for new market players and EdTech startups to obtain the necessary investments and reach the DEC procurers and end users**. They skew the system in favour of incumbent providers due to their established relationship with ministries of education and other facilities responsible for public procurement of educational products, legacy presence in the market and knowledge of the procurer's requirements and processes. • **While technological developments will need further action at policy levels, some countries, regions and educational institutions** (especially ECEC and schools) **still struggle to meet basic needs to navigate the digital transformation**. In several countries, there is still no adequate broadband connectivity and/or equipment in classrooms, and educators and learners do not have access to the necessary devices. This affects the use and take up of DEC.

Source: Ecorys, 2023.

Chapters 4 and 5 delve deeper into the governance, regulatory, funding and policy landscape for DEC across the EU27, complementing the market analysis.

4.0 Governance and funding across the EU

This chapter builds on the chapter 3 analysis of the DEC marketplace in the EU. While chapter 3 provided an overall appraisal of enablers and obstacles to the healthy functioning of the DEC marketplace, chapter 4 examines public sector governance, regulatory arrangements, and funding – which also constitute an important part of the overall DEC ecosystem. In the following sections, we examine the state-of-play across the Member States, with attention to how different country approaches to governance and funding enable or hinder DEC development. We conclude the chapter with a discussion on how governance and funding arrangements may be strengthened.

The sections below examine:

- **Governance and regulatory arrangements:** In Section 4.2, we provide an overview of the range of authorities involved in the governance and provision of DEC, including existing examples of structures and mechanisms for coordination and engagement with stakeholders across the public and private sectors, with examples from different levels of education. We analyse existing standards and regulations to support the efficient and safe use and monitoring of quality digital education content.
- **Funding streams for DEC:** Complementing the analysis of the DEC marketplace in Chapter 3, in section 0 we consider the impacts of current public spending at national and EU levels, as well as procurement practices, on the development and use of digital education content.
- **Key elements of a healthy and sustainable approach to governance and funding of DEC in Member States:** Based on analysis of the current state-of-play, we provide suggestions on how countries may strengthen DEC governance and funding in section 4.3.

4.1 Governance and regulatory arrangements

In this section we present an overview of current governance and regulatory approaches to DEC. The analysis highlights a complex governance landscape, where different levels (national, regional, local) interact and share responsibilities with regards to policy and regulatory approaches. It also reveals shortcomings in ensuring inter-institutional coordination and stakeholder engagement. The analysis reveals the crucial role of public authorities in the provision of DEC in the majority of Member States. This has an impact on market dynamics as well as the autonomy of education institutions, and educators' use of digital resources. Lastly, the section examines public-private partnerships, highlighting their potential for DEC.

4.1.1 Core governance: public authorities involved in policymaking for and provision of DEC

The core governance of DEC largely reflects the structure of national education systems in terms of allocation of responsibilities and competences, however the role of national digital/education agencies and ministries of education stands out as crucial for policy and guidance.

Core governance includes the establishment of policy priorities and objectives, curricula development, allocation of public funding, and organisation of the procurement, provision and dissemination of DEC. As with education more broadly, the core governance of digital education content requires the involvement of a wide range of public authorities, acting at different levels of government and exercising a variety of roles (see the stakeholder analysis in Chapter 2 for more details on roles and responsibilities).

Overall, the core governance of DEC is split across the following levels:

- **National / federal ministries:** These range from ministries with a specific mandate on education policy to ministerial authorities involved in other policy areas that are relevant to the development and use of DEC (e.g. culture; finance; public procurement; copyright; data privacy). Ministries often rely on

specialised departments and national digital/education agencies to support the implementation of policy and funding priorities.

- **Regional and municipal authorities:** These are public authorities operating at regional or local level with different levels of autonomy compared national and / or federal ministries across EU Member States.

- **Education institutions:** These are public institutions operating within their specific education level: i.e. early childhood education and care (ECEC); primary and secondary education; higher education (HE); and vocational education and training (VET). As with regional and local authorities, education institutions are granted differing levels of operational autonomy, depending on country-specific arrangements in the different EU Member States.

The variety of governance systems reflects the richness of EU education systems. Within countries, the **core governance of DEC is a complex and fragmented, where different stakeholders are involved and approaches implemented, depending on the country, educational level, and stage of the DEC life cycle.** This, in turn means, both challenges and opportunities for the DEC market. On the one hand, divisions of responsibilities across governance levels and overall high levels of institutional autonomy can lead to better responsiveness to local needs.

On the other hand, fragmentation, along with multiple approaches to pedagogical priorities (e.g. when curricula are defined at regional/municipal level, or by education institutions themselves), investments (e.g. when school budgets are by ministerial or municipal authorities), may result in varying rates in the digital transformation of education even within the same country (e.g. depending on investment in infrastructure, skills development).

Public authorities have a greater degree of control over enrolments, curricula, pedagogies, as well as administration and procurement primary and general secondary education than in early years and post-secondary education. While the specificities of each national systems must be respected, there is a strong need for soft governance approaches (e.g. guidelines, frameworks) at EU and national levels that can support the integration of DEC in education.

Governance dynamics are not fixed, and can change not only across EU Member States, but also between education levels within the same country, so the development of strict typologies and categorisations is not possible, nor particularly helpful. However, countries can be placed on a spectrum from highly centralised to decentralised. In general, across all Member States, ministerial authorities – with the ministry of education usually taking a leading role. In countries following more centralised approaches to governance (e.g. AT, BG; CY; CZ; EL; FR; HR; HU; LU; MT; PT; SK), it is often the case that, beyond defining the policy framework for the digital (education) transformation, ministerial authorities take a leading role in the provision of DEC, through national platforms or repositories (see section 4.1.1.1 below).

However, even in Member States with more centralised governance approaches, higher education institutions, on average, benefit from higher levels of autonomy in defining priorities, strategic objectives and course curricula, compared to ECEC and primary/secondary schools. In countries with more regionalised and localised approaches to education policy (e.g. BE; DE; DK; EE; ES; FI; IE; IT; LV; LT; NL; PL; RO; SI; SE), overarching strategies set up at national level are further defined and operationalised by public authorities at lower levels of government (i.e. regional and / or local).

Box 12. Examples of ministerial oversight

SELECTED EXAMPLES OF MINISTERIAL OVERSIGHT
In **Hungary**, different ministries and agencies are jointly responsible for education policy, and indirectly for digital education content. While HE and VET are formally under the remit of the Ministry of Culture and Innovation and the National Office of Vocational Education and Training and Adult Learning, the National Education Authority, which operates under the Ministry of Interior Affairs, oversees all levels of education and provides guidance and advice on digital education content for ECEC, primary and secondary and higher education.
In **Portugal**, ministerial responsibilities for DEC are coordinated by the Directorate General for Education (DGE)[181]. Within DGE, the Educational Resources and Technologies Team (ERTE) specifically focuses on ICT Curricular Integration, DEC, digital skills, training and capacity building. The purpose of ERTE[182] is to propose ways and means of integrating ICT into all levels of education and teaching.
In **Denmark**, VET institutions ("erhvervsskolerne") are self-owned institutions and are governed by boards. The VET programmes are decided by "trade committees" ("De faglige udvalg") represented by social partners (unions and employer representatives) . Due to their autonomy, the degree of digitisation of, and across, institutions and programmes vary, depending on the use of digital platforms, teachers' digital tools, and whether/how the students are taught digital literacy.
In **France**, the Ministry of Education and Youth is responsible for steering educational content, curricula and examinations. It has set up a Directorate of Digital Education (DNE), which is responsible for digital education policy (including guidelines for DEC and support for innovation), and which coordinates several committees of partners and runs the Academic Directorates for Digital Education (DANEs - bodies responsible for implementing digital education policy in partnership with regional, departmental and local authorities).
As far as DEC is concerned, the various local authorities responsible for infrastructure and equipment can fund DEC for their educational institutions. At the higher education level, however, individual institutions have financial and administrative autonomy and have established a number of roles that can help them navigate the digital transformation, including Digital Academic Officers (advisors helping universities to develop partnerships with EdTech companies for the production of digital tools, resources or services).

Source: Ecorys, 2023.

The key role played in several EU Member States by specialised departments or agencies is particularly relevant for DEC[183]. These agencies, for which mandates can either be exclusively focused on digital education (e.g. digital agencies) or broader areas (e.g. national education agencies) provide critical support not only for the implementation of general policy priorities and objectives, but also for stimulating the development and use of digital education content by educators and learners. Activities carried out by state agencies, depending on the national context, include:

- **Technical knowledge to support policymaking in the area of (digital) education (e.g. CY, EL, ES; HU; IT; LU; PT):** For example, in Cyprus the Pedagogical Institute provides policy recommendations on digital education and DEC to the Ministry of Education. In Luxembourg**,** the Ministry of Education, Childhood and Youth is in charge of drafting and implementing education policies,[184] in cooperation with the Pedagogical and Technological Research and Innovation Coordination Service (SCRIPT).
- **Awareness raising and promotion (e.g. AT):** For example, in Austria, while the Federal Ministry of Education, Science and Research is responsible for education and curricula of primary and secondary

[181] https://www.dge.mec.pt/
[182] https://erte.dge.mec.pt/missao-erte
[183] Eurydice (2019). Digital education at school in Europe. https://eurydice.eacea.ec.europa.eu/publications/digital-education-school-europe
[184] See: https://menej.gouvernement.lu/fr.html.

schools and higher education institutions, its work on digital education is supported by the Agency for Education and Internationalisation (OeAD), which implements targeted initiatives to promote “digital learning”.

- **Implementation of DEC related projects and initiatives (e.g. HR; LT; SK):** In Croatia, CARNET – the Croatian National Digital Agency – is responsible for the implementation of the E-schools project, which provides centralised access to digital education content to educators and learners and represents the main DEC provider in the country.

- **Providing support to education institutions, educators and learners, including through the provision of training, tools, and guidance (CZ; FR; FI; IE; MT; NL):** In Finland, the National Agency of Education (EDUFI)’s publication on ‘’Criteria for a high-quality digital leaning solution’’ aims to support schools and municipalities in selecting digital applications with a focus on their pedagogical uses, in line with the objectives included in national curricula for each level of education. The publication also offers advice on related issues, including on how to customise digital learning to meet the specific needs of individual learners, and how to use digital solutions to engage with parents.

With so many different approaches to governance, **effective alignment across institutions, and in some cases, interagency coordination around common goals and objectives, as well as between public authorities and other stakeholder groups that may inhabit and influence the education ecosystem, can represent a crucial success factor** both for the implementation of existing strategies and priorities, and for building bridges between governance, policy, and practice. However, based on the country mapping conducted for this study, effective coordination for DEC is still underdeveloped.

Cooperation structures between public authorities at different levels of governance and multi-stakeholder fora may serve as an avenue for a stronger DEC ecosystem but are currently underdeveloped

Given the diversity of governance arrangements and national contexts, rather than a one-size-fits-all approach, DEC ecosystems across Europe inevitably rely on a wide range of horizontal and vertical coordination mechanisms. Examples of coordination structures exist across Member States, albeit with clear gaps (e.g. not including all relevant stakeholder groups and/or not specifically targeting DEC).

For instance, **structures for cooperation between public authorities operating across different policy areas relevant for DEC** (education; finance; procurement; copyright; data privacy) **are lacking**, potentially leading to either unmet needs in the DEC ecosystem, or overlapping roles and responsibilities. Other, structures for horizontal cooperation exist. However, as these focus on common goals and objectives for education or digital education overall, targeted discussions and exchanges on the use of technologies for the development, curation and distribution of educational content may not receive sufficient attention, with fewer opportunities for mutual learning and exchange, or ultimately stifled progress in policy development and implementation.

Existing structures are highly institutional, meaning that opportunities for educators’ and learners’ voices to be heard appear to be limited to formal opportunities for participatory policymaking -- where these exist. This may also be a reflection of institutional cultures where meaningful participation of educators and learners in policy design, implementation and evaluation is not systematic.

Vertical coordination structures can also help bridge the increasing complexity of education system governance, by allowing for better communication and coordination, while respecting school autonomy and decentralisation where these are well developed within education systems. Isolated examples of cooperation structures providing spaces for public authorities at different levels of governance (i.e. national, regional and / or municipal) to exchange on education policy, developments and objectives, can be found (e.g. FI and DE).

However, as with horizontal structures, **exchanges are usually on broader priorities on digital education, with DEC as one among many of possible topics of discussion.** As a result, without a specific mandate to explore and find synergies on DEC-specific issues, it is not possible to show whether this type of coordination structure has any concrete impact on the development and use of digital education content on the ground, beyond awareness raising and sharing of good practices.

Box 13. Examples of structures for inter-governmental cooperation

SELECTED EXAMPLES OF INTER-GOVERNMENTAL COORDINATION
In **Finland**, the National Agency for Education (EDUFI) regularly organises so-called ''Digi Arenas'' – fora for municipalities to share pedagogical methodologies and practices as well as technological solutions for education.
In **Germany**, the Conference of Ministers of Education brings together ministry representatives from all Lander, to liaise on policy priorities. Furthermore, the Higher Education Forum Digitisation (Hochschulforum Digitalisierung) is a partly publicly financed body providing a platform for HE institutions to exchange on digitisation strategies.[185]

Source: Ecorys, 2023.

Country mapping data and stakeholder consultation research highlight the importance of **collaboration with key stakeholder groups at different stages of the DEC life cycle (e.g. production, curation, distribution, use and evaluation) for governance**.

In countries where multi-stakeholder cooperation structures can be found (e.g. EE; FR; IE; LV; MT; NL; SE), these bring together public authorities and private actors, through the organisation of discussion fora and events to either share practices and discuss industry, market and policy developments (EE; LV; SE; MT); explore opportunities / set the conditions for future cooperation (IE; NL).

For the most part, the scope of these structures goes beyond digital education content, as they often represent discussion fora on digital education or skills development more broadly. France and Sweden, exceptionally, have developed multi-stakeholder structures to promote innovative solutions for digital education content, albeit in the context of specific initiatives (i.e. Edu-up[186]), exist (see more in the box below). These multi-stakeholder structures often allow public authorities to engage with industry representatives, and for the latter to showcase their products and services, with some possibilities for direct engagement with education institutions, educators and learners (or their representative organisations).

Box 14. Examples of multistakeholder fora

SELECTED EXAMPLES OF MULTI-STAKEHOLDER FORA
In **Sweden**, the Forum for Information Standardisation in the School System (FFIS)[187] has been set up, led by the Swedish School Administration and the steering group includes representatives from Swedish Association of Local Authorities and Regions (SKR) and the Swedish Edtech Industry, to bring together municipalities and the EdTech sector to discuss standardisation. The specific focus of the FFIS is to promote interoperability to avoid future lock-ins in specific technologies and suppliers.
To this end, the FFIS provides a space for representatives from relevant stakeholder groups to exchange information (e.g. between school leaders, and between school leaders and public authorities and/or private actors providing digital services). The FFIS allows participants to discuss and/or identify the need for new standards, and to promote the use of existing standards by showcasing good practice examples and developing common guidelines and positions.

[185] https://hochschulforumdigitalisierung.de/
[186] https://eduscol.education.fr/1603/le-dispositif-edu
[187] See https://www.skolverket.se/om-oss/var-verksamhet/skolverkets-prioriterade-omraden/digitalisering/forum-for-informationsstandardisering-i-skolvasendet

The FFIS carries out its work through different working groups: each working group is tasked with monitoring recent developments linked to their specific focus area, review and agree on key terms and concepts, and identify concrete solutions to specific issues.[188]

In **Malta**, the government and the Chamber of Commerce set up a public organisation, Tech MT, to promote digital skills development among students.[189] Tech MT aims to provide opportunities to tech companies to showcase their work through the organisation of national and international symposia. Tech MT can also act as a consortium to apply from EU funding and cooperates with the Ministry of Education for this purpose. However, education institutions do not participate in any of the activities organised by Tech MT.

In **Ireland**, the Department of Education plans to establish an Industry Consultation Group to provide a formal means of communication between the Department and key industry stakeholders to examine the potential for industry to support digital transformation and capacity building in schools. The Higher Education Association (HEA) funds the Teaching and Learning Forum (TLF)[190] which is a platform for discussion and collaboration among practitioners in the field of teaching and learning in higher education. TLF has been actively promoting collaborative approaches to professional development of teaching staff and the sharing of resources for faculty members in the use of technology for teaching and learning.

In **Latvia**, the National Digital Skills and Jobs Coalition (eSkills Partnership), established in 2013, acts as a platform for different stakeholder groups to discuss and implement actions to promote digital skills development.[191] Coalition members include different ministries and public agencies, Latvian ICT associations, the Chamber of Commerce and Industry and representatives from academia.

In **France**, the Edu-up Commission has been established by the Directorate for Digital Education as part of the Edu-up initiative, which provides grants for innovative projects developing digital education content.[192] The Edu-up Commission brings together representatives from different stakeholder groups, including academics, EdTech, EdPub, public authorities (e.g. relevant ministries and their departments; national agencies). The role of the Commission is to evaluate project applications and therefore support innovative approaches to DEC.

Source: Ecorys, 2023.

Across the above-mentioned structures for cooperation**, the lack of engagement with the direct users (and potential creators) of digital education content, namely educators and learners in governance,** is particularly surprising. Supporting educators and learners' agency entails more than ensuring they possess the necessary skills and confidence to take up digital resources in their daily practice[193] As highlighted by consulted stakeholders, learners' and teachers' engagement is crucial in the initial phases of policy design, at implementation stage, and in formative and summative evaluation processes to assess programmes and initiatives.

Consultations revealed that examples of the involvement of users in the development of DEC exist (e.g. educators cooperating with commercial providers through co-creation processes on the initiative of private companies or as required in public contracts), this is not systematic, and tends not to happen in governance processes or throughout the whole DEC lifecycle. To this end, consultations stressed the need to consider educators and learners as a key stakeholder group that does not represent passive-users but rather active agents of change at all stages of policymaking, implementation and evaluation.

[188] https://www.skolverket.se/om-oss/var-verksamhet/skolverkets-prioriterade-omraden/digitalisering/forum-for-informationsstandardisering-i-skolvasendet/ffis-arbetsgrupper
[189] https://tech.mt/
[190] https://www.teachingandlearning.ie/
[191] https://digital-skills-jobs.europa.eu/en/about/national-coalitions/latvia-eskills-partnership
[192] https://eduscol.education.fr/1603/le-dispositif-edu
[193] See Damsa, a. Langford. M, Uehara, D., Scherer, R. (2021) Teachers' agency and online education in times of crisis. Computers in Human Behavior, Volume 121; and Aagaard, T., & Lund, A. (2019). Digital agency in higher education: Transforming teaching and learning. Routledge.

Consulted stakeholders noted the importance of existing EU-level mechanisms such as the Working Groups, which bring together representatives from education ministries as well as other relevant stakeholders and which support international peer learning. They also suggested that the development of a European-level central hub could serve as a central source of monitoring of new developments in DEC, as a repository for research, and a network coordinator.

4.1.1.1 Provision of DEC: from public repositories to the open market

In general, public authorities play a central role in the provision of DEC through central repositories of resources, but attitudes vary across Member States: from more prescriptive approaches to greater space for institutional and individual autonomy

A key feature of DEC governance is represented by the **level of intervention by public authorities in the provision of digital education content** to education institutions, educators and learners.

Based on research, three main approaches to accessing, producing and sharing DEC can be identified:

- **Primarily public approaches:** Public online platforms are set up by ministerial authorities and/or their supporting agencies, acting as the main and/or single point of entry for education institutions, educators and learners to access DEC;
- **Mixed approaches:** One or more public online platforms are either set up or planned by (national/regional) to support education institutions, educators and learners to access DEC, however DEC by other providers is also available on the open market; and
- **Primarily private approaches:** No public platforms for the dissemination of DEC exist at the national/regional/local level, leaving local authorities (i.e. municipalities and education institutions), educators and learners to purchase DEC in the open market, in compliance with overall policy priorities, objectives and curricula.

These can be compared and contrasted with levels of autonomy granted to education institutions and/or educators to freely choose digital education content to be used for teaching learning and assessment.

Table 9 provides and overview of dynamics across both dimensions (provision of DEC and level of autonomy). Annex 7 provides an overview of existing platforms across models.

Table 9 – Models of DEC provision and levels of autonomy, by country

	Model	Description	Member States
PROVISION OF DEC	**Primarily public - Public platforms as primary source for DEC**	Public online platforms are set up by ministerial authorities and/or their supporting agencies, acting as the main and/or single point of entry for education institutions, educators and learners to access DEC.	CY; EL; SK; HU
	Mixed - Public DEC platforms exist alongside products and services on the open market	One or more public online platforms are either set up or planned by (national/regional) to support education institutions, educators and learners to access DEC, alongside other products and resources available on the open market.	AT; BE; BG; CZ; DE; DK; EE; ES; HR; FR; IE; LT; LV; NL; MT; PT; PL; RO; SI
	Private - No public DEC platforms	No public platforms for the dissemination of DEC exist at the national/regional/local level, leaving the choice to local authorities	FI; IT; SE; LU

		(i.e. municipalities and education institutions), educators and learners to select DEC in the open market, in compliance with overall policy priorities, objectives and curricula.	
	Model	Description	Member States
LEVEL OF AUTONOMY	**High autonomy**	Education institutions and educators are free to choose the education resources to be used for teaching	IE; FI, IT; LT, NL; RO; SI; BG; FR; BE; CZ; DK; DE; ES; MT
	Medium autonomy	Education institutions/educators can choose the education resources to be used for teaching out of a pre-approved list of resources	AT; PL; LV; LU; SK; SE; HR; PT
	Low autonomy	Education institutions/educators/learners' choice of DEC is constrained by the lack of an open market	EL; CY; HU

Source: Ecorys, 2023.

All three approaches to DEC provision present their own challenges and opportunities, as explored below.

Centralisation of content provision through primarily public and mixed approaches can promote models of free educational content but may affect individual choice and market dynamics.

Overall, primarily public and mixed approaches represent the main models of DEC provision across Member States.

Primarily public approaches are present in a small number of Member States (CY; EL; HU; SK), where public authorities exercise a near monopoly on the provision of digital education content. In this countries, state-run online repositories are set up by ministerial authorities or agencies under their responsibility, acting as the main or only point of access for education institutions, educators and learners, for DEC. Usually, the content made available on these platforms is procured at central level, and internal processes are established to select and appraise resources.

These repositories also often offer the possibility for educators to share their own content, allowing for its further dissemination. In terms of coverage, these platforms aim to match national curricula and objectives, and target primarily educators and learners within compulsory education.

Mixed approaches are implemented in the majority of Member States, where public repositories are available, often alongside open-market DEC. The majority of platforms within this model primarily target compulsory education, while only a limited number of repositories provide resources for HE and VET. This may be closely related to the high level of autonomy of higher education institutions and to the specific dynamics within VET which foresee strong cooperation between education and training providers and industry actors, with more limited opportunities for public authorities to take on a strong role in the promotion and dissemination of DEC within these education levels.

Within this model, subgroups can be identified, based on the level of provision, target users, and degree of autonomy for educators and learners:

- In some countries (e.g. DE; RO), platforms have been, or are now being established, at the regional (DE) or local (RO) level. This allows platforms to better comply to specific educational priorities and objectives as identified by state or local authorities;

- While some Member States only rely on one main, central platform, other countries (e.g. AT; BE; BG; CZ; EE; FR; HU) have developed a variety of public platforms, either catering for different users (e.g. educators or learners); and/or different educational levels; and

- In the majority of Member States (IE; LT, LT; NL; RO; SI; BG; FR; BE; CZ; DK; DE; ES; MT) public repositories play a supportive rather than prescriptive role in the provision of DEC, to be acquired through procurement or direct purchase by teachers, learners and their families. However, this is not the case in a small number of Member States (AT; HR: LV: PL; PT), where, while formally allowing education institutions and educators to purchase and use education materials outside of public repositories, their freedom of choice is de facto restricted to pre-approved lists of resources.

Both approaches to DEC provision present some key **advantages:**

- **Access to DEC is facilitated**, potentially stimulating its take-up and use in the classroom, as educators and learners can rely on a single repository to select materials to integrate in their teaching, learning and assessment practices. Furthermore, a more uniform approach to DEC can be implemented, and there may be better oversight on adherence to technical and pedagogical specifications, which may support the identification of quality resources.

- **Possibility for public authorities to quality assure content before it is shared with users**, potentially allowing for better quality materials to be made available to educators and learners, matching learning objectives to be achieved as part of national curricula. This approach can better support educators to identify quality content without having to rely exclusively on their own expertise and skills.

- **More transparent and safer data analytics and monitoring**, as public authorities managing online platforms can track how users interact with the content, and potentially use this information to adapt the offer to match needs and inform the development and/or implementation of national strategies for digital education/digitalisation. Data analytics by public authorities may offer more safeguards against data privacy breaches, as opposed to data processing by private providers.

  The use of data for monitoring purposes is however more complex in countries adopting a mixed-approach to provision, as use of open market DEC is not part of the dataset, and many of these platforms are open access, therefore making it impossible to accurately monitor use by specific groups of stakeholders.

- Lastly, a greater role of public authorities in the provision of DEC is conducive to **models of education that prioritise free and equitable provision** and are more cautious with regards to engaging with the private sector.

However, research and stakeholder consultations conducted for this study pointed to several **pedagogical, economic, ethical, and technological challenges.**

- **Negative impact on education institutions and educators' freedom of choice.** This is particularly the case in countries implementing primarily public approaches to provision, like Greece and Cyprus, where public authorities are the only providers of DEC. However, it should be noted that in these countries, public authorities are also the only providers of printed educational content, therefore limited freedom of choice is not a DEC-specific issue.

  Limited choice also affects educators in countries like Slovakia where schools and teachers are still formally able to acquire resources from the open market, but no public funding is made available for this purpose, de facto limiting their purchasing power. Negative impacts on freedom of choice can also be found in mixed models, as public repositories may lead to an over-reliance on pre-selected, and often free resources, and discourage exploration of the broader DEC market. This is especially the case where budgets available to schools for DEC are limited.

- **Greater risk of state interference with content**, the compulsory use of content offered on a single state-run repository does not allow for the freedom of choice that is needed for a plural and critical approach to education.
- **The focus on core subjects included in national curricula may result in less stimulus for innovation** in DEC for non-core subjects which, by its very nature, requires constant updating, experimentation and creativity in order to learn and teach differently without ignoring the technological developments that generally affect society and the economy more rapidly.
- **Market dynamics suffer from dominant role of public authorities.** Although private providers compete in procurement processes to have their products included onto national platforms, the marketplace is inherently less dynamic. Centralised provision overrides incentives for companies to create independent content, and the risk of duplicating what is already available on public repositories – often for free -- is higher. The pool of providers might be smaller, as SMEs and start-ups may be less equipped to take part in large procurement processes and therefore be put at a disadvantage.

A small number of Member States fully rely on the open market for the provision of DEC, with differing levels of purchasing autonomy across local authorities, education institutions and educators themselves.

In a small number of EU Member States (FI; IT; LU; SE), no public repository for DEC has been established. This means that the provision of DEC is left to individual procurement and purchasing decisions between education institutions, educators, and learners on one side, and private providers in the open market on the other. This model also may present **advantages and drawbacks**:

- **Favouring freedom of choice**, by allowing users have greater purchasing powers.
- **Supporting market dynamics** as private providers to compete for the same customer base, potentially leading to competitive/more affordable prices and higher quality, more innovative products.
- **Reliance on individual schools and educators' own motivation to engage with DEC,** as change in day-to-day practices with regards to teaching, learning and assessment is left to school leaders and educators, who are free to choose whether to take on the challenge of advancing DEC in their education institution.

4.1.1.2 Public-private partnerships for DEC

Harnessing public-private partnerships as levers for better cooperation between public authorities and the private sector, and encouraging increased development and use of DEC, and innovation

Considering the variety of approaches to the provision of digital education, **public-private partnerships could strike a middle ground between public authorities' willingness to play a central role in the DEC lifecycle, and the needs of the private sector.**

In many educational systems, **the COVID-19 pandemic and the accelerated technological transformation have represented and continue to represent an opportunity for EdTech companies to further establish their role as partners for public authorities**. For example, during emergency school closures, the quick switch to online remote teaching and learning bought EdTech companies to the centre of essential educational services[194] both through the provision of free educator training opportunities and free access to digital support for educational institutions, educators, and learners to ensure continuity[195]. Moreover, institutions negotiated emergency contracts with companies to acquire infrastructure, online platforms, and other solutions[196].

[194] Williamson B and Hogan A. (2020). Commercialisation and privatisation in/of education in the context of Covid-19. Education International.
[195] Adrián Zancajo and others, Digitalization and beyond: the effects of Covid-19 on post-pandemic educational policy and delivery in Europe, *Policy and Society*, Volume 41, Issue 1, March 2022, Pages 111–128, https://doi.org/10.1093/polsoc/puab016
[196] Ibid.

While cooperation between public authorities and the private sector is not a new phenomenon**, the combined effect of the COVID-19 pandemic and the accelerating pace of the digital transformation may lead to a corresponding increase in private-public partnerships**. There is evidence that this has happened to some extent, with many new collaborations emerging across Europe[197]. The sustainability of partnerships remains to be seen following the transition from emergency distance learning to business as (the new) normal. However, efforts by the European EdTech sector to develop guidelines[198] for sustainable public-private partnerships to support the development of innovative education approaches, attest to this type of collaboration.

Examples from the ground indicate that **not only are public-private partnerships relatively widespread, they also generally aim to achieve specific objectives that can result in concrete impacts**. For instance, many public-private partnerships contribute to providing infrastructure, mobilising resources and fostering political will to invest in the digital transformation. In Estonia, for example, a memorandum of understanding between the Ministry of Education and Research, the Ministry of Economic Affairs and Communication, and EdTech Estonia aims to strengthen coordination in digital education, particularly for the development of e-services.

Box 15. Selected examples of partnerships for infrastructure and general cooperation

SELECTED EXAMPLES OF PUBLIC-PRIVATE PARTNERSHIPS FOR INFRASTRUCTURE AND GENERAL COOPERATION

In **Estonia**, the memorandum of understanding and cooperation between the Ministry of Education and Research, the Ministry of Economic Affairs and Communication, and EdTech Estonia sets out responsibilities and common targets, providing a framework for further future cooperation.[199] As such it represents an example of a public-private partnership aiming to strengthen coordination in the area of digital education.

In the **Netherlands**, the Edu-K[200] is a coalition composed by the PO Council, the VO Council, the MBO Council, the Ministry of Education, Culture and Science, the national association of publishers (MEVW), distributors (KBb-E) and software suppliers (VDOD). Through Edu-K, these parties aim to ensure a well-functioning digital education ecosystem and thus create the preconditions for the successful use of ICT in teaching and learning at primary, secondary and vocational education level. SURF is a cooperative association of Dutch educational and research institutions working together to acquire or develop the best possible digital services and encourage knowledge sharing through continuous innovation.

In the **Netherlands**, the 'Digital education well organised'' initiative[201] is a public-private programme to ensure that the Dutch digital infrastructure is efficient, secure, reliable and futureproof. The initiative is based on a close cooperation between the Ministry of Education, Culture and Science, national associations of publishers (GEU), distributors (KBb-E) and educational software suppliers (VDOD). The partnership is rooted in agreements on core working standards and financial commitments (EUR 34 million for each partner).

The National Education Lab AI (NOLAI) initiative[202] aims to increase the quality of primary and secondary education by investing in intelligent technologies that support learning and teaching. Schools, scientists and business leaders from both EdTech and traditional publishers, will develop new prototypes through co-creation, to promote safe practices related to the use of AI in education. The initial funding foreseen for the initiative is EU 80 million for the first 10 years. A further budget of EUR 63 million is also planned for scaling.

Source: Ecorys, 2023

[197] Melstveit-Roseme, M., Day, L., Fellows, T., Staring, F., Vicentini, L., and Looney, J. (2021) Enhancing learning through digital tools and practices: how digital technology in compulsory education can help promote inclusion. Luxembourg: Publications Office of the EU.
[198] See https://static1.squarespace.com/static/5fac2fdb0da84a28cc76b714/t/638efaecfbc59e2b574cb19a/1670314736445/Foundations+for+Public+Private+Partnerships+EEA.pdf
[199] https://digital-skills-jobs.europa.eu/en/inspiration/good-practices/edtech-estonia
[200] See https://www.mevw.nl/samenwerking-in-de-leermiddelenketen
[201] See https://www.rijksoverheid.nl/documenten/rapporten/2021/10/28/digitaal-onderwijs-goed-geregeld
[202] See https://www.ru.nl/en/research/research-news/schools-researchers-and-companies-join-forces-in-the-national-education-lab-ai-to-work-on-intelligent-technology-in-education,

While not directly linked to DEC, these types of public-private partnerships are perceived by consulted stakeholders as helpful to create an enabling environment for the successful integration of digital education content in teaching and learning practices by supporting the development of well-functioning digital education ecosystem, enhancing cooperation, and stimulating innovation. However, evidence on the direct impact of these partnerships is scarce and requires increased efforts to measure their concrete results. Other types of public-private partnerships, bring together institutions, universities, EdTech companies, and researchers, to increase the use of digital tools and resources in teaching and learning, including through test beds for the introduction of emerging technologies in education. While these still represent a minority of partnerships, they play an important role as educators and learners are often the direct beneficiaries of the measures implemented by partners. As such these public-private partnerships make a tangible impact on the DEC ecosystem.

Box 16. Selected examples of partnerships for content

SELECTED EXAMPLES OF PUBLIC-PRIVATE PARTNERSHIPS FOR CONTENT

In **France**, a partnership between the Canopé Network and EdTech France was launched in 2022. The objective of this public-private partnership is to strengthen the French EdTech sector by adapting digital offers to the needs of teachers[203]. Moreover, a private-public partnership for innovation and AI (P2IA) was launched in 2019 to provide primary school teachers with AI-based tools and contents to support students in learning French and Mathematics[204].

In **Sweden**, the Swedish EdTest,[205] an initiative by the Nacka municipality which brings together 13 other municipalities representing 700 preschools and schools, as well as EdTech companies and research institutions,[206] provides a space for educators, companies and researchers to meet and build mutual trust, while driving the quality and the development of digital tools together. The aim is twofold: strengthening educators' digital skills so that they can make more informed use of the digital learning resources they need and use; and improving EdTech companies' understanding of real classroom needs and to adapt their services around these.

The methodology revolves around three steps[207]: 1) assessing needs and pairing teachers and companies, as relevant; 2) testing by administering EdTech solutions in the classroom and holding regular meetings and discussions between companies and teachers; 3) following up and evaluating, by holding interviews and workshops. To date, 200 teachers and 50 companies have participated in the project. Feedback from participants indicates the projects continues to provide added value for both teachers (who report being better equipped to choose and integrate digital tools into their teaching) and companies (who report positive outcomes on their product development practices and better marketing prospects)[208].

However, challenges remain, particularly in relation to ensuring participation from educators, who often lack time, or may not recognise the value of digital tools, or be less willing to cooperate with the private sector[209].

In **Ireland**, Education and Training Boards[210] - statutory education authorities with responsibility for education and training - regularly cooperate with industry partners in the context of the Skills to Advance scheme[211] for training. Examples to date include the development of an aquafarm VR simulator by Galway and Roscommon

[203] See https://www.reseau-canope.fr/fileadmin/user_upload/espace_institutionnel/Dossier_de_presentation_Reseau_Canope_2022.pdf
[204] Jean, A. and C. Gilger (2022), *Partnership for innovation and artificial intelligence (P2IA).* Available at https://primabord.eduscol.education.fr/partenariat-d-innovation-et-intelligence-artificielle-p2ia
[205] https://edtest.se/en/aktuellt
[206] https://swedishedtechindustry.se/nationell-testbadd-for-edtech/
[207] Compendium on digital inclusion in education - Publications Office of the EU (europa.eu)
[208] Ibid.
[209] Ibid.
[210] See https://www.etbi.ie/etbs/
[211] See https://www.solas.ie/programmes/skills-to-advance/

ETB;[212] a wind energy VR simulation by Mayo, Sligo and Leitrim ETB[213] and VR for training in healthcare sensitive settings developed by Dublin and Dún Laoghaire ETB.[214]

In **Lithuania**, the 'EdTech' project was launched by the Ministry of Education, with the objective if encouraging collaboration among key stakeholders (DEC providers, educators and students)[215]. As part of the project, an open call was launched for schools to express their interest in testing new Edtech products in classes, including educational games, programmes, VR equipment. These schools will be matched with Lithuanian and international EdTech companies participating in the initiative. To supervise the project, the Ministry of Education also appointed an ''EdTech'' coordinator. The EdTech Lithuania Alliance gathers key stakeholders from the industry to develop education solutions, including the vedliai.lt platform, which provides tools for primary school educators to teach IT; the Oxsico plagiarism software; as well as game-based learning solutions such as "Three Cubes".[216]

Consultations carried out for this study further confirmed that **public-private partnerships are a key feature of education governance arrangements, and act as a mechanism for developing and updating more complex service lines for digital education content that require a wider range of different technical and pedagogical expertise.** Surveyed DEC providers stated that they have, to a varying degree, engaged in fora established by public authorities within the countries where they operate. However, they also highlighted this as an area for further improvement, calling for **greater trust and support from public authorities for the professionalisation of the digital education content market,** through stronger public-private partnerships that make better use of consultation with the sector to avoid duplication.

At the same time, as outlined above, consultations showed different approaches by public authorities, with policy approaches in some countries prioritising free access to education and content, with corresponding reduced willingness to invest in and cooperate with the private sector. As such, the future of public-private partnerships will require broader reflections by policymakers on how to best engage with the private sector in the long run, to understand how to best harness their potential for innovation in education, while ensuring that the provision of education remains rooted in horizontal values and principles such as equity, quality and inclusivity.

4.1.2 Peripheral governance of DEC: regulatory approaches to technical standards

The peripheral governance of digital education content refers to regulatory approaches to the safe use of DEC, namely copyright and licensing, privacy and data rights, interoperability, metadata, and accessibility.

A wide range of national and transnational regulations and industry standards on technical requirements exists across the EU, but these are not always specific to DEC and guidance for end-users is scarce.

Our research shows that there is a wide range of regulations and industry standards both within Member State and at EU level for technical requirements for DEC. This diversity, which was evident in both the study stakeholder consultations and desk research, emerged as a common challenge for the digital education marketplace.

Regulatory approaches in Member States can be grouped into three broad categories,[217] each of which reflects a different general approach to DEC technical requirements for in the following five areas: copyright and licensing; privacy and data rights; interoperability of systems; and platforms, standards for metadata, and accessibility and inclusion.

Table 10 provides an overview of the three categories, their key characteristics and the country distribution.

[212] See www.gretb.ie
[213] See www.msletb.ie
[214] See www.ddletb.ie
[215] See https://www.nsa.smm.lt/projektai/tiriamieji-projektai/projektas-skaitmenine-svietimo-transformacija-edtech/in-english/
[216] https://three-cubes.net/
[217] For this research task, only data from 22 Member States was triangulated as information on this topic was not available for CY,EE, EL,SI,SK. Data for BE is also partial as data from Wallonia on this topic was not available.

Table 10 – Regulatory approaches to technical requirements for DEC, by country

Model	Description	Member States
National standards established for technical requirements for DEC	• Technical requirements for DEC for most or all categories, with quality criteria agreed at national level. • Validation and certification of technical requirements are developed at a national level and are part of an overarching digital strategy. • In some cases, a public platform has been developed to centralise DEC access, distribution and data management. • In some cases, guidelines have been developed to support educators and/or publishers to comply with technical requirements.	BG; FR; IE; LT; PL; PT
National standards established only for some technical aspects of DEC (e.g. metadata of users, copyright, interoperability, etc.)	• National technical requirements and quality criteria for DEC, complemented by more generic legal technical requirements (e.g. GDPR). • Requirements for validation and certification of DEC are fragmentary, due to lack of a common framework and responsibilities split across different ministries. • In some cases, close cooperation between publishers, educators and public authorities is established to agree on common practices for technical aspects of DEC.	AT; CZ; ES; IT; LU; LV; MT; NL
Technical aspects are covered by generic existing standards (e.g. GDPR) and/or not covered by specific DEC-related provision	• Technical requirements are covered by existing regulatory frameworks (e.g. GDPR), not specifically targeted to DEC. • Requirements for validation and certification of DEC are fragmentary, due to lack of a common framework and responsibilities split across different ministries. • Compliance with technical requirement is primarily a ensured by DEC providers themselves.	BE (NL); DK; LV; RO; HR; SE

Source: Ecorys, 2023

Copyright, licensing and data privacy generally benefit from strong regulation. This is also the case for accessibility and inclusiveness, which are often key principles guiding Member States' approaches to digital education content. In contrast, regulations covering standards for metadata and the interoperability of systems and platforms are often lacking and/or missing.

Only a minority of **Member States has specific regulations in place covering all technical aspects (i.e. copyright, licensing, data privacy, interoperability, accessibility) for DEC**. In the majority of cases technical requirements for DEC are present for most or all categories, with a validation and certification process tacking place at centralised level. Some countries (e.g. IE) in this category have linked these regulatory efforts to an overarching digital strategy that guides their approach to digitalisation of public services, including education. Other countries (e.g. BG, PL, LT) are ensuring the compliance of DEC producers with the technical criteria by centralising DEC access via a unique public platform (both private and publicly-owned) which standardises technical requirements and data management across all DEC. In most cases, a set of guidelines has been developed to support educators and DEC providers with compliance with technical requirements.

Our research shows that most of the EU Member States **only have national standards for some technical aspects of DEC or do not have any DEC-specific requirements,** preferring to rely on existing broader legislation to cover these issues. As mentioned above, national arrangements for validation and certification of technical requirements are often quite fragmentary, without a common framework for DEC and with various ministries sharing the responsibility. Compliance with GDPR regarding data privacy and data rights is often required but additional regulations can also apply.

While there are examples of initiatives to provide guidance to educators and DEC providers (see box below), consulted stakeholders found this approach to be insufficient, noting that they are left to navigate a complex regulatory landscape, with multiple regulations applying to DEC to various degrees, without the necessary support. Consulted DEC providers, for example, mentioned that, while existing EU-level instruments such as the EU Assessment List for Trustworthy ArtificialBox Intelligence (ALTAI) guidelines are a helpful practical tool to address accountability and liability aspects[218], there is a need for stronger guidance on best practices in data governance and data management, operational standards, and copyright protection to help them navigate an increasingly complex regulatory landscape amid the emergence of new technologies.

Equally, consulted stakeholders stressed that further support and clearer guidance would be beneficial for end-users (i.e. educators and learners), not only to better understand how existing legal and non-legal standards apply to digital education content, but also to clarify potential grey areas where roles and responsibilities are blurry (e.g. when re-using and re-sharing existing material). Specific areas where consultees identified a need for additional guidance and/or standards to respond to the current insufficient level of knowledge, included the ethical use of data and interoperability, which continue to be seen as challenges to the development and uptake of digital education content.

Box 17. Inspiring practices on guidance on technical aspects for DEC

The **European Union Intellectual Property Office Observatory** (EUIPO) hosts and maintains a Frequently Asked Questions (FAQs) web page on copyright matters[219] to help teachers and students in the EU to find information on using copyright protected content in the context of education and training, particularly online.

The **French Copyright Exploitation Centre** set up a website targeted at teachers and professors to provide user-friendly information and respond to questions on copyright.[220]Furthermore, the French High Authority for the Dissemination of Works and the Protection of Rights on the Internet offers informational material on copyright targeted at educators[221].

The **Irish Copyright Licensing Agency** (ICLA) provides a comprehensive range of copyright and licencing guidelines for schools and colleges. Guidance on data protection, moreover, is provided through the GDPR4Schools website[222].

The **Netherland's National Committee for Data Protection** has set up a Digital Education Working Group to raise awareness around data protection amongst children, teenagers and adults[223]. Furthermore, the Pedagogical and Technological Research and Innovation Coordination Service published a guide targeted any stakeholder producing pedagogical content. It provides guidelines for the design and the development of didactic material for students with specific needs, and includes information on the type of visuals, graphics, fonts, to be used for better accessibility. This guide applies to print and digital education content[224].

[218] https://digital-strategy.ec.europa.eu/en/library/assessment-list-trustworthy-artificial-intelligence-altai-self-assessment
[219] https://euipo.europa.eu/ohimportal/en/web/observatory/faq-for-teachers
[220] 'Centre français d'exploitation du droit de copie', see : http://www.cfcopies.com/site-pedagogique/index.html.
[221] '*Haute Autorité pour la Diffusion des Œuvres et de la Protection des droits sur Internet'* – Source : 'Comprendre les droits d'auteurs avec les fiches Hadopi', Eduscol website, last modified in November 2021, available at : https://eduscol.education.fr/2992/comprendre-les-droits-d-auteur-avec-les-fiches-de-l-hadopi.
[222] www.gdpr4schools.ie
[223] Commission Nationale pour la Protection des données (2021), '*Rapport d'activités 2021'*, available at : https://cnpd.public.lu/content/dam/cnpd/fr/publications/rapports/cnpd/rapport-annuel-annexes-2021-cnpd.pdf, p.94.
[224] See: SCRIPT (2020, 'Guide pour la conception et la réalisation de matériel didactique à l'attention des élèves à besoins spécifiques', available at : https://www.script.lu/sites/default/files/publications/2022-02/Guide%20mat%C3%A9riel%20didactique.pdf

Source: Ecorys, 2023.

Another **highlighted issue for DEC providers is software and/or platform lock-ins**, which require them to use specific protocols and systems for their content, such as proprietary login APIs, proprietary cloud solutions or VPN management systems. In some cases, DEC providers are required to use already existing platforms (both public and private) for DEC to upload and distribute their content instead of their own proprietary systems. According to experts, these requirements are often put in place to avoid overburdening educators with the management of multiple platforms and simplify access for DEC but they often lead to increased costs for DEC providers, which are not reflected in their contracts.

These software/platform lock-ins are usually very lengthy (reported to be up to 20 years in some cases) and force DEC providers to adapt their offer to systems that they have little control of, and can lead, in some cases, to issues with the user experience such as missing features or content, linked to software incompatibilities or outdated systems. Experts also reported concerns regarding the compliance of some of these third-party solutions with GDPR requirements, particularly regarding data management and protection of their user base. As they do not have a full control over the data generated by their DEC offerings provided via these platforms, this can lead to situations where their DEC offerings are no longer compliant with GDPR, particularly if the software/platform provider is not already in full compliance with the requirements of the law regarding data management and protection.

Lastly, in a minority of Member States (e.g. BE, PL), close cooperation between publishers, educators and public authorities has led to the agreement of common practices for technical aspects of DEC, but this is not the case for the majority of countries.

Further details of the state of play across copyright and licensing, privacy and data rights, interoperability, metadata, and accessibility are explored below.

Copyright, licensing, privacy and data rights benefit from existing standards at EU and national level, however challenges related to guidance remain.

A small minority of Member States (e.g. IE, PL, PT) have developed specific arrangements covering copyright and licensing for DEC, with the vast majority of countries applying existing and broader copyright arrangements to digital education content. As mentioned above, a key characteristic of these specific arrangements is the use of a central licensing agreement or/and a central public platform that regulates access to DEC content and ensures that copyrights and licensing are respected.

For most Member States, however, existing and broader copyright and licencing regulations apply to DEC, without any specific provisions for DEC or central coordination mechanisms, and it is up to publishers and users to ensure that their materials respect existing laws. In some countries (FR and LU), the copyright concept of “pedagogical exception” applies to DEC[225]. Sectoral agreements to ensure authors’ consent for use of their work, and offer them compensation, are a widespread practice, as in non-digital education.

Nevertheless, **available data show that copyright and licencing are a difficult to enforce in most countries**, particularly in the production, distribution, and use of OERs. Teachers are often unaware of the intricacies of relevant copyright laws, although most Member States (e.g. CZ, FR, HU, IE, LT, LU, NL, PL, PT, SK) provide educators with regular training and guidelines on copyright and licensing to attempt to cover these gaps.

On data privacy and data rights, available data indicates that the vast majority of EU countries rely on GDPR as their main regulatory tool for DEC, with a small minority of countries having developed specific complementary arrangements for the sector and/or relying on generic national-level regulations on the topic.

[225] The concept of ‘’pedagogical exception’’ means that not all copyrighted works are treated equally in the context of education. For example, for selected types of materials, copyright is not infringed by individual educators or learners as long as the copyrighted material is used for the purpose of giving or receiving instruction, and the material is used to illustrate a point about the subject being taught . For more information, see https://www.copyrightuser.org/understand/exceptions/education/ and Nobre T. (2017).Copyright and education in Europe https://rightcopyright.eu/wp-content/uploads/2017/04/15casesin15countries_FinalReport.pdf

Available data indicates that most EU Member States require DEC producers to follow GDPR regulations while designing their products and require them to be GDPR compliant before they can be used in educational settings.[226] Some countries (e.g. BE, FR and LU) have created Data Protection Officer (DPO) positions in their ministries, with oversight responsibilities for DEC, and some have required education facilities to start hiring DPOs. Lastly, some EU countries (e.g. FR, PL and PT) have created specific ministry-level units dedicated to review and control of data protection for students, teachers and educational staff. France, for example, has created the role of Digital Resources Access Manager to oversee data exchanged by education institutions and DEC providers.

Regulatory approaches to interoperability and metadata are lagging behind, resulting in bottlenecks for national and transnational markets.

In regard to interoperability of DEC formats, systems and platforms, regulations across the EU are highly fragmented, hampering our analysis of this aspect. The DEC provider survey conducted for this study highlighted this issue as a key obstacle for the EU DEC marketplace (the third most cited challenge).

Available data seems to indicate that **only a minority of EU Member States (BG, EL, LT, SE) developed specific criteria for interoperability of systems and platforms that require DEC providers to develop products compliant with specific protocols and software standards to operate in their educational systems.** In some of these countries, interoperability is ensured by building on international standards (e.g. Unicode[227]; UTF-8[228]; W3C; MINT-Metadata Interoperability Services[229]) to ensure interoperability between specific operating systems and/or software, web platforms and compatibility with public repositories.

Sweden represents an example of a country where national interoperability standards have been set up through a consortium of EdTech industry representatives, as well as public authorities. The free-to-use SS12000:2020 standard, which is an agreement on how different IT systems should communicate with each other, and how data are to be transferred from one system to another at the educational facility level.

Box 18. Inspiring practices on interoperability standards

Focus on interoperability standards in education in Sweden: The Swedish Institute for Standards (SIS)[230], an international organisation specialised in national and international standards set up a technical committee - **SIS technical committee 450 – Information management in the education sector** to promote interoperability and enable secure and efficient information management.[231] The committee brings together stakeholders in the education sector (e.g. EdTech companies, public authorities) to monitor European and international developments in the area of standardisation, developing new standards and contribute to an increased use of IT in education settings[232].

Together with the Forum for Information Standardization in the Education System (FFIS)[233], the committee is tasked with identifying areas where standards are needed, covering all education levels. Furthermore, the committee carries out its work through several working groups, including a working group on digital learning resources, which focuses on metadata and information exchange within the process of ordering/delivery of digital learning resources[234]. The committee developed the SS12000:2020 standard to support more efficient systems for transferring data, both within and between different IT systems used in education. In the long run, the committee aims to contribute to ensuring reduced costs and improved quality

[226] For more information, see Annex 2 on EU policy instruments.
[227] https://home.unicode.org/
[228] https://blog.hubspot.com/website/what-is-utf-8
[229] Megalou, Elina & Kaklamanis, Christos. (2014). PHOTODENTRO LOR, THE GREEK NATIONAL LEARNING OBJECT REPOSITORY.
[230] https://www.sis.se/en/about_sis/sisorganisation/
[231] https://www.sis.se/standardutveckling/tksidor/tk400499/sistk450/
[232] Ibid.
[233] https://www.skolverket.se/om-oss/var-verksamhet/skolverkets-prioriterade-omraden/digitalisering/forum-for-informationsstandardisering-i-skolvasendet
[234] https://www.sis.se/standardutveckling/tksidor/tk400499/sistk450/

and to information exchange with other sectors[235]. The committee's work is funded through a combination of participants' fees, as well as grants and market contributions/standardization support from SIS[236].

Source: Ecorys, 2023.

For other Member States, the interoperability of systems and platforms is the sole responsibility of DEC providers, leading to increased fragmentation of the market and the incompatibility of many DEC products with existing standards and platforms used at national and local level. One particular issue is the difference in procurement practices for hardware and software, particularly with regards to who has the responsibility to approve acquisition. Often acquisition of hardware/ software is not coordinated with the acquisition of DEC, leading to incompatibilities, bugs and other technical issues which limit the use of DEC in educational systems.

Our research also highlighted that Member States (DE, FR, NL) are aware of these issues and are working on enhancing the interoperability of DEC products within their territories as a short to mid-term goal. The most common first step is the development of technical guidelines for DEC producers, as well as common standards for all DEC that is purchased for use in their national education systems. However, technical guidelines alone are not sufficient to address different interoperability approaches and the compatibility between content across systems.

Standards for metadata also remain a key obstacle for the EU DEC marketplace and were the fourth most cited challenge by the DEC provider survey respondents. Desk research revealed that standards on metadata exist in France, Croatia, Spain and Sweden[237]. The standards in these four countries cover how various elements of DEC from different IT systems should communicate with each other, how data are to be transferred from one system to another and how the source code/algorithm should be audited by competent authorities. Some **Member States, such as Bulgaria and the Netherlands, enforce standards for metadata via their use of central DEC platforms or via public-private partnership agreements between schools and suppliers about the processing of personal data.**

Lastly, in some instances, initiatives (either industry-led, or established by public authorities) have been implemented to tackle issues related to identify management and authentication, by setting up single sign-on systems and/or meta-platforms, where users can access digital education resources from different platforms. This is, for example, the case in Italy where the *Zaino Digitale*[238] project has been implemented by the Association of Italian Publishers (AIP) since 2017. The project provides families, students, and teachers with a single gateway to access digital content (mainly digital textbooks and supplementary resources) from different publishers' platforms.

Another example is Bulgaria's Digital Backpack initiative[239], launched in 2023 by the Ministry of Education and Science and implemented by a consortium, to create a single identity platform to support digital education, store student data, provide data analytics, and access to DEC. Furthermore, in France, Digital Work Spaces/Virtual Learning Environments (ENTs) are regional, departmental or local platforms complying with a national level plan drawn up by the Ministry of Education, and include tools for producing and sharing content, as well as content purchased by public authorities in the geographical area and level concerned.

Accessibility is prioritised by Member States, with guidelines in place for both students and providers

The majority of EU Member States have developed guidelines for DEC providers to develop DEC with assistive technologies and accessibility built in their design. Examples of these guidelines include the

[235] Ibid.
[236] Ibid.
[237] Please note that the country mapping did not identify information on national standards for metadata for the remaining Member States. However, stakeholder consultations highlighted this as a clear area for further development, supporting the findings that gaps in regulation exist.
[238] https://registrazione.zainodigitale.it/FR/#/
[239] https://edu.mon.bg/

Digisprong Knowledge Centre[240] (BE), Kennisnet[241] (NL), Zesummengdigital[242] (LU) or the Teiresias Center[243] (CZ). These different guidelines cover an extensive array of topics regarding accessibility and inclusion such as how to integrate refugee children into DEC, language options for foreign-born or minority-language students, adjustable settings for visual and audio resources, specific apps for reading aids for people with Special Education Needs or how to adapt content for gifted students. The available data also indicate that some Member States have yet to develop specific standards for accessibility for DEC beyond existing, broader accessibility policies.

Lastly, responses from the DEC provider survey also indicate that providers prioritise accessibility, with over two thirds of surveyed organisations reporting offering adaptive solutions for learners with special educational needs or disabilities (67%), over half offering multilingual content and services (58%) and one quarter of providers (375) reported specifically attending to gender sensitivity in their content, while neurodiversity features (24%) in just under one quarter of offers.

There is no consensus among stakeholders on the need for more regulation, but there is a strong preference for more guidance and capacity building opportunities to be made available.

Consultations found a lack of agreement among stakeholders on the need for stronger regulations for DEC technical requirements. Consulted stakeholders generally agreed that additional regulatory frameworks would not necessarily positively impact DEC. While more regulations regarding interoperability and metadata are welcome overall, stronger requirements regarding accessibility, data privacy, copyright and licensing could act as a barrier to the development of DEC particularly OER.

In addition, regulations might impinge on the freedom of educators and educational institutions to choose the materials that best fit their needs and those of their learners. There is a clear call that better guidance to support educators across the EU be provided. Guidance on copyright, ethical use of data and interoperability are seen as particularly useful by stakeholders and there are several examples of Member States (BE, CZ, FR, HU, LT, LU, NL, PL, PT and SK) that have implemented these types of guidelines at national and regional levels.

4.1.3 Monitoring and evaluation of DEC

While monitoring and evaluation systems are in place in several Member States, approaches vary.

There is a wide range of national and transnational regulations and industry standards for quality assurance in the EU. In data gathered through consultations, the country mapping exercise and the DEC provider survey, the diversity of regulations and standards emerged as the most common challenge in the digital education marketplace. Available data shows that differences in curricular standards among EU Member States, along with different levels of integration of digital tools and content within teaching, learning and assessment, and within teacher education programmes make it difficult to have a common EU-level approach to quality assurance. Fragmentation of DEC quality assurance across different levels of government and/or among different ministries also emerged as a related challenge. Without specific guidance and/or training, DEC providers find it difficult to fully understand the different requirements and procedures they need to comply with.

Based on our research findings, we have grouped Member States into four broad categories[244],according to their general approach to quality assurance of educational content, and their adaptation to this emerging market.

[240] https://www.vlaanderen.be/kenniscentrum-digisprong/themas/e-inclusie
[241] https://www.kennisnet.nl/artikel/6601/waarom-is-digitoegankelijkheid-belangrijk-en-wat-betekent-het-voor-de-school/
[242] https://zesummendigital.public.lu/fr.html
[243] https://www.teiresias.muni.cz/
[244] For this research task, only data from 23 Member States was triangulated as information on this topic was not available for CY,EE,FI,IE,SI. Data for BE is also partial as data from Wallonia on this topic was not available.

Table 11 provides an overview of the categories, their key characteristics and the country distribution.

Table 11 – Approaches to quality assurance for DEC, by country

Approaches	Description	Member States
National quality assurance for DEC in place.	• Validation and certification of DEC at national level. • QA processes with independent experts for DEC, with regular checks and updates. • Quality frameworks for DEC are present, with quality requirements agreed at national level. • OER is regulated via quality content frameworks. • In some cases, responsibility for validation and certification of DEC can vary according to ISCED level. • In some cases, a quality seal is provided, with involvement of educators and education institutions. • In some cases, a public platform has been developed to centralise DEC access and quality control.	BG; CZ; EL; ES; FR; HR; HU; LT; PL; SK
National quality assurance only for some specific types of DEC.	• Validation and certification of DEC takes place at both national and regional/local level. • Validation and certification of DEC established at national level for specific types of DEC (e.g. mobile learning platforms). • Responsibility for validation and certification of DEC may vary according to ISCED level.	AT; MT; IT
No specific national quality assurance for DEC but existing standards for educational content apply	• Validation and certification of DEC takes place at centralised level. • Validation and certification of DEC follows the same processes as for printed educational content. • No specific quality frameworks for DEC developed. • Quality assurance of DEC done by publishers and users, DEC needs to comply with existing regulations to be used in educational contexts. • The development and use of OER is unregulated.	LU; PT
Quality assurance is the sole competence of regional/local authorities, publishers, educators and/or other users	• Validation and certification of DEC is delegated to regional/local authorities. • In the majority of cases, no specific quality frameworks for DEC were developed but some Member States have guidelines. • Quality assurance of DEC is done by publishers, or indirectly by users through market dynamics (i.e. users select and purchase materials that they perceive to be of quality). • The production and use of OER is unregulated.	BE(NL); DE; DK; LV; NL; RO; SE

Source: Ecorys, 2023.

The majority of EU Member States have developed specific quality assurance processes for DEC content (BG; CZ; EL; ES; FR; HR; HU; LT; PL; SK). In the majority of cases there is a specific procedure for validation and certification of DEC at national/regional level, with a dedicated team of independent experts with experience with DEC at the helm. The specificities of these arrangements and the requirements vary from country to country, but available data shows a clear understanding that DEC needs to undergo an evaluation process beyond procedures applicable to printed educational content.

Box 19. Inspiring practices on quality assurance

Greece's system of quality seals: DEC is quality assured through a quality seal system centrally managed via a public online platform. There are five quality seals, covering quality of design, quality of content, trustworthiness of source, overall pedagogical quality and quality of metadata arrangements. Currently, there are approximately 30 institutions in Greece providing quality seals, with the majority being public.

Finland's collaborative approach to quality assurance: A collaborative approach to quality assurance, involving educators and education institutions. Materials are first identified by teachers and then appraised by the relevant education institution which has the responsibility to ensure the content is compliant with legal technical requirements.

Croatia's triple quality assurance system: DEC is quality assured through a triple system that consists of an external independent evaluation (covering the relevance of methodology, of content, and the inclusiveness of the developed materials), an expert evaluation from the Education and Teacher Training Agency, and an external evaluation by end users based on an anonymous questionnaire.

Source: Ecorys, 2023.

Data also indicates that some countries in this category may have distinct tracks for validation and certification of materials for compulsory education, VET and Higher Education. Typically, more established, centralised systems have been developed for primary and secondary school DEC, while at Higher Education level, certification happens more by departments or individual professors is more typical.

Our research also identified **another group of Member States that only have a quality assurance system for specific types of DEC (AT; MT; IT).** Like the first group, in the majority of cases for validation and certification of DEC, there is a specific procedure and a dedicated team of independent experts with experience with DEC at the helm. However, certification only applies to a subset of DEC (e.g. mobile learning apps for AT, OER for IT) or is only applied to professionally developed DEC (MT). Another major difference is that countries in this category have opted for a mix of centralised and decentralised validation process, with primary and secondary education institutions having more freedom to design OERs and procure DEC than Higher Education institutions in most cases.

Another **smaller group of Member States does not have any specific national standards for DEC, but instead apply existing standards for educational content to DEC (LU; PT).** Countries in this category use their established systems of validation and certification to assess the quality of DEC before use in educational contexts. The validation and certification of DEC is done, in the majority of cases, at national level, following the same procedures for other educational content, however it is expected that DEC producers do most of the compliance work beforehand, by ensuring that their materials are in line with existing legislation before submission. The production and implementation of OER in educational contexts is unregulated in most cases, with educators having the main responsibility for quality control of content.

The final category encompasses **all Member States that rely on regional/local authorities, DEC producers, educators and/or users to quality assure the content of DEC (BE(NL); DE; DK; LV; NL; RO; SE),** representing the second largest category in our classification. The specificities of these arrangements vary from country to country, but available data indicates that most these countries rely on the DEC market to regulate itself, with educators at local level playing a key role in quality assurance. In most countries (BE, DK, DE and SE), this is linked to their highly decentralised educational systems, which provide significant autonomy to education institutions. In some of these countries **(BE, DK and SE)**, educators have guidelines and training to

evaluate DEC. In other cases **(LV, NL, RO)**, a common understanding of quality DEC has not been developed, and there is no push for regulation of the DEC market.

4.2 Funding streams for DEC

This section builds on the market analysis in Chapter 3, providing further analysis of funding arrangements for DEC across the EU. The challenges posed by an overall lack of transparency in public budgeting, as well as the complexity of funding arrangements across governance levels are highlighted. An overview of the role played by EU funding programmes in promoting the development and use of DEC at the national level, as well as challenges and opportunities are also noted.

Research and consultations revealed that, across EU Member States, there are three main sources of funding for digital education content: 1) public education expenditure; 2) special funds linked to specific initiatives relevant for DEC; 3) EU funding programmes (under both direct and indirect management). However, existing funding arrangements raise concerns with regards to transparency and adequacy of public spending, and over-dependency on grant systems which may not guarantee sustainability.

4.2.1 National funding streams for DEC

Data on public investment on digital education content at centralised and decentralised level is scarce and budgetary responsibilities are scattered across levels of governance, contributing to fragmentation and higher market risk

As shown in Chapter 3 (market analysis), while evidence on expenditure on education is generally available at the national level, **data on public investment on digital education remains scarce**. Desk research confirms that no consolidated comparative data providing an overview of expenditure on digital technologies – let alone digital content – either by governments, or by education institutions is available.[245]. This is due to accounting and reporting rules that are not designed to disaggregate between the different types of expenditure related to digital education[246].

At the level of education institutions, information is equally opaque; within budgets for individual schools, only resources for textbooks are ringfenced, while spending for digitalisation usually falls under ''capital expenditure'' (i.e. infrastructure), or is classified as ''expenditure on other resources'', which includes expenses on various types of supplies, including (digital) learning materials[247].

Another layer of complexity is represented by the fact that **funding for the acquisition of education resources, both print and digital, usually involves more than one education governance level**[248]. Overall budgets and financial allocations are usually decided at national levels, and resources are then redistributed to intermediate authorities (e.g. regions, municipalities) to be provided to individual institutions. However, there can be significant variations both between and within countries. For example, in Romania financial resources for the general purchase of operational goods and services are provided from the national level to regional and local administrations, while local tax revenues are used by regional and / or local authorities to purchase educational resources,[249] potentially leading to inequalities within the same country.

In other countries, the approach is reversed: while regional and local authorities are responsible for the financial administration of education, resources for teaching materials are allocated to schools directly by ministries (e.g. CY, SI)[250]. Furthermore, **approaches vary across levels of educations**, with the role of central, regional and municipal authorities being more prominent within ECEC and primary/secondary education, while higher education institutions overall operate with a higher degree of autonomy as self-governing bodies.

[245] OECD (2023). Shaping Digital Education - *Enabling Factors for Quality, Equity and Efficiency.* Available at https://www.oecd-ilibrary.org/education/shaping-digital-education_849af8d0-en
[246] Ibid
[247] Ibid.
[248] Eurydice (2014), Financing Schools in Europe: Mechanisms, Methods and Criteria in Public Funding.
[249] Ibid.
[250] Ibid.

Consultations revealed that, beyond expenditure on education, **some Member States have put in place specific funding programmes designed to serve several purposes.** For example, in Austria the FLAF fund, provides financial support for the purchase of both schoolbooks and compulsory digital tools (e.g. learning apps), with around EUR 120 million spent per year. the acquisition of education. Schools also receive funding from the FLAF programme: 85% of this budget must be spent on books/DEC from the list of approved learning materials by the ministry ("Schulbuchliste"), while the remaining 15% can be used by schools to procure materials of their own choosing.

In Bulgaria, national programmes (e.g. national programmes on ICT in pre-school and school education; national programme for development of STEM) have their own annual budgets that can contribute to the acquisition of DEC, albeit not directly. In Germany, the Digitalpakt Schule[251] federal programme provides about EUR 6.5 billion to schools and local bodies for the acquisition of both hardware and DEC. In Estonia and Ireland, special funding is in place to provide subsidies to local administrations and/or schools to support digital education. However, as beneficiaries are allowed discretion on how subsidies are spent between ICT infrastructure, equipment, training, or digital education content.

Box 20. Inspiring practices on funding for DEC

The French Edu-Up funding tool supports the production of DEC: The Edu-up tool[252] seeks to support companies and start-ups or associations producing innovative content by making available up to €70,000 per selected project in the form of a grant for an initial impetus and by facilitating access to classrooms for the duration of the project, enabling services to be tested with and by users.

Government support for digital education content in higher education in Ireland and the Netherlands: Ireland's Higher Education Authority (HEA) provides some project-based funding to support specific initiatives or projects undertaken by higher education institutions. This can include funding for research projects, the development of new courses or programmes, or the introduction of new technologies. There are examples of sector-led initiatives to support DEC practice, sometimes with funder support. For example, the HEA in Ireland has supported the Teaching and Learning Forum in Ireland that has enabled the development and sharing of resources and implementation in teaching and learning practice.

In the Netherlands, the sector led SURF initiative[253] has supported ICT collaboration between education and research institutions, which has underpinned digital transformations and practices in the sector.

Source: Ecorys, 2023.

While public budgets and special funds represent important funding streams, a lack of budgetary and reporting rules foreseeing an obligation for education institutions to disaggregate their spending, discretion on how subsidies are spent, and an inherently fragmented system where responsibility for financial decision making is scattered across levels of government, result in an overall **lack of transparency on public spending on digital content.** This stands as a **barrier not only to sizing the DEC market, but also to evaluating levels of adequacy of investment.** Table 12 aims to exemplify the potential impact that public funding on digital education content, based on approximations on potential amounts earmarked for DEC per individual students per year across the EU.

[251] https://www.digitalpaktschule.de/
[252] https://eduscol.education.fr/1603/le-dispositif-edu
[253] SURF is the collaborative organisation for IT in Dutch education and research | SURF.nl

Table 12 – Hypothetical approximation of public spending for DEC across the EU

Educational level	School population in 2020 (million)[254]	Potential investment in DEC per year		
		EUR 1 per student	EUR 10 per student	EUR 100 per student
ECEC	13.6	EUR 367.2 ml	EUR 3.672 bn	EUR 36.72 bn
Primary school	23.3	EUR 629.1 ml	EUR 6.29 bn	EUR 62.9 bn
Secondary school	36.9	EUR 996.3 mln	EUR 9.963 bn	EUR 99.63 bn
	Total	EUR 1.99 bn	EUR 19.5 bn	EUR 1.99 trn

Source: Ecorys, 2023.

Existing challenges within public spending also have **implications for public procurement and market dynamics**. The survey of DEC providers showed that public funding from regional or national authorities represents the second most frequently accessed funding streams for both newer and older organisations, and that they routinely collaborate to bid to public authorities as well as drawing down individual service contracts. However, consulted DEC providers stressed that **without dedicated budgets for digital content, avenues to sell their products are limited, resulting in higher risks, particularly for smaller players, and potentially lower profitability.**

Therefore, greater transparency and increased investment levels would represent an important lever to stimulate the market and encourage the private sector. Furthermore, from the side of education institutions and educators, consultations highlighted the importance of ensuring autonomy in procurement decisions on learning content, but also the **need for guidance and training for educators and administrative staff to gain the necessary know-how to be able to engage in procurement.**

From technical requirements to burdensome procedures and pricing practices, approaches to public procurement provide additional barriers both on the supply and demand side.

As outlined in Chapter 3, the study found that national procurement frameworks for DEC have developed in contrasting ways across Europe, with Member States implementing different models (i.e. centralised, decentralised, and mixed), depending on the level of involvement of public authorities at the national, regional, or local level, and the autonomy granted to education institutions to procure digital education content directly.

While differing procurement models mirror the diversity of governance arrangements within education systems and across education levels, consultations with stakeholders highlighted other factors that contribute to making public procurement difficult to navigate, both on the supply and demand sides.

For instance, **differing technical requirements depending on contract size and type of contracting authority**, provide for a complex system that reward more experienced organisations and can price-out start-ups and SMEs. The market for DEC in the EU operates similarly to traditional publishing of educational content, resulting in established publishers having extensive experience in complying with different public procurement requirements, as well as with providing solutions that are in line with technical and curricular needs. At the same time, the latter may not be as clear for other less experienced players, resulting in a higher threshold for access and contributing to other existing challenges that disproportionately affect smaller organisations (e.g. lack of experience with partnerships; high administrative burden)[255].

[254] https://ec.europa.eu/eurostat/web/products-eurostat-news/-/ddn-20220428-3#:~:text=93.3%20million%20pupils%20and%20students%20enrolled%20in%20the%20EU%20%2D%20Products%20Eurostat%20News,-Back%2093.3%20million

[255] https://single-market-economy.ec.europa.eu/publications/analysis-smes-needs-public-procurement_en

Some Member States have attempted to tackle these challenges by establishing separate public procurement procedures for DEC providers, to allow newer players to engage in public procurement, and not be discouraged by traditional publishers' competitive advantage. For example, in Sweden, Adda, the procurement agency for the national association of municipalities (SALAR), launched two separate competitions, one for distribution of books and another for distribution of digital learning resources, managing to break publishers' existing monopoly in the distribution of digital textbooks/learning resources. In France, through the Innovation Partnerships for AI (P2IA),[256] the government launched a competition for the creation of DEC to support French and mathematics teachers in primary education by relying on a Swiss Round system, allowing several consortia of companies to apply, compete and move through the different stages of the bid, each one focused in designing and tailoring DEC solutions for the government to acquire. The system allowed several companies to be selected and contracted,[257] resulting in more organisations to benefit from the process.

Extensive and burdensome administrative requirements also constitute a challenge, according to consulted stakeholders who highlighted that the majority of Member States do not readjust their administrative requirements according to the size and delivery capacity of bidders, once again penalising smaller players, and resulting in start-ups and SMEs avoiding public contracts. This finding is further supported by the responses to the DEC provider survey conducted for this study, which showed that newer organisations (0-9 years) reported the most substantial difficulties with engaging in procurement, with 52% of them identifying unfavourable procurement conditions as a high challenge, compared with 15% and 17% for the 10-19 and 20+ years categories. Consequently, newer organisations were also more likely to rely on self-funding to maintain their operations.

Inadequate pricing within public contracts, compared to the actual costs of producing DEC solutions, was mentioned by consulted stakeholders as another key issue. According to consulted providers, public procurement contracts do not always price DEC realistically, often leading DEC providers to agree to prices that are too low to be financially sustainable, once again damaging participation from smaller players that cannot afford extensive discounts. This practice can manifest in different ways and has impacts on quality. For instance, public authorities may lack financial resources to acquire DEC, and therefore prioritise low prices over quality, promoting a race to the bottom.

Bids do not always take into account hidden costs that can heavily impact providers (e.g. ensuring compatibility with specific software/hardware, issues related to use of personal data, licenses, etc). This may reveal an overall lack of understanding of DEC from public authorities, who may not be aware of the costs of producing DEC, based on the assumption that digital content may be less costly to produce and disseminate compared to printed materials due to its digital nature.

Lastly, consulted stakeholders highlighted a widespread practice of requesting free pilots to test DEC solutions with educators and learners, before commissioning larger purchases. While this allows for the testing of DEC solutions with the target group before committing to a purchase, the costs of providing, maintaining and updating the pilot as well as customer service are often not taken into account.

Lack of sustainable demand for DEC products also stands out as a challenge, linked to the need to further support for educators to understand how DEC can contribute to the achievement of learning objectives, as well as to provide opportunities for capacity building with regards to procurement processes, which are often highly complex and technical. A promising practice in this regard is represented by the EdTech procurement guidelines[258] developed by the Swedish Edtech Industry and targeting DEC procurers. These include important elements to consider when buying and/or procuring edtech (i.e. educational technology, IT - digital services and products for schools).

In some Member States (DK, SE, FI) there are mechanisms in place for municipalities to launch joint public procurement framework procedures to provide educational content for primary and secondary schools. This

[256] https://primabord.eduscol.education.fr/partenariat-d-innovation-et-intelligence-artificielle-p2ia
[257] https://eduscol.education.fr/1911/l-intelligence-artificielle-pour-accompagner-les-apprentissages-des-fondamentaux-au-cycle-2
[258] https://edtechkartan.se/att-kopa-edtech/stod-vid-inkop-och-upphandling/

allows local and regional authorities to also participate as a buyer in DEC and provide schools with the opportunity to take part in the procurement process.

Politicisation of public procurement was also identified as a risk by consulted stakeholders, who underlined the importance of guaranteeing the independence of DEC providers and educators. In some Member states, DEC providers are facing increasing pressure to make their educational content compliant with political propaganda, putting their independence and the quality of their content at risk. One way Member States are enforcing this is through the public procurement processes, namely by requiring the approval of content via a politically biased evaluation group.

Last, differing procurement models, paired with the obstacles outlined above, as well as having to overcome language barriers and interoperability issues, may pose additional challenges to DEC providers operating/looking to operate across Member States.

4.2.2 EU funding for DEC

EU funding programmes act as an important driver for change in digital education, but content is yet to become a primary focus and long-term sustainability of project results is uncertain.

Over the years, EU funding programmes such as Erasmus+, the European Social Fund, the European Regional Development Fund, and Horizon 2020 have been key resources to stimulate digital transformation in education. As shown in the DEC provider survey, EU funding represents the third most frequently used source of funding among private companies, after self-funding and national budgets.

The survey evidence shows that consortia which come together for the purpose of bidding on ring-fenced EU funds feature prominently within the European DEC marketplace, and compete with more experienced, procurement-savvy providers, who routinely engage in multiple bids for research, innovations and test beds, and newly established and smaller players. These smaller players often report frustrations with their ability to access and participate in a cost-effective manner in this procurement landscape.

At the same time, **DEC has only marginally benefitted from EU resources**. Perhaps because of the continued focus on digital infrastructure and skills development at policy level, with content only starting to be included in frameworks and strategies, investments generally mirror these policy priorities. Evidence from the study suggests that **EU support has been largely deployed to support digital and technical skills through training, as well as the provision of equipment** across levels of education. While crucial to establishing a strong environment for digital education content to be used and developed, these projects can only indirectly lead to a healthy and sustainable DEC ecosystem.

Nonetheless, examples of EU-funded projects directly related to DEC can be found, generally in two domains:

- **Projects developing the necessary infrastructure to access DEC.** These often entail the creation and set up of publicly administered online platforms and repositories for educators and learners to access digital resources to support teaching, learning and assessment. These represent the most common use of EU funds for DEC.

- **Projects supporting the development of digital education content.** In practice, this approach has often led to implementation of pilot projects, with limited possibilities for scaling up, as outputs are rather specific to the project itself or the consortium involved, with less focus on adaptability.

Table 13 – Examples of EU-funded projects relevant to DEC

EU Fund	Selected Examples Of EU-Funded Projects
ERASMUS+	The **Digital ECEC project**[259] aims to enhance learners' and teachers' ability to generate new knowledge, and to share and distribute best practices among ECEC communities. To this end, the project focuses primarily on training ECEC teachers on how to create digital content, including animations, through a training platform[260]; on identifying good practices on the use of ICT in ECEC settings; and on creating a digitalisation framework for ECEC. The project's *Compendium of Good practices of ICT tools in the ECEC sector*[261] provides examples of the pedagogical use of digital tools and materials.
	The **ONLIFE project**[262] aimed to develop a methodology to support school teachers to adapt to online and hybrid teaching throughout the COVID-19 pandemic. As part of the project, an online learning platform[263] was set up, and guidance documents developed. The Guidebook on Patterns for enhancing digital technologies in School Education[264] includes a number of case studies from Italy, Romania, Cyprus, Spain, Greece and Poland on the introduction of digital technologies in learning and teaching.
	The **MENTEP (Mentoring Technology-Enhanced Pedagogy)** project[265] aimed to enhance the uptake of ICT in teaching and learning, by developing and disseminating TET-SAT,[266] a prototype tool for teachers to self-assess their progress in Technology-Enhanced Teaching (TET). TET-SAT focuses on four dimensions of digital pedagogical competence: digital pedagogy, digital content use and production, digital communication, and collaboration and digital citizenship.
EUROPEAN SOCIAL FUND AND EUROPEAN REGIONAL DEVELOPMENT FUND	The **e-Schools: Establishment of the system for the development of digitally mature schools** project aimed to increase information and communication technology use in primary and secondary education in Croatia by providing ICT equipment and educational tools for schools and teachers[267]. In the second phase of the project, the focus shifted to the provision of digital education content, making teaching scenarios or modules for chemistry, biology, mathematics, physics, as well as cross-curricular topics available to primary and secondary school students and teachers. Each module includes different types of DEC (e.g. electronic books; simulations; animations; tests; presentations)[268]. At the end of each module, students can undertake an online assessment to find out what educational outcomes they have achieved.
	The **RED** project[269] aimed to design, produce, make available and disseminate freely accessible interactive digital educational resources, scientifically and pedagogically validated, for the curriculum areas of experimental sciences, mathematics and Portuguese, for the 1st cycle of basic education (from 6 to 10 years old). The project also provides scientific and didactic guidance for teachers to support them with becoming more accustomed with digital learning environments.

[259] https://digitalecec.eu/
[260] https://digitalecec.eu/courses/creating-educational-content-with-animation/
[261][261] https://digitalecec.eu/wp-content/uploads/2022/11/Digital-ECEC-IO1-Compendium-of-ICT-good-practices.pdf
[262] https://onlife.up.krakow.pl/
[263] https://projectsmoodle.up.krakow.pl/login/index.php
[264] https://onlife.up.krakow.pl/wp-content/uploads/sites/82/2022/03/O1-Guidebook-Patterns-for-enhancing-digital-technologies-in-School-Education-Booklet.pdf
[265] http://mentep.eun.org/home
[266] http://mentep.eun.org/tet-sat
[267] https://ec.europa.eu/regional_policy/en/projects/croatia/e-schools-project-to-increase-ict-use-in-croatia-s-education-system
[268] https://pilot.e-skole.hr/wp-content/uploads/2016/12/Prirucnik_Koristenje-alata-za-izradu-digitalnih-obrazovnih-sadrzaja.pdf
[269] https://www.poch.portugal2020.pt/pt-pt/Paginas/default.aspx

EU Fund	Selected Examples Of EU-Funded Projects
HORIZON 2020	The **Up to University** project[270] implemented in Hungary, is a free-to-use e-learning framework that encompasses a 30-hour blended training. Upon successful completion of the training, secondary school teachers gain knowledge and acquire a set of tools that help them prepare their students for the challenges and the e-learning environment of the higher education system.

Source: Ecorys, 2023.

The EUR 723 billion made available under the Recovery and Resilience Facility (RRF) for Member States to support reforms and projects, including on digitalisation, has given new impetus to investments in digital education. An analysis of National Recovery and Resilience Plans (NRRPs), however, reveals investment patterns similar to those outlined above for projects supported by EU funding programmes. In the majority of Member States, NRRPs give priority to investment in digital infrastructure and ICT equipment for education, with only a smaller portion prioritising content (e.g. BE, DE, EL, PT, RO).

Box 21. Inspiring practices within National Recovery and Resilience Plans

Germany to build its first national online education platform: Germany's NRRP will invest EUR 630 million into the country's first national online education platform (Nationale Bildungsplattform)[271]. This is meant to act as a "meta-platform", bringing together existing solutions to help learners acquire competences based on their individual learning pathways.

Belgium to focus on investing in content production: Belgium's NRRP articulates support for digital education in two stages. While the first stage is focused on stimulating the acquisition, implementation, and use of adequate IT in schools and for teachers and learners; the second stage prioritises the production and use of learning content, learning environment, learning pathways, and competence enhancement of teachers and school teams[272].

Greece supported a project on digital content in schools: Greece's NRRP includes a specific pillar on the digital transition which identifies the digitalisation of education as a priority[273]. More than 500,000 school pupils and students all over Greece have already received vouchers for the purchase of IT equipment (tablets, laptops, desktops), and by December 2025, at least 36,000 interactive learning systems will be installed in primary and secondary school classrooms across the country.

Under this pillar, in 2022, the Ministry of Education and Religious Affairs provided support to the 'Development of Digital Content in Schools' project, which sought to promote the development of new digital content and its integration into an online digital environment featuring artificial intelligence, dynamic updates and collaboration opportunities with teacher communities.

Portugal to support the acquisition of DEC across 330 subjects: Portugal's NRRP aims to create the conditions for educational and pedagogical innovation through the development of competences in digital technologies, their transversal integration in the different curricula and the modernisation of the Portuguese education system[274]. In particular, the digital education reform covers the reinforcement of teachers' digital skills, the strengthening of schools' technological infrastructure, including through digital equipment and internet access, and the development of digital educational content. A programme to produce DEC for the

[270] https://up2u.kifu.hu
[271] https://commission.europa.eu/business-economy-euro/economic-recovery/recovery-and-resilience-facility/germanys-recovery-and-resilience-plan_en
[272] https://dermine.belgium.be/sites/default/files/articles/FR%20-%20Plan%20national%20pour%20la%20reprise%20et%20la%20re%CC%81silience.pdf
[273] https://commission.europa.eu/business-economy-euro/economic-recovery/recovery-and-resilience-facility/greeces-recovery-and-resilience-plan_en
[274] https://commission.europa.eu/business-economy-euro/economic-recovery/recovery-and-resilience-facility/portugals-recovery-and-resilience-plan_en

primary and secondary curriculum is also being developed. It is to be funded by the RRF, with tenders being prepared for the acquisition of digital education content across all 330 subjects included in the curriculum[275].

Romania to invest in the development of more than 65.000 OERs by 2025: Romania's NRRP allocates EUR 700 million to the digitisation of education[276]. This includes the provision technological equipment and resources for online educational purposes. Furthermore, an additional investment of EUR 78 million is foreseen for establishment of an online evaluation platform for students by 2024, as well as for the development of at least 65.000 open educational resources by 2025.

Source: Ecorys, 2023.

Consultations with key stakeholders pointed to several challenges and opportunities linked to the use of EU funds for DEC. As with national-level public funds, key issues include **disproportionate investment in infrastructure and hardware over content**, as shown above. Sustainability also remains an issue for consulted stakeholders, as they highlighted risks associated with a **''grant culture'' that relies on time-limited projects, which, while stimulating innovation, may not be necessarily conducive to scale up and promotion of existing solutions.** Competence in fund administration both within education institutions and private companies result in EU funding not being invested wisely.

Looking forward, stakeholders consulted highlighted **the need to not only ring-fence more funding for content within EU programmes, but also to promote a bottom-up approach**, where funding for ground-level initiatives is provided, rather than only centralised solutions. This would stimulate more public investment from national authorities, while providing much needed support to providers – SMEs companies and start-ups in particular.

Along these lines, consulted stakeholders stressed that, aside from funding for DEC solutions, **EU programmes could be used to stimulate the demand for DEC**, for example by providing support at a user-level (e.g. through digital vouchers), benefiting students, teachers and families, or mobilised to support educators to integrate DEC into their teaching, syllabi and/or libraries.

4.3 Key elements of a healthy and sustainable approach to governance and funding of DEC in Member States

The previous sections have highlighted challenges and opportunities within existing national arrangements for the governance and funding of DEC and identified possible areas for action across education levels. Based on this analysis, we summarise key elements of a healthy and sustainable approach to governance and funding of DEC in the Member States below.

Core governance of DEC: institutional arrangements and regulatory approaches

Overall, across Member States, **responsibilities for the governance of DEC are split relatively clearly between public authorities at the national, regional, and local levels**, although there are differences across education levels. Most Member States implement more decentralised approaches to DEC, as with their education governance more broadly, with regional and local authorities taking the lead in setting the policy directions for DEC and supporting its procurement and dissemination.

A large group of countries, however, adopts the opposite approach, by centralising policy and procurement decisions at ministerial level. A third groups, moreover, adopts a mixed approach, with the overall policy direction being set at centralised level, but with extensive autonomy recognised to education institutions.

Regardless of the allocation of responsibilities across governance levels, in most Member States specialised digital and/or education agencies, institutes or departments play a central role in the

[275] https://www.tcontas.pt/pt-pt/ProdutosTC/Relatorios/RelatoriosAuditoria/Documents/2022/rel020-2022-2s.pdf
[276] https://commission.europa.eu/business-economy-euro/economic-recovery/recovery-and-resilience-facility/recovery-and-resilience-plan-romania_en

development and use of DEC. Their efforts to provide guidance and training, set standards, and raise awareness around digital education, tools, and resources, represent a driving force for change across Europe.

Inter-institutional cooperation is currently lagging behind. While in many Member States either horizonal (i.e. inter-governmental) or vertical (i.e. between levels of governance) cooperation structures exist, their impact on DEC is low as their scope is rather wide (i.e. broadly on education or digitalisation). On the contrary, **multi-stakeholder cooperation** (e.g. through fora, projects and public-private partnerships**), while seemingly less widespread across the EU, is on average more focused on DEC-relevant issues and therefore more impactful** (e.g. leading to the development of digital content; the establishment of online platforms; stimulating innovation through pilot projects).

Peripheral governance of DEC: technical specifications and monitoring

While quality assurance for DEC is being implemented or is planned in most Member States, action on technical specifications is lagging behind, albeit their adaptation to educational context is still progressing rather slow. In general, there has been more **progress on copyright, licensing, privacy and data rights,** as most countries have established, if not DEC-specific, at least broad national and EU standards applicable to digital content. On the other hand, **interoperability and metadata, while benefitting from more tailored standards in some Member States, stand out as areas where regulation is largely lacking. Last, accessibility represents an area where Member States are performing well across the board,** perhaps as a reflection of efforts to establish quality standards, and in line with inclusive education as a long-standing policy priority in national education systems.

Funding

Across all Member States, **public budgets for education represent a key funding stream for DEC**, as national education policies generally include public financing for both infrastructure and teaching content (digital or otherwise). However, **public spending for DEC has not reached its full potential**, due to lack of clarity on specific investment levels for digital content (see Chapter 3 discussion on challenges of sizing the DEC marketplace).

On balance, **special funding programmes at national levels, and EU funding programmes are more impactful as they have allowed for more tailored support for specific initiatives and have encouraged innovation.** Despite some good examples across Member States, in the majority of countries**, there is room for further tailoring in the use of national and EU funds targeted to DEC initiatives**, and to ensure long-term sustainability and scaling up of successful approaches.

Looking forward

This Chapter showed how DEC benefits from a rich institutional landscape, where public authorities at different levels are responsible for different but complementary key dimensions of DEC governance – from policy to procurement, from copyright and data rights to quality assurance. Given the complexity of the governance landscape, and while respecting national approaches and priorities, greater cooperation across institutions and levels (e.g. through formal structures or processes) could be a crucial step to ensure better synergies and better results for DEC.

This may lead to more impactful policy and regulatory changes, for example by bridging the gap between existing standards and regulations covering key technical domains (e.g. privacy, intellectual property rights; licensing) and educational practices, and leading to better accountability to address unethical and opaque practices.

Building on existing positive example of multistakeholder fora, these initiatives could be further streamlined through increased investment, spaces for exchanges and peer learning (across stakeholder groups, educational level, and the public and private sector).This could also ensures that key stakeholders, educators and learners in particular, are routinely consulted to inform decision making on funding and procurement for DEC; and that they can play an active role in deciding how and which resources are used, provided that they supported by guidance to make informed choices about affordances and risks.

While it remains up to Member States to decide if and how to tackle these challenges, the EU can play an important role in promoting more effective governance, for example by providing guidance and opportunities for knowledge-sharing; supporting research and data gathering for an increased understanding of the scale and impact of existing challenges; and providing formal spaces for stakeholder engagement and peer-learning. Possible areas for EU intervention will be further explored in chapter 6.

Lastly, the funding landscape for DEC also reveals potential areas for improvement. First, there is a need to ensure a coordinated use of national and EU funds to support equitable market growth. This entails setting strategies and budgetary and reporting rules that allow for steady funding streams and better disaggregation of public expenditure to monitor investment in DEC; as well as implementing procurement rules and guidelines that endorse fairness and pluralism, while ensuring quality of deliverables.

In addition, ring-fencing resources for DEC, better use of EU funding for DEC-specific initiatives, and ensuring broader relevance of projects and support for dissemination of results may ensure more effective investment. In chapter 6, we further examine how some of these challenges could be tackled through EU level interventions.

Drawing on the analysis of the current governance and funding arrangements for DEC across EU Member States, in the Box below we summarise key messages and takeaways from chapter 4.

Box 22. Governance and funding across the EU – key messages

Key messages
• **Responsibilities for the governance of DEC are split relatively clearly between public authorities at the national, regional, and local levels** across Member States although there are differences across education levels. • In most Member States **specialised digital and/or education agencies, institutes or departments play a central role in the development and use of DEC**. Their efforts represent a driving force for change across Europe. • **Inter-institutional cooperation is currently lagging behind.** On the contrary, multi-stakeholder cooperation (e.g. through fora, projects and public-private partnerships), while seemingly less widespread across the EU, is on average more focused on DEC-relevant issues and therefore more impactful: for example: leading to the development of digital content; the establishment of online platforms; stimulating innovation through pilot projects. • While quality assurance for DEC is being implemented or is planned in most Member States, **action on technical specifications is less developed** as their adaptation to educational context is still progressing rather slow. • In general, there has been **more progress on copyright, licensing, privacy and data rights**, as most countries have established, if not DEC-specific, at least broad national and EU standards applicable to digital content. **Interoperability and metadata**, while benefitting from more tailored standards in some Member States, stand out as **areas where regulation is largely lacking**. **Accessibility represents an area where Member States are performing well**. • **Public budgets for education represent a key funding stream for DEC**, across all Member States, as national education policies generally include public financing for both infrastructure and teaching content (digital or otherwise). **However, public spending for DEC has not reached its full potential**, due to lack of clarity on specific investment levels for digital content. • **Special funding programmes at national level, and EU funding programmes are more impactful** as they have allowed for more tailored support for specific initiatives and have encouraged innovation**.** Despite some good examples across Member States, there is room for further tailoring in the use of national and EU funds targeted to DEC initiatives, and to ensure long-term sustainability and scaling up of successful approaches.

Source: Ecorys, 2023

In chapter 5 we turn to an examination of DEC in national education policies and curricula, and in pedagogical practices. We also provide an overview of current trends and expected developments as more advanced technologies are introduced in education. These issues centre on the uses and added value of DEC for teaching, learning and assessment, and constitute the third major set of concerns in the overall DEC ecosystem

5.0 Policies, practices and trends

In this chapter, we present an overview of DEC in policy and practice across the EU Member States, and current trends in the development and use of digital education content, including more advanced technologies. Effective integration of DEC to support and add value to teaching, learning and assessment is also the main objective of digital education. As in chapters 3 and 4, challenges and opportunities are highlighted. This is the third key area of the overall DEC ecosystem addressed in this study. The sections examine:

- **Approaches to policy and curricula:** In section 5.1, we examine the extent to which and how DEC has been integrated within relevant policies and curricula at Member State level, to support its use in teaching, learning and assessment, as well as challenges and opportunities.
- **Pedagogical challenges and opportunities:** Section 5.2 draws on findings from the literature review conducted for this study, highlighting the need for greater attention to how content may enhance teaching, learning and assessment across the lifelong learning spectrum.
- **Trends in digital education content:** Section 5.3 explores current trends in the development and use of digital education content, and the expected growth in integration of more advanced technologies in education.
- **Key elements of a healthy and sustainable approach to policy, practice and development of DEC in Member States:** Based on analysis of the current state-of-play and opportunities to further develop DEC, in section 5.4 we provide suggestions on how countries may strengthen each of these areas.

5.1 Approaches to policy and curricula

The section presents an overview of the current DEC landscape in the EU, with a focus on key trends across existing policies and national curricula, and emerging challenges. Overall, policy and curricula are adapting effectively to the broader digital transformation. However, visibility for DEC in policy and curricula is still relatively low.

5.1.1 A snapshot of the current DEC policy landscape

Digital education is an ongoing policy priority, but approaches differ across EU Member States

Over the past two decades, policy frameworks, strategies and models have been developed to support educational institutions to respond to the digital transformation. Approaches to digital education have also evolved over time. To date, three generations of digital education policies can be identified:

- **First-generation digital education policies**, dating back to the late 1990s, primarily focused on infrastructure and on ensuring access to broadband and ICT equipment in education institutions[277].
- **Second-generation digital education policies** went on to tackle digital skills and competences. By 2011, all EU countries had developed at least a general strategy to support digital education[278].
- **Third-generation digital education policies** took a further step to foster the systemic integration of digital education in educational settings, with content development starting to be integrated into frameworks and strategies[279].

[277] JRC (2017). Digital Education Policies in Europe and Beyond.
[278] Ibid.
[279] Ibid.

Virtually all education systems across the EU currently have developed policy strategies for digital education[280]. Policymaking for digital education usually follows one of three routes[281]:

- **Digital transformation strategies** support country-level digital transformation over time in a number of areas, including education;
- **Education strategies** set out the key national educational priorities and objectives, including for digital education, generally across all education levels; or
- **Digital education plans** set out het national vision for the digital transformation in the area of education, either encompassing all education levels or tailored to the needs of a specific level.

More recently, however, education has been impacted by disruptive events. **The COVID-19 pandemic and the war in Ukraine and displacement of more than 4 million children have made the need for and potential of digital transformation in education increasingly apparent**[282]. The extent to which national responses to the sanitary crisis will result in substantive and durable policy change, is yet to be seen. The OECD reports that since the COVID-19 crisis, several countries (e.g. BE(NL), FI, HR, LT and NL) introduced new digital education strategies, while others updated existing frameworks[283].

Accelerated technological developments (e.g. AI, VR, AR, blockchain etc.) are also increasing pressure on policymakers to anticipate potential impacts, including potential benefits and drawbacks for education (including DEC). Applications like ChatGPT, launched in November 2022, have already triggered heated debates among educators, researchers, technologists, ethicists and policymakers and the general public on how sophisticated chatbots will affect teaching, learning and assessment[284].

Moreover, there are additional several challenges within (digital) policy-making, including:

- **Policy instruments are not always developed within a clear governance structure, and may not include strategies for implementation** (e.g. specific action plans and funding for their roll-out) or for monitoring[285].
- Consultations indicated **that inflexibility and inertia, as well as lack of coordination between levels of governance are key shortcomings**, and are compounded by technological changes that often outpace national policy responses.
- The **EU policy landscape has yet to reach full maturity and does not fully support the systematic integration of DEC** within teaching, learning and assessment.

While most EU Member States refer to digital education content in their digital (education) policies, national level DEC-specific strategies are generally lacking.

A thorough review of existing digital education strategies highlights that attention to DEC is increasing. For example, a number of EU Member States have adopted strategies on OERs (e.g. DE,[286] NL[287]). However, in the vast majority of EU Member States, there is no clearly established **vision for the development and use of**

[280] Eurydice (2019). *Digital Education at school in Europe.*
[281] OECD (2023). *Shaping Digital Education - Enabling Factors for Quality, Equity and Efficiency.* Available at https://www.oecd-ilibrary.org/education/shaping-digital-education_849af8d0-en
[282] Vincent-Lancrin, S., C. Cobo Romaní and F. Reimers (eds.) (2022), *How Learning Continued during the COVID-19 Pandemic: Global Lessons from Initiatives to Support Learners and Teachers*, OECD Publishing, Paris, https://doi.org/10.1787/bbeca162-en.
[283] OECD (2023). *Shaping Digital Education - Enabling Factors for Quality, Equity and Efficiency.* Available at https://www.oecd-ilibrary.org/education/shaping-digital-education_849af8d0-en
[284] Hirsh-Pasek K., Blinkoff E (2023). *ChatGPT: Educational friend or foe?* Available at https://www.brookings.edu/articles/chatgpt-educational-friend-or-foe/
[285] European Commission (2023). *Staff-working document accompanying the Proposal for a Council Recommendation on the key enabling factors for successful digital education and training and the Proposal for a Council Recommendation on improving the provision of digital skills in education and training.* Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52023SC0205
[286] https://www.bmbf.de/SharedDocs/Publikationen/de/bmbf/3/691288_OER-Strategie.html
[287] https://www.versnellingsplan.nl/en/about-acceleration-plan/

digital education content, or plans to develop tailored strategies in the near future. Currently, two broad types of approach can be identified for the integration of DEC within policy and strategies:

- Broader frameworks regulating the digital transformation; or
- Digital education policies.

Table 14 provides an overview of these approaches.

Table 14 – Approaches to DEC coverage across policy instruments, by country

Policy Instruments	Type A – Direct coverage		Type B – Indirect coverage	
	Description	Member States	Description	Member States
Digital transformation strategies	• Policies include direct mentions of DEC. • Varied areas of focus: from access, to promoting the use of digital resources and tools; or establishing quality assurance processes for digital resources. • Varied approaches depending on educational levels	EL, PL, PT	• Policies only indirectly apply to digital education content • Focus generally is on the enabling conditions for its development and use (e.g. digital skills and infrastructure).	CY, DK, SK
Education strategies		BG, CZ, EE, HR, LV, RO		LT
Digital education strategies		AT, BE, FR, HU, IE, IT, MT, NL, SE, SK		DE, FI, LU, SI

Source: Ecorys, 2023.

Type A – Direct references to DEC within policies

Some **key trends** emerge in policy instruments across EU Member States explicitly addressing digital education content. Across these instruments, DEC is referred to in a variety of ways, including:

- As a type of educational resource mentioned within general digital transformation and education strategies (BG, CZ, HR, LV, PL, PT, RO).
- To promote its development and use among educators and learners, in particular through the deployment of online tools for examinations and other types of assessment (BG, HR, LV, PL); or to foster the development of digital resources where these are still lacking (e.g. BE, IE, IT).
- To promote better access to DEC (AT, BE, IE, IT, MT, NL, PT, SK) and highlight DEC as an essential component of more flexible and interactive learning pathways (CZ, EE).
- To engage and empower educators, including through individual accounts for the acquisition of resources (e.g. FR).
- To identify DECs as key resources for improving educators' digital skills through training, or defining processes and certifying the quality of digital education content (e.g. AT, EL).

Box 23. Examples of DEC in national policies (direct coverage)

SELECTED EXAMPLES OF DEC IN NATIONAL POLICIES
In 2018, **Croatia** passed legislation recognising digital educational content as "other educational materials". The Act states that all educational materials need to "comply with scientific principles and ethical standards" and be "pedagogically, didactically and methodologically suitable for use in teaching in the subject for which they are envisaged". Digital education content that fulfils these criteria is published in a virtual repository by the Ministry of Education, acting as a guarantor of quality[288].
In **Greece**, one of the 36 actions foreseen under the Digital Transformation Strategy 2020-2025[289], is ''Digital Education Content and E-learning services for Higher Education (HE)'', and includes measures for development of DEC for HE and for modernising horizontal platforms.
In **Austria**, the Digital School strategy[290] focuses on three main areas: supporting digital skills for students; promoting digital learning and education; and fostering the integrated use of digital approaches in education. The objectives also involve improving the supply of high-quality digital education content. The Action Plan accompanying the strategy includes measures on making use of MOOCs to enhance teachers' digital skills; setting up the EduTech online platform[291] to provide curated content; and establishing a quality seal for digital learning tools.

Source: Ecorys, 2023

Type B – Indirect references to DEC within policies

Broader frameworks for digital transformation or education which may be indirectly applied to digital education content (CY, DK, LT) generally **refer to the enabling conditions for digital education to thrive, and for an increased use of digital resources and tools by educators and learners**.

The focus ranges from general commitments to promoting digitalisation in education, to mission statements on the need to foster the development of digital skills and competences, as well as equal access to ICT equipment. Other digital education strategies (DE, FI, LU, SI) are only indirectly relevant to DEC as their primary focus is on: promoting skills development and ensuring that education institutions can benefit from access to ICT tools (e.g. computers; tablets); outlining commitments for the development of online learning platforms for educators and learners; and /or on improving the overall readiness of education systems to embrace the digital transformation (e.g. through adapting curricula and programmes).

[288] See https://www.zakon.hr/z/1747/Zakon-o-ud%C5%BEbenicima-i-drugim-obrazovnim-materijalima-za-osnovnu-i-srednju-%C5%A1kolu
[289] Digitalstrategy.gov.gr (n.d.). Digital Transformation Strategy 2020-2025., pp. 243-244 (In Greek).
[290] See https://digitaleschule.gv.at/
[291] See https://eduthek.at

Box 24. Examples of DEC in national policies (indirect references)

SELECTED EXAMPLES OF POLICIES INDIRECTLY TACKLING DEC
In **Luxembourg**, the 2020 ‘’Simply digital - future competences for strong children’’ strategy focuses on learners’ competence development while the ‘’One2One strategy’’ aims to ensure students in secondary schools have access to digital devices. The key new elements of the curricula in Luxembourg's schools are of a digital nature.
In **Germany**, the 2016 ‘’Education offensive for digital knowledge society’’ identifies the promotion of teachers’ and students’ digital skills and ensuring schools’ access to adequate hardware and infrastructure as key priorities.
In **Lithuania**, the National Strategy for Education 2013-2022 and the Progress Strategy ‘Lithuania 2030’ highlight the need to promote a ‘knowledge society’ including through the development of digital infrastructure and skills, and by updating educational content to meet the needs of modern society.

Source: Ecorys, 2023.

Despite increased visibility of digital education content in policy, DEC is still at an early stage of maturity.

While the majority of strategies include explicit references to DEC, **current policy frameworks hardly act as a clear roadmap towards the full integration of DEC in the education**.

Shortcomings within existing policy approaches include:

- **Primary focus on infrastructure**: Strategies are still focused on providing the necessary digital infrastructure (e.g. high-speed internet connection and digital devices) or managing challenges associated with digital education (e.g. skills development among educators and learners) to bridge digital divides.
- **Significant variation in the provision of concrete, in-depth guidance on content**: Most strategies are rather aspirational, with only general commitments to improving access to digital resources and platforms, or broad goals for the use of digital materials to enhance digital competences.
- **DEC is not routinely included in strategies across all education levels:** DEC is mostly referenced at primary and secondary school levels (e.g. AT, BE, IE, SE). This can be partially explained by the fact that digital education remains a relatively underdeveloped area within early childhood education and care (ECEC) in terms of policy and strategy; and by the greater level of autonomy granted to higher education and VET institutions. Overarching strategies are either absent (e.g. SE), or are general in nature and do not feature provisions on types of educational content which may be used.

Despite existing gaps, **in a minority of Member States (e.g., EE, FR, SE) strategies clearly promote the pedagogical use of digital education content and recognise its role in supporting teaching, learning and assessment across education levels.** These strategies usually correspond to countries with a longer history of digitalisation in education (i.e., with greater levels of digital maturity), highlighting how national policies across the EU are evolving at different paces.

Box 25. Inspiring practices in national strategies

Sweden has moved from ensuring access to increasing use: In Sweden, digital education content, referred to as 'digital learning resources'[292], has been included in several consecutive policy strategies, which show how the approach to DEC has been evolving within the country. For example, while the National Digitalisation Strategy for the School System (2017-2022)[293] focused on regulating access to digital resources, the draft National Digitalisation Strategy for the School System (2023-2027)[294], aims to both improve the digital competences of students and increase the use of digital tools and resources for learning purposes.

Digital education content is a core component of the education system in Estonia: Digital education content has become nearly synonymous with traditional education content, as all educational literature has been required to be in a digital format since 2015 (available on Opiq,[295] offering digital versions of textbooks by Estonia's largest educational publishers)[296].

France aims to streamline the use of DEC across education levels: The 'Digital and Education Strategy France 2030' ('Stratégie Enseignement et Numérique de France 2030') aims to develop an education offer which relies on both digital tools and DEC[297]. The strategy includes targeted actions such as 'Implementation of 'Digital Demonstrators in Higher Education', 'Priority equipment and research programmes', and 'Digital Education Territories' – streamlining equipment, training, digital educational resources and e-parenting support throughout the education system.

Source: Ecorys, 2023.

Consulted stakeholders highlighted that **the current DEC policy void**, while representing an opportunity for more flexibility in the market and freedom of choice for practitioners, **results in a lack of a shared understanding of DEC and its potential added value**. The policy void also leads to a lack of coherence in approaches to its use (i.e.– even between education levels and within institutions). However, they also stressed that **policy frameworks are not the be-all and end-all for DEC**, as strategies alone do not automatically lead to greater use of digital content or its increase integration education.

Rather, consulted stakeholders largely agreed on the importance of **long-term strategies to develop the enabling conditions for a well-functioning digital education ecosystem in Europe, where digital education content can thrive**. Stable and adequate funding and infrastructure, as well as training and continuous professional development (CDP) for educators, opportunities for collaborative professional learning, and finally, stakeholder engagement in DEC policy design, implementation, and evaluation are essential elements in DEC ecosystems.

[292] The National Agency for Education has developed a framework which distinguishes three different types of digital learning resources: 1.) digital tools 2.) digital content and 3.) digital teaching aids292. 1.) Digital tools include everything from digital hardware (e.g. computers, tablets) to online learning platforms and software. 2.) Digital content is understood as digital material that is not necessarily related to the school's curriculum, courses or subject plans, but which become digital learning resources when employed in the context of teaching (e.g. entertainment game re-purposed for educational use). 3.) Digital teaching aids are seen as resources that are specifically designed for teaching and that, like a textbook, cover a larger area of knowledge or an entire subject.

[293] The Swedish Government (2017). *Regeringen beslutar om nationell digitaliseringsstrategi för skolväsendet*. Available here.

[294] https://www.skolverket.se/om-oss/press/pressmeddelanden/pressmeddelanden/2022-12-19-ny-digitaliseringsstrategi-satter-undervisningens-kvalitet-i-fokus

[295] See https://www.educationestonia.org/organisation/opiq/

[296] Haaristo, H.S., Räis, M.L., Kasemets, L., Kallaste, E., Aland, L., Anniste, K., Anspal, S., Haugas, S., Jaanits, J., Järve, J., Koppel, K., Lang, A., Lauri, T., Michelson, A., Murasov, M., Mägi, E., Piirimäe, K., Põder, K., Rajaveer, K., Sandre, S.-L, Sõmer, M. 2019. Elukestva õppe strateegia vahehindamine. Tallinn: Poliitikauuringute Keskus Praxis, Rakendusuuringute Keskus CentAR.

[297] 'L'innovation au service de l'enseignement scolaire : Annonces des premiers lauréats Ed Tech de France 2030', Secrétariat général pour l'investissement (SGPI), Modified on 28 June 2022, available at : https://www.gouvernement.fr/l-innovation-au-service-de-l-enseignement-scolaire-annonces-des-premiers-laureats-ed-tech-de-france#:~:text=de%20France%202030-,Ambition,au%20long%20de%20la%20vie.

Box 26. Inspiring practice enhancing cooperation for DEC

Slovakia's action plan to encourage cooperation for digital education and content: The programme of school digitalisation though 2030 includes ''digital technologies and digital education content in the curriculum'' as one of five strategic action areas. The strategy is supported by an action plan which outlines policies for each strategic area and for all relevant institutional players (e.g. Ministry of Education, education institutions), as well as a specific timeframe and funding streams for implementation.

Source: Ecorys, 2023.

Box 27. Key themes and stakeholder concerns related to DEC across the lifelong learning spectrum

DEC in early childhood education and care is typically linked to developmental learning methods, including content with an emphasis on play, video, and graphical interfaces. Evidence from the literature suggests that 'gamification' at ECEC-level is becoming increasingly popular, e.g., digital knowledge games, quizzes, puzzles etc. There is some evidence that this type of learning can boost active participation, curiosity and engagement while helping young children to grasp concepts[298]. In Malta, for example, digital content is used playfully for video-watching and singing among toddlers, and consists of colourful and interactive materials that encourage physical movement, coordination and imagination[299]. Such activities can be referred to as "digital play" and have been found to support the development of motor skills as well as early literacy[300].

Furthermore, consultations **with school stakeholders at national level highlighted the positive role of DEC in primary and secondary schools.** In particular, DEC is considered as a key component for supporting digital skills curricula, including social and employment skills. There was also interest in the role that new technologies, including AI and learning analytics, can play in helping learners of different abilities, while enhancing education practices such as assessment and feedback. However, school stakeholders acknowledged that most schools were not equipped with the knowledge or skills needed to fully leverage 'advanced DEC'.

Issues cited typically included local factors such as low levels of digital competence, shortages of IT-staff at schools, and costs of DEC, and an emphasis on hardware or administrative systems in procurement. This also risks creating inequalities within schools systems, including the potential for some schools to experience persistent difficulties with access to compatible and up-to-date technologies in comparison to other parts that may be better funded or equipped to adopt these technologies.

The findings also suggest that teachers and students in primary and general secondary education have continued with a blend of digital, distance and face-to-face teaching and learning practices following the post-COVID crisis return to classrooms. Furthermore, many educators at this level have developed new skills and competences to leverage DEC to help make schooling more engaging, tailored, immersive and fun.

However, workshop discussions also raised concerns about the use of DEC, including approaches that are overly led by technology and innovation rather than educational needs and outcomes. In this context there was some concern about the degree to which evidence of the effectiveness of DEC was available, especially where significant shares of education budgets are being directed toward DEC that has not been properly tested.

Lastly, DEC has a strong presence in higher education. Possibly due to the of the autonomy of higher education systems, there appear to be few dedicated DEC policy frameworks in higher education at national

298 Liu W, Tan L, Huang D, Chen N, Liu F. (2021). When preschoolers use tablets: The effect of educational serious games on children's attention development. *International Journal of Human-Computer Interaction 37*(3), 234–248. https://doi.org/10.1080/10447318.2020.1818999

299 Country mapping

300 Bird, J., & Edwards, S. (2015). Children learning to use technologies through play: A Digital Play Framework. British Journal of Educational Technology, 46(6), 1149-116

or other relevant regional policy levels. For example, the European Digital Education Content Framework (EDECF) survey identified only two Member States with policies in relation to digital education content in higher education.

There is significant variation between researchers, subjects, academic departments and institutions in the development and use of digital education content. This reflects the diversity of curricula and teaching practices noted above. Academics are largely responsible for the design of their programme curricula, including setting reading of lists and developing associated teaching materials, and results in significant variation between programmes offered by different institutions in the same discipline.

Source: Ecorys, 2023.

5.1.2 DEC in national curricula

The integration of DEC in national curricula reflects differing policy maturity levels.

In the vast majority of EU Member States, particularly within compulsory education, core curricula are defined at the national level, with ministries of education setting out the key learning outcomes to be achieved, and the competences and skills to be developed.

Curricula have been evolving over the years to include the promotion of digital skills and competences. However, curricula, which are only renewed every ten years or so do not necessarily lend themselves to keeping pace with the accelerating pace of digital transformation or supporting innovation in teaching, learning and assessment.

Box 28. Examples of DEC in national curricula

In **Lithuania**, the general curriculum framework for ECEC, primary and secondary education, as updated in September 2022, includes a description of digital competences and defines intended learning outcomes for each level of education, including the use of digital technologies and digital education content as part of teaching curriculum. In this updated framework, DEC is mentioned as a tool to support and evaluate the development of digital competencies among students.

In **Denmark**, "IT and media", features as a cross-disciplinary priority, to be integrated in all mandatory subjects, and ensures that digital tools and resources can be integrated in teaching, and in pedagogical and didactic materials to enhance the learning experience.

Source: Ecorys, 2023

While national curricula often focus on promoting digital education, and mention of digital education content or resources (LT, SE, EE, FI, FR, DE, ES, NL, DK), these are typically referenced in passing, without a coherent approach to fostering their development and use. In the vast majority of curricula, references to DEC are fairly general (e.g. digital resources are listed among other types of materials that can support education) or broadly relate to how digital tools and resources can support digital skills development (e.g. LT). This indicates a relatively low understanding of what DEC is and its potential for education.

Exceptions, however, exist, and can be found in Member States (e.g. SE) where policy frameworks promote increased use of DEC as a key objective, resulting in national curricula that include guidance on how digital resources can support the achievement of educational outcomes. While this points towards a **correlation between levels of policy maturity, and the integration of DEC in curricula**, consulted stakeholders stressed the need to **find the right balance between digital and print education content and digital, blended and face-to-dace learning,** also in light of debates around ''digital sobriety''[301] with the objective of supporting high quality education.

[301] https://epale.ec.europa.eu/en/blog/digital-sobriety-how-can-we-adapt-our-uses-positive-impact-environment

Box 29. Inspiring practices in national curricula

Integration of DEC in Digital Learning Plans in Ireland: The National Council for Curriculum and Assessment (NCCA) is the body responsible for developing curricula for primary and post-primary education. The development process entails engaging with a range of partners, including schools, teachers, subject experts, and technology providers, on ongoing basis. The NCCA informs the development of education content to respond to needs of teachers and students. This includes meeting with education publishers to inform them of new curricula so that they can prepare new textbooks and other resources in time for roll out in schools.

Furthermore, while each school is autonomous in deciding what (printed or digital) materials will be purchased by students and families based on the school's learning plan and teacher preferences, each school is expected to draw up a Digital Learning Plan, outlining the vision of the school for the embedding of digital technologies in teaching, learning and assessment, including the provision and use of digital education content and incorporate targets and priorities for improvement and development.

Sweden's national curricula includes guidelines for the use of digital tools for learning: In Sweden, digitalisation is a recurring theme in the national curriculum for compulsory education. The curriculum includes guidelines for the use of digital tools and media for attaining knowledge, processing information, problem-solving, creation, communication, and learning, across subjects and in different contexts.

Source: Ecorys, 2023.

The integration of DEC in teaching and learning is influenced by school autonomy and overall provision of guidance and support.

Beyond different maturity levels with regards to policy frameworks, other factors affect the integration of DEC

Increased autonomy of education institutions across countries influences teaching, learning and assessment practices. At ECEC, primary and secondary education level, governance arrangements mean that Member States generally grant a high level of autonomy to individual education institutions. This allows individual education institutions to set their own curricula (often as a cooperative exercise with school leaders and boards, teachers, and parents) to address the specific needs of their learners and educators, and in compliance with the standards and objectives included in overarching ministerial guidelines.

In some Member States (such as IE), education institutions, are required to develop their own digital education plans, to complement curricula, outlining the modalities to ensure that digital technologies are implemented within teaching, learning and assessment, which can include the development and use of DEC. At HE and VET levels, institutions act as self-governing bodies in most Member States. As such, higher education institutions tend to be fully independent in deciding the extent to which, and how to use digital resources in their programmes for teaching, learning and assessment. As such the use of digital education content is likely to vary both across education levels, and within education institutions within the same level.

Consulted stakeholders identified **differences in curricular standards among Member States, along with different levels of integration of digital tools and content within teaching, learning and assessment, and within teacher education programmes, as key pedagogical and didactic challenges**. While the DEC provider survey revealed that organisations regularly adapt their products and services to respond to curricular needs, course fragmentation remains an obstacle, particularly for providers engaging in different national markets, and may price out smaller companies which do not have the necessary resources to adapt their offer to operate across countries.

This stakeholder observation is further supported by the fact that more than two thirds of DEC providers surveyed indicated that pedagogical and didactic challenges as the most difficult barriers to overcome. At the same time, educators are required to identify and sometimes to adapt resources that best fit their own pedagogy and objectives, or potentially to create digital resources themselves, all the while gaining an understanding of the risks associated with the production, use and dissemination of DEC (e.g. breaches of copyright and licensing; privacy rights). The high level of autonomy of individual education institutions to define specific

objectives and modalities to achieve these within teaching and learning, has shown to lead to better learning outcomes,[302] but, when it comes to DEC, positive results can only be achieved if **education institutions and educators are adequately supported to make informed choices.**

There is a need to balance school autonomy with centralised support to enhance educators' agency and know-how, and to provide spaces for meaningful exchange with DEC providers. Ultimately, **strategies to promote DEC may need to recognise the complexity of education systems and prioritise "soft" governance approaches that aim to influence rather than mandate practices**, bridging different needs.

Last, **the integration of DEC in individual institutions may be affected by other factors, including the availability of financial resources** for the acquisition of DEC, educators' and learners' (as well as their parents and carers) **digital competences, school leadership** in fostering digitalisation within education, and the overall digital maturity in the country (although it might be noted that digital maturity may vary *within* across regions within the same Member State).

Box 30. Integration of DEC in curricula across the lifelong learning spectrum

Study findings suggest that DEC **in early years education** is less prominent than in other education levels. Evidence from the DEC provider survey and findings from the country mapping corroborated this, indicating low interest in integration of DEC into ECEC curricula and syllabi. DEC was reported to be of little or no priority (CZ, DE, HR, LU, NL) or falling outside the digital school strategy (AT, BE). However, there were also education systems that do offer an introduction to the digital tools in ECEC curricula and policy (FR, IT, LV, MT, PL, PT SE). In Latvia, for example, children are taught to recognise the difference between virtual and physical realities, how to use the internet and technology in healthy ways, as well as the importance of limiting screen time.

In Finland, it was found that the use of digital tools at ECEC-levels were capped to a few hours per week during which toddlers were playing with a 'wide spectrum of DEC'. In Slovenia, digital education content was not used by toddlers themselves – instead digital aids (mainly interactive whiteboards and video projections) were used by pre-schools teachers to make learning more engaging and interesting.

For what concerns primary and secondary education, the key theme is the prominent role of educators in developing and sharing DEC in support of curricular aims. Feedback from stakeholders highlighted the variety of roles that primary and secondary educators play in DEC. In many Member States (e.g. BE, FI, LV, NL and SE) teacher involvement in co-design of digital education content was a noted part of the DEC field. Teachers are users and creators of DEC, whilst also sharing and distributing content, and collaborating on the development of content and new practices.

In many cases the sharing and development of DEC has been led by educators themselves to support their own practice whilst sharing in educator led professional networks and communities. In addition, initiatives such as EdTech testbeds can provide meeting places for developers, teachers and researchers where they can drive innovation together and create services and products that are more relevant and meaningful. However, stakeholder feedback highlighted persistent concerns about the reliance on teacher generated DEC on workloads where materials were not supplied or accessible through open sources.

For example, educators often report that they do not find digital content that caters to their specific needs, particularly where they are looking for tailored content in their language, relevant to their curriculum and local context. One example is Malta, where 'Education Officers' (civil servants) have been allocated for each school subject to identify and develop digital education content that can support teachers to deliver curricula.[303]

At the **higher education level**, whilst there is some external validation of curricula by professional or regulatory bodies for specific disciplines, in general external quality assurance focuses on processes rather than curricula and teaching. In addition, institutions are typically highly decentralised, and there is a high

[302] Wilkoszewski, H. and E. Sundby (2014), "Steering from the Centre: New Modes of Governance in Multi-level Education Systems", *OECD Education Working Papers*, No. 109, OECD Publishing, Paris, https://doi.org/10.1787/5jxswcfs4s5g-en
[303] https://curriculum.gov.mt/en/The-Department/Pages/Education-Officers.aspx

degree of diversity between departments. This includes highly distinct pedagogical models within institutions, such as between humanities and science subjects, as well as, in some cases, separate administrative structures and teaching infrastructure.

Source: Ecorys 2023

5.2 DEC to support effective teaching, learning and assessment

While much of the focus on DEC has been on the **intrinsic properties of the software, greater attention to how content may enhance teaching, learning and assessment is needed**. In this sense, it is just as important to consider *the context* in which these digital resources are utilised, and in particular, how and why teachers engage and integrate the content into their classroom interactions. Thus, it is generally not about sifting through ''high vs low quality'' digital content or tools, but rather identifying the most *appropriate* tool(s) for the specific learning objectives and tailoring them as needed. Accordingly, the literature stresses that clearly identifying context-specific learning needs should always be the point of departure for selection of digital content[304].

At the policy level and within schools and school networks, recognition of the importance of teacher agency and opportunities to act (creatively), negotiate, and translate digital education content into meaningful teaching practice is essential. In this context, there is a clear need for greater attention to educator competences to use technology generally, but also within specific contexts as relates to confidently modifying and experimenting with digital content to best suit their learning objectives.

The EU plays an important role in supporting integration of digital technologies in education settings across the Member States. Frameworks and tools have been developed to support education and training institutions and ministries in to diagnose progress and needs for further development of their digital education plans within their own specific contexts. The emphasis is on using digital technologies to support more flexible learning environments, and to redesign or re-interpret the content, pedagogical approach, and ways of engaging with learners[305].

The European Commission's Joint Research Centre has developed the DigComp,[306] DigCompOrg[307] and DigCompEdu[308] frameworks as well as the widely used SELFIE diagnostic tool to support educational institutions and ministries to integrate digital technologies. These frameworks highlight that digital technologies are meant to enhance teaching, learning and assessment. While AI-based learning analytics support more personalised approaches to learning (programmes that scaffold learning) or identify learners who are at risk of failure or dropout (learning management systems), ultimately, educators and learners interpret and analyse evidence of learning and decide on next steps.[309]

Educators may also develop new formats and pedagogical methods, depending on the affordances and limits of different digital technologies, and how they support specific learning aims. Learners may collaborate on online platforms, or take opportunities to plan, monitor and reflect on their learning.[310]

Elements considered as important for the integration of digital technologies in education are distilled in the JRC's DigCompOrg framework.[311] The overview below highlights the pedagogical dimension of the framework,

[304] Damsa, a. Langford. M, Uehara, D., Scherer, R. (2021) Teachers' agency and online education in times of crisis. Computers in Human Behavior, Volume 121
[305] https://joint-research-centre.ec.europa.eu/european-framework-digitally-competent-educational-organisations-digcomporg/digcomporg-framework_en
[306] https://joint-research-centre.ec.europa.eu/digcomp_en
[307] https://joint-research-centre.ec.europa.eu/european-framework-digitally-competent-educational-organisations-digcomporg/digcomporg-framework_en
[308] https://joint-research-centre.ec.europa.eu/digcompedu_en
[309] Ibid.
[310] Ibid.
[311] https://joint-research-centre.ec.europa.eu/european-framework-digitally-competent-educational-organisations-digcomporg/digcomporg-framework_en

including content and curricula, teaching and learning practices, assessment, teacher professional development, and teacher collaboration and networking.

Table 15 – Pedagogical dimensions of digital learning

Dimension	Description	Outcome
Content and Curricula	Digital Content and OER are widely promoted and used.	Staff and students are the creators of contents.
		Content repositories are widely and effectively used.
		Intellectual property and copyright are respected.
		Digital tools and contents are licensed as required
		Open Educational Resources are promoted and used.
	Curricula are redesigned or re-interpreted to reflect the pedagogical possibilities afforded by digital technologies.	Subject-based learning is reimagined to create more integrated approaches.
		The time and place of learning is rescheduled.
		Online provision is a reality.
		Learning in authentic contexts is promoted.
		Digital learning provision is evident across curriculum areas.
		Students' digital competence is developed across the curriculum.
Teacher and Learning Practices	Digital Competence is promoted, benchmarked and assessed.	Staff and students are Digitally Competent.
		Safety, risks and responsible behaviour in online environments are foregrounded.
		The Digital Competence (DC) of staff and students is benchmarked.
		DC is included in staff appraisal.
	A rethinking of roles and pedagogical approaches takes place.	Staff are partners in change.
		New roles are envisaged for staff.
		New roles are envisaged for students.
		Pedagogical approaches are expanded.
		Personalised learning is developed.
		Creativity is promoted.

Dimension	Description	Outcome
		Collaboration and group work is expected.
		Social and emotional skills are developed.
Assessment practices	Assessment Formats are engaging and motivating.	The scope of formative assessment is extended.
		Summative assessment is diversified.
		Self- and peer-assessment are promoted.
		Rich, personalised and meaningful feedback is encouraged and expected.
	Informal and Non-Formal Learning are recognised.	Prior, experiential and open learning are recognised and accredited.
	Learning Design is Informed by Analytics.	Learning analytics is given strategic consideration.
		A code of practice for learning analytics is in place.
		Learning is supported through learning analytics.
		Quality management and curriculum/programme design are supported through learning analytics.
Professional Development		A commitment to Continuous Professional Development (CPD) is evident.
		CPD is provided for staff at all levels.
		CPD is aligned with individual and organisational needs.
		A wide range of CPD approaches is evident.
		Accredited/certified CPD opportunities are promoted.
Collaboration and Networking	Networking, sharing & collaboration is promoted.	Networked collaboration for staff to pool expertise and share contents is the norm.
		Knowledge exchange efforts are recognised.
		Students engage in effective networking.
		Participation in knowledge-exchange activities and events is promoted.

Dimension	Description	Outcome
		Internal collaboration and knowledge exchange is expected.
	A strategic approach is taken to communication.	An explicit communication strategy is in place.
		A dynamic online presence is evident.
	Partnerships are developed.	A commitment to knowledge exchange through partnerships is evident.
		Staff and students are incentivised to be actively involved in partnerships.

Source: Table adapted from DigCompEdu

These priorities speak to the importance of stronger partnerships between educators, learners and (other) digital education content developers to ensure they are fit for purpose.

At the same time, the literature review conducted for this study found that **content creators and producers face several challenges** when it comes to the **production and development of high-quality digital education content.** These include i) the difficulties of producing diverse digital education content, ii) the lack of incentives to produce content, iii) students' lack of skills to participate in the production of content, iv) the prevalence of non-educators designing content for education and a general lack of **EdTech provider expertise in pedagogy/ understanding of how teachers might most effectively use technology** (or a suite of technologies) to promote learning aims, including for higher-order learning interlinked with v) the absence of student and teacher voice in the production of digital education content.

The literature review also identified **several challenges in the procurement** of high-quality digital education content. These include: i) procurement rules that disincentivise small local players, ii) the unchecked power of EdTech brokers, and iii) the challenges of collaboration across EU MSs on regulations and data privacy. **Factors that prevent the integration of digital education content in classrooms were also identified**. These include inadequate resources, internal barriers, lack of pedagogical digital competences, and cost.

Enabling factors directly address these challenges. Findings from the literature review were that **several enabling factors affect the creation of high-quality digital education content**, including: i) intentionally designed content, ii) the involvement and consideration of end-users, iii) content developed to support blended or flipped learning, and iv) the availability of diverse content.

In terms of **procurement**, identified factors encompass: i) the existence of intermediaries between digital content producers and end-users, ii) clear quality and protection guidelines, iii) structured dialogue with stakeholders, and iv) school leadership "buy-in". When it comes to **use**, identified enablers include: teacher motivation and creativity, teacher training and competence development, and a collaborative school environment.

Box 31. DEC in teaching, learning and assessment across the lifelong learning spectrum

Recent pedagogical trends in higher education have placed much greater emphasis on problem solving and structured peer learning. For example, the video capture of lectures and the digital availability supporting resources means that lectures are now an asynchronous (and scalable) form of digital education content. Therefore, in the context of higher education, digital education resources may include for example:

- Formal course or programme materials such as reading lists and lecture notes and slides as well as dedicated learning resources, such as e-textbooks or other digital tools.
- Online platforms to support collaborative work, allowing better communication, group collaboration, and face-to-face lectures.
- Learner generated materials, including online class fora and message boards, online chat and collaborative functions, presentations or other digital outputs or tasks.
- Digital journals and research outputs, including systematic digitalisation of research journals and growing use of online blogs to support research dissemination and exchange.
- Digital primary research and learning items such as online sources, such as news sources and other types of primary source materials.

Source: Ecorys, 2023.

5.3 Trends in digital education content: challenges and opportunities

In this section, we explore current trends in DEC as identified in the literature review conducted for this study. They include a range of newer, more advanced digital technologies that have the potential to shape, and in some cases to disrupt, digital education content and educational practices. We first note some of the key technologies that have enabled new approaches in digital education and then identify main trends.

Box 32. Technologies shaping current and emerging trends in digital education

Several technologies are shaping current and emerging trends in digital education. Basic definitions and the relationships between several newer technologies, along with selected examples of uses in education, are set out below.

Artificial Intelligence (AI), machine learning and **deep learning** are interrelated and nested terms. AI is the umbrella term, and refers to technologies that simulate human cognition (e.g. learning, problem-solving, and so on). It uses predictions and automation to address complex tasks[312].

AR / VR - Augmented reality (AR), in computer programming, a process of combining or "augmenting" video or photographic displays by overlaying the images with useful computer-generated data. **Virtual reality (VR),** is the use of computer modelling and simulation that enables a person to interact with an artificial three-dimensional (3-D) visual or other sensory environment. VR applications immerse the user in a computer-generated environment that simulates reality through the use of interactive devices, worn as goggles, headsets, gloves, or body suits, which send and receive information.

In a typical VR format, a user wearing a helmet with a stereoscopic screen views animated images of a simulated environment. The illusion of "being there" (telepresence) is effected by motion sensors that pick up the user's movements and adjust the view on the screen accordingly, usually in real time (the instant the user's movement takes place)[313]. Both AR and VR support immersive and experiential learning.

[312] https://www.ibm.com/blog/ai-vs-machine-learning-vs-deep-learning-vs-neural-networks/.
[313] https://www.britannica.com/technology/augmented-reality#:~:text=augmented%20reality%2C%20in%20computer%20programming,with%20useful%20computer%2Dgenerated%20data.

Big data - refers to new technologies and technical infrastructure developed to collect and make sense of the masses of data structured, semi-structured and unstructured now being generated and stored online. These technologies support data integration across platforms, data mining, analytics and information[314] [315].

In the education sector, big data encompasses the emerging fields of **educational data mining (EDM)** and **learning analytics (LA).** There is significant overlap between these two areas, the major difference being that EDM is more concerned with research on learning processes, contexts, and institutions, while LA is more concerned with acting on data to predict performance and to tailor and adapt learning[316].

Blockchain technologies - provide a secure and accessible platform for storing and sharing academic records (including digital badges and other micro-credentials).[317] In addition, blockchain technologies now under development could facilitate widespread access to open educational resources, research publications, and so on[318].

Deep learning is a subset of machine learning. It uses multiple layers of algorithms to progressively extract information from raw data, and is underpins machine translation, voice recognition, and other technologies which may also make content more accessible to diverse learners[319].

Educational data mining refers to mining and analysing data collected during teaching[320]. Data such as students' education records, examination results, class participation, are mined, and machine learning algorithms are used to predict future performance[321].

Fifth generation broadband cellular networks (5G) introduce significant improvements to broadband networks, including a larger bandwidth, greater reliability, lower latency, and higher density of devices. These features support new technologies requiring higher bandwidth, such as Augmented and Virtual Reality (AR/VR)[322].

Internet of Things – refers to "devices with sensors, processing ability, software and other technologies that connect and exchange data with other devices and systems over the Internet or other communications networks."[323] IoT enables education learning management systems, assistive technologies for learners with disabilities, interactive white boards, student monitoring, among other uses[324] [325].

Machine learning is a subset of AI focused on using "…self-learning algorithms that derive knowledge from data in order to predict outcomes" (Aggarwal, 2023). In education, it may use adaptive learning to identify areas where learners are having difficulties and flag these for teachers. Machine learning may also use "predictive analytics" to detect patterns in student learning (see terms related to different types of learning analytics below)[326].

[314] https://www.ibm.com/analytics/big-data-analytics#:~:text=Next%20steps-,Overview,sizes%20from%20terabytes%20to%20zettabytes.
[315] https://www.geeksforgeeks.org/data-integration-in-data-mining/#:~:text=Data%20integration%20is%20the%20process,or%20discrepancies%20between%20the%20sources.
[316] https://circlcenter.org/educational-data-mining-learning-analytics/
[317] https://elearningindustry.com/the-future-of-blockchain-technology-in-education#:~:text=Summary%3A%20Blockchain%20technology%20has%20the,emerging%20in%20the%20education%20sector.
[318] https://online.maryville.edu/blog/blockchain-in-education#curricula
[319] Zhang, W. J., Yang, G, Ji, C., Gupta, M. M. (2018). On Definition of Deep Learning. 2018 World Automation Congress (WAC): 1–5. doi:10.23919/WAC.2018.8430387. ISBN 978-1-5323-7791-4. S2CID 51971897
[320] https://www.cmu.edu/datalab/getting-started/what-is-edm.html
[321] Yağcı, M. (2022). Educational data mining: prediction of students' academic performance using machine learning algorithms. Smart Learn. Environ. Vol. 9, No. 11. https://doi.org/10.1186/s40561-022-00192-z
[322] https://www.howtogeek.com/340002/what-is-5g-and-how-fast-will-it-be/
[323] https://en.wikipedia.org/wiki/Internet_of_things#cite_note-Linux_Things-1
[324] Labarthe, H., Luengo, V. and Bouchet, F. (2018). Analyzing the Relationships Between Learning Analytics, Educational Data Mining and AI for Education. Published in ITS Workshops 11 June 2018 https://ceur-ws.org/Vol-2354/w2paper2.pdf
[325] Kassab, M. DeFranco, J., Laplante, P. (2019). A systematic literature review on Internet of things in education: Benefits and challenges. Journal of Computer Assisted Learning. https://doi.org/10.1111/jcal.12383
[326] https://intellias.com/benefits-of-machine-learning-in-education/

Learning analytics refers to the "measurement, collection, analysis, and reporting of data about learners and their contexts, for purposes of understanding and optimizing learning and the environments in which it occurs"[327].

- **Adaptive analytics** - LA models may also rely on data mining techniques to track learner progress and identify which interventions may be more effective for individual learners. Data gathered in LA, in turn, can nourish EDM which requires large and detailed data sets. These tools go far beyond current learning measurement technologies and assessment systems in their ability to gather data on learning as well as on institutional management[328].
- **Predictive analytics** in education draw on learner data, including demographic data, data on past performance and current engagement (e.g. frequency of logins, participation in discussion posts). Learners are then classified (e.g. "high performer", "at risk") and offered advice and encouragement, based on these data. For example, lower achieving learners may be encouraged to participate in online discussions more often – based on data showing that discussion participation is correlated with better performance – or higher achieving students may be directed to more advanced levels[329].

Learning Management Systems – refers to software applications for the administration, documentation, tracking, reporting, automation, and delivery of educational courses, training programs, materials or learning and development programmes[330].

Tagging – refers to the process of adding tags to raw data, indicating to target responses to be used in a machine learning model. Tagging is also sometimes referred to as 'labelling' or 'annotation'[331].

Source: Ecorys, 2023.

Trend #1 – Digital content is generated with learning analytics

Over recent years, the adoption of learning analytics software and technologies such as LMS and big data in digital educational publishing has grown substantially[332,333]. On the demand side, there are higher expectations on personalised learning experiences, especially among students in higher education[334]. On the supply side, vendors are increasingly pairing their educational content with data analytics, providing them with a constant flow of data to help measure impact and improve the accuracy and prediction of their services[335].

Learning analytics has been defined as the "measurement, collection, analysis, and reporting of data about learners and their contexts, for purposes of understanding and optimizing learning and the environments in which it occurs"[336]. Among other uses, learning analytics has the potential to trace and map knowledge that occurs during the learning process and improve learning by "comparing the learner's level of knowledge with the actual content that needs to be mastered"[337].

Learning management system (LMS) are the most common application of learning analytics technology[338], and have been described as capturing student behaviours as 'digital breadcrumbs' as students interact and navigate

[327] Yilmaz, R. and Yilmaz, F. (2022). Learning Analytics Intervention Improves Students' Engagement in Online Learning. Technology, Knolwedge and Learning. Vol. 27, No. 4, pp. 1 - 12 DOI: 10.1007/s10758-021-09547-w
[328] https://www.igi-global.com/dictionary/reflections-on-adaptive-learning-analytics/96816
[329] https://www.techtarget.com/searchcio/definition/learning-management-system
[330] https://www.solaresearch.org/about/what-is-learning-analytics/
[331] https://toloka.ai/blog/machine-learning-tagging-text/#:~:text=In%20reality%2C%20computer%20systems%20have,responses%20it%20needs%20to%20predict.
[332] Molenaar, I. (2021), "Personalisation of learning: Towards hybrid human-AI learning technologies", in OECD Digital Education Outlook 2021: Pushing the frontiers with AI, blockchain, and robots, OECD Publishing.
[333] D'Mello, S. (2021), "Improving Student Engagement in and with Digital Learning Technologies", in OECD, Digital Education Outlook: Pushing the frontiers with AI, blockchain, and robots, OECD Publishing.
[334] https://www.technavio.com/report/digital-education-content-market-industry-size-analysis
[335] Ibid.
[336] Karaoglan Yilmaz, F. G., & Yilmaz, R. (2022). Learning analytics intervention improves students' engagement in online learning. Technology, Knowledge and Learning, 27(2), 449-460.
[337] Siemens, G. (2013-08-20). "Learning Analytics: The Emergence of a Discipline". American Behavioral Scientist. 57 (10): 1380–1400. doi:10.1177/0002764213498851. ISSN 0002-7642. S2CID 145692984.
[338] Norris, D. (2011). 7 things you should know about first-generation learning analytics (report). Retrieved from EDUCAUSE website: https://library.educause.edu/resources/2011/12/7-things-you-should-know-about-firstgeneration-learning-analytics.

in the digital space[339]. When students read an eBook or PDF, for example, data can almost instantly detail the date, time, and duration of students' digital movements, including if, when, and for how long they read an electronic text[340].

Box 33. Trend in practice

Adobe Systems offers the Creative Cloud for Education which allows universities to tailor learners' experience through mobile engagement and online communities with the help of inbuilt analytics, content management tools, and automation software. Beyond offering compelling digital experiences such as infographics, animations, mobile app designs, and 3D and AR content, the cloud collects data on learner's progress through modules, helping them to personalise goals, learning content and effective learning paths.

Source: Ecorys, 2023.

Trend #2– Digital education content developed for studying and playing

Gamification in education – or game-based learning -- has the potential to encourage and motivate students to reach their goals and stimulate innovative thinking, leading to the creation of new skills and knowledge from a young age[341] [342]. While educational games are becoming widespread across education sectors today, the literature suggests that the VET-sector in particular is increasingly embracing this genre of content (European Commission – VET WG, 2020). Reasons include the sector's 'learning by doing' nature and traditional emphasis on work-based learning, requiring an appropriate mix of digital, occupational and technological competences[343].

Similarly, despite significant concern among many ECEC practitioners and parents that the use of technologies in early childhood can restrict children's imagination and make them passive, the literature suggests that digital content is increasingly created to support learning through play for younger learners[344] [345] [346]. As such, while the ECEC Edtech market is largely lagging behind other education levels, a general trend of many Edtech companies moving ''downstream'' from ISCED 1-3 education into the ECEC space can be observed[347].

The academic literature suggests that hesitations and uncertainty around the (appropriate) use of digital tools in ECEC ought to be mediated through the sharing of targeted good practices and research evidence around children's digital play to the whole-school community. The dissemination of such evidence could support educators in identifying and implementing children's activities with technologies in a play-based way that complements traditional playtime activities, while also reassuring parents that potential risks are mitigated (e.g. through controlled and limited exposure). An example of this is found in the Danish research initiative ''Digital Learning Through Play'', which aims to collect a solid evidence base regarding how digital content and tools can help to foster qualities of play such as creativity, collaboration, communities, commitment and curious investigation in younger learners[348]. Another Danish example can be found in Box 29.

[339] Norris, D. (2011). 7 things you should know about first-generation learning analytics (report). Retrieved from EDUCAUSE website: https://library.educause.edu/resources/2011/12/7-things-you-should-know-about-firstgeneration-learning-analytics
[340] Mutimukwe, C., Viberg, O., Oberg, L. M., & Cerratto-Pargman, T. (2022). Students' privacy concerns in learning analytics: Model development. British Journal of Educational Technology.
[341] Kapp KM (2012). The Gamification of Learning and Instruction: Game-based Methods and Strategies for Training and Education. San Francisco, CA: Pfeiffer.
[342] Ozcinar, Z., Orekhovskaya, N. A., Svintsova, M. N., Panov, E. G., Zamaraeva, E. I., & Khuziakhmetov, A. N. (2021). University Students' Views on the Application of Gamification in Distance Education. *International Journal of Emerging Technologies in Learning (iJET)*, *16*(19), pp. 4–15. https://doi.org/10.3991/ijet.v16i19.26019
[343] Ibid.
[344] European Commission, Directorate-General for Education, Youth, Sport and Culture, Melstveit Roseme, M., Day, L., Fellows, T., et al., Enhancing learning through digital tools and practices : how digital technology in compulsory education can help promote inclusion : final report : October 2021, Publications Office, 2021, https://data.europa.eu/doi/10.2766/365846
[345] Rafal Wajszczyk (2014), A study of the impact of technology in early education. Available at: https://www.diva-portal.org/smash/get/diva2:737018/FULLTEXT01.pdf
[346] Edwards, S. (2013). Digital play in the early years: a contextual response to the problem of integrating digital technologies and play based learning in the early childhood curriculum. European Early Childhood Education Research Journal, 21(2), 199-212.
[347] An example of this is Kahoot's recent expansion into ECEC from school-level education: https://www.edsurge.com/news/2021-12-15-expanding-into-early-childhood-is-good-for-edtech-companies-is-it-good-for-kids
[348] https://distance-learning-through-play.dk/da/

Box 34. Trend in practice

Combining gamification with virtual reality (VR) technology, the startup Labster, in Denmark, offers a gamified 3D learning virtual environment where learners are required to solve a real-world problem within the context of a story, in which, for example chemistry students are able to map out and visualise chemical reactions. Far from being limited to a laboratory, the learning venue can also be a forest, or even the desert plains of an imaginary exoplanet.

Source: Ecorys, 2023.

Trend #3– Students and teachers are increasingly empowered as content creators

While the digital education content market is still largely dominated by educational publishers and content offered through EdTech companies, the literature suggests that it is becoming increasingly common for teachers and students to create content themselves[349] [350] [351]. New and accessible digital editing tools allow them to produce effective digital education content easily, and this content can be broadly disseminated through platforms and social media.

Arguably, as already explored in foregoing chapters on quality criteria and enablers, teachers themselves are best positioned to anticipate and respond to the unique needs of their classrooms[352]. While teachers traditionally were tasked with delivering someone else's content, today's teachers can use digital content to become creators and designers of learning experiences. Indicating that this is a highly valued skill, respondents in the *Open Public Consultation (OPC) on the Digital Education Action Plan 2021-2027,* voted 'creating digital content' to be the most attractive digital skill, selected by 60% of the educators and 46% of the education and training staff[353].

Like teachers, students are also increasingly **co-creators of content. Especially in VET and in higher education, their own use of content is increasingly recognised as part of their coursework and can be recognised in systems of individual learning accounts**[354]. Having students offer their own content is a way to boost student engagement, which is critical considering that researchers have known, for a long that time, that collaborating with other students leads to better learning outcomes at all levels (Deslauriers 2011[355]).

Box 35. Trend in practice

Being aware that student-created content can be particularly helpful in explaining challenging subjects, two German engineering students at the University of Rostock decided to shoot a video for a project on thermodynamics (i.e. physical science that deals with the relations between heat and other forms of energy). Encouraged by their professor, they began uploading a series of videos which quickly became popular well outside the faculty. Today, their most popular pedagogical video has more than 13.000 views and 35% of the viewers are young women in STEM subjects, according to YouTube Analytics – providing key metrics for video and channel performance.

Source: Ecorys, 2023.

Trend #4 – Awareness of the importance of data integrity and privacy is more widespread

Some digital education content aims to be as user-tailored, targeted and personalised as possible, an approach that may require vast amount of personal data, including behavioural data. As explained earlier in this section,

[349] Grant, A., Huang, S., & Abimbade, O. (2022). Collaboration, Creativity, and Learning Analytics: Student Created Content in a Higher Education Course.
[350] Brian P. Coppola, Jason K. Pontrello (2020). Student-Generated Instructional Materials. Active Learning in College Science, pages 385-407
[351] Park, W. et al (2019) "Interactive AI for Linguistic Education Built on VR Environment Using User Generated Contents," 2019 21st International Conference on Advanced Communication Technology (ICACT), pp. 385-389, doi: 10.23919/ICACT.2019.8701950.
[352] https://www.21clhk.org/presentations/teachers-as-content-creators-the-21st-century-shift-from-learning-delivery-to-learning-design/
[353] https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/12453-Digital-Education-Action-Plan/public-consultation_en
[354] Grant, A., Huang, S., & Abimbade, O. (2022). Collaboration, Creativity, and Learning Analytics: Student Created Content in a Higher Education Course.
[355] Deslauriers, L., Schelew, E., & Wieman, C. (2011). Improved learning in a large-enrollment physics class. science, 332(6031), 862-864.

data analytics can help improve institutional decision making, advancements in learning outcomes for at-risk students, greater trust in institutions due to the disclosure of data, and significant evolutions in pedagogy, among other things[356].

However, **education data may contain sensitive and personal information, and users using digital education resources may not see or understand the digital footprint they leave behind,** and the extent to which information travels to third parties across or beyond the education landscape[357]. Teachers may lack the necessary experience or knowledge to critically assess a particular resource or content and be oblivious about the ethical implications that digital platforms raise for student data privacy, or simply lack the time and resources to address these issues[358].

Some scholars further emphasise that the sense of urgency following the Covid-19 pandemic led to a hasty patchwork use of platforms, with little regard to the privacy of users and their digital rights[359]. This is an issue because EdTech companies may have an incentive to provide free or low-cost products, given that the extraction of data surplus from users of digital technologies often has a greater value than raised from selling products[360].

Box 36. Trend in practice

In a move to better safeguard the data privacy of school staff and students, in 2021 the Dutch government commissioned a data protection impact assessment of Google Classroom. Based on the findings, Google was required to improve several of their privacy settings before their products were allowed in Dutch schools again. The Dutch government also has imposed restrictions on the use of the Chrome OS and the Chrome web browser until August 2023 over concerns about data privacy.

Source: Ecorys, 2023.

Trend #5 – Digital education content is complementing non-digital material

Examples of DEC complementing non-digital education material and, by doing so, strengthening the learning experience, include Open Education Resources (OER) and Open Educational Practices (OEP). These are free online repositories of learning or pedagogical material that can provide engaging alternatives to voluminous textbooks or one-sided lectures. OER/OEP have been described as a way to 'democratise education 'as they enable more freedom of choice and more significant opportunities for students to shape their learning community[361].

Crucially, they are also allowing learners without recourse to face-to-face education (e.g. due to physical, geographical or cultural barriers) to access high-quality provision, while offering chances for students to participate in peer learning and self-assessment[362]. Ease of access to and findability of OER has been identified as a key challenge in stakeholder consultations conducted for this study. The extent to which OER is taken up more broadly will depend to a significant extent on more structured data tagging (e.g. at the level of 'chunks'), with pedagogical descriptors.

Micro-learning, which refers to small learning units or short-term learning activities may also be considered as an alternative to non-digital material. Andriotis (2018)[363] describes micro-learning as the "…cheaper-to-produce

[356] Long, P., & Siemens, G. (2011). Penetrating the fog: Analytics in learning and education. Educause Review, 46(5), 30–40 Retrieved from https://er.educause.edu/articles/2011/9/penetrating-the-fog-analytics-in-learning-and-education
[357] https://www.coe.int/en/web/data-protection/-/protect-children-s-personal-data-in-education-setting-
[358] Foulger, T. S., Wetzel, K., & Buss, R. R. (2019). Moving toward a Technology Infusion Approach: Considerations for Teacher Preparation Programs. Journal of Digital Learning in Teacher Education, 35(2), 79–91. https://doi.org/10.1080/21532974.2019.1568325
[359] Pangrazio, L., Selwyn, N., and Cumbo, B. (2022). A patchwork of platforms: mapping data infrastructures in schools. Learning, Media and Technology.
[360] Hillman, V. (2022) EdTech procurement matters: It needs a coherent solution, clear governance and market standards
[361] European Commission. (2020). Commission staff working document for the Digital Education action Plan 2021-2027. European Commission: Brussels.
[362] Koseoglu, S., & Bozkurt, A. (2018). An exploratory literature review on open educational practices. Distance education, 39(4), 441-461.
[363] https://elearningindustry.com/what-is-microlearning-benefits-best-practices

sibling of regular eLearning." Lessons may be broken down into 5–10-minute segments, or even 20 seconds, in order to present learning in the form of manageable chunks[364].

Box 37. Trend in practice

In a move to harness the benefits of digital resources in education, Croatia passed a legislative act in 2018 that recognised digital educational content as 'other educational materials'. Content will be published in a virtual repository as decided by the Ministry of Education, acting as a guarantor of quality. The legislative act states that "the requirement for educational materials to be published in a virtual repository is that […] they comply with scientific principles and ethical standards, and are pedagogical, psychological and didactic-methodically suitable for use in teaching in the subject for which they are envisaged".

Source: Ecorys, 2023.

Trend #6 – There is more attention to making digital education content accessible for all

As seen in previous sections, **the literature points to digital education content's potential to widen access to learning**[365]. This is particularly the case when it comes to levelling the playing field for traditionally marginalised learner groups. For example, open and user-adapted resources can increase access to education through assistive technologies for SEND-learners and multilingual learning resources for migrant learners. Inclusive digital education content can also help better connect learners from a distance, which holds particular potential to widen educational offers for rural learners, as well as learners with long-term illnesses[366].

In the UNESCO Recommendation on Open Educational Resources (OER), countries are encouraged to support this development by ensuring that OER are "gender-sensitive, culturally and linguistically relevant" and that such resources are "accessible anytime and anywhere for everyone, including individuals with disabilities and individuals coming from marginalized or disadvantaged groups"[367].

To realise this vision, a key obstacle in Europe has been to ensure **access to digital technology**, both inside and outside of the classroom. In the EU, the 'digital divide' persists in spite of significant progress in the last decade. The shares of students attending highly equipped and connected schools differs remarkably between education levels – ranging from 35% (ISCED 1) to 52% (ISCED 2) to 72% (ISCED 3)[368]. Meanwhile, an average of fewer than 1 in 5 European students attend schools with a high-speed Internet above 100 mbps[369]. As many institutional providers and homes still struggle with connectivity, **providing digital education content available in offline, printable, and in downloadable formats are factors that developers and designers may consider.**

Trend #7 – Internet-enabled devices are increasingly a part of learning environments

A trend that has been driving the growth of digital education content is **the rapid penetration of internet-enabled devices in learning environments**. Digital tools have become omnipresent in learning environments, both formal and non-formal, especially so since the COVID-19 outbreak.

Until recently, the internet was primarily accessed via computers that were expensive to procure and purchase for schools, parents and students. With the proliferation of various internet-enabled devices (e.g. mobiles and tablets), a wide range of content for teaching and learning have become available, including OERs and MOOCs, that extend the range and quality of available materials. On a range of devices, today's teachers are able to direct students to a multitude of sources, and students are free to develop digital competences and research

[364] https://cetl.westernu.edu/articles/microlearning-chunking/
[365] European Commission, Directorate-General for Education, Youth, Sport and Culture (2021) Melstveit Roseme, M., Day, L., Fellows, T., et al., Enhancing learning through digital tools and practices : how digital technology in compulsory education can help promote inclusion : final report https://data.europa.eu/doi/10.2766/365846
[366] https://op.europa.eu/en/publication-detail/-/publication/b12644c4-315c-11ec-bd8e-01aa75ed71a1
[367] https://unesdoc.unesco.org/ark:/48223/pf0000370936
[368] 2nd Survey on Schools on ICT (European Commission, 2019).
[369] Ibid.

skills by exploring online content on their own[370]. The global NGO 'the Internet Society' has praised this development, but encourages policymakers to seek ways to integrate the wealth of new resources into local conditions without "discouraging the development of local content or […] the role and experience of local teachers".[371] Further attention is needed so that devices and content do not become disruptive elements that students use to engage in inappropriate behaviours such as cheating and cyber-bullying[372].

Box 38. Trend in practice

Likely to accelerate the use of internet-enabled devices in education, the EU Recovery and Resilience Facility (RRF) represents a major investment into digital education. Member States have earmarked funds to invest in the digital infrastructure and the connectivity of schools, often with a focus on disadvantaged and rural schools. Two examples are Slovakia, aiming to increase its share of highly connected classrooms from 30% to at least 90%, and Italy, which has set the objective of transforming 100,000 classrooms into 'flexible and connected learning environments'.

Source: European Commission. Education and training monitor Executive Summary. (2021).

Trend #8 – "Education platforms" are shaping how digital education content is used

The term 'Education platforms' has been referred to as 'conceptually vague' and may refer to a wide array of resources including: digital textbooks, learning management systems, digital tutoring systems, MOOCs, school networks, adaptive educational content platforms, and digital test platforms.

Following a first phase (mid-1990 to 2010) of digital education characterised by the introduction of hardware and educational software, the 'platformisation' of education marks a second stage whereby EdTech players are looking to find ways to collect their data and improve the accuracy of educational algorithms[373].

In light of this development, contemporary digital education content is typically part of a "platform ecosystem", whether a commercial platform, a "prosumer" commercial platform that relies on and/or includes teacher-created materials, or an open resource platform or a combination of these. Platforms have in recent years gained popularity as the cloud-based technology underpinning them, allows convenient access independent of time and space. Platforms that have more users and more user data, are also improving as they generate 'network effects', resulting in more predictive power and thereby an increased customer loyalty and retention[374].

UNESCO notes in a report[375] that the platformisation of education opens up numerous ethical questions that will need to be considered and addressed by education stakeholders, including:

- Who will be the authors of the 'new worlds' of digital learning?
- Who will participate in the discussions that will affect education as a public good?
- Who controls student privacy and learning data?

Box 39. Trend in practice

The Bulgarian popular educational portal ucha.se offers video lessons for children, students, parents and teachers in an interactive and engaging way with the aim of improving the acquisition of knowledge and skills, inspiring motivation for learning, and provoking emotional engagement. Implemented at national level, the education portal is considered particularly appropriate for students with learning difficulties, and for underachieving students with poor grades.

[370] Internet Access and Education: Key considerations for policy-makers - Internet Society
[371] Ibid.
[372] Turning on mobile learning in Europe: illustrative initiatives and policy implications; UNESCO working paper series on mobile learning; 2012 - 216165eng.pdf
[373] Ibid.
[374] Rivas, A. (2021). The Platformization of Education: A framework to Map the New Directions of Hybrid Education Systems
[375] Ibid.

Source: Ecorys, 2023.

Trend #9 – Blended learning

At the EU level, blended learning has been defined as a blending of "school site and other physical environments away from the school site […]; or a blending of "different learning tools that can be digital (including online learning) and non-digital"[376]. Blended learning approaches have been highlighted to support creativity and personal expression – these include open educational resources (OER), craft tools, realia (objects found and used in everyday life), published texts, and writing and visual arts tools[377].

Blended learning was widespread during the pandemic and revealed both possibilities and challenges. Among other benefits, well-organised blended learning can contribute towards making learners increase their autonomy, motivation and agency, and become self-directed learners[378]. For teachers, blended learning enables differentiating and personalising their pedagogies to different student needs, including those who are vulnerable and/or have special needs.

Box 40. Trend in practice

As learning environments use more technology than ever before, publishers have responded by developing 'blended packages' which includes both digital and traditional education content. The Swedish publisher Gleerups, for instance, offers alongside its textbook in mathematics, a complementary 'Mathematics portal'– giving students a personalised and 'gamified' experience. Powered by algorithms, the portal adjusts difficulty levels depending on how well assignments are completed, rewarding right answers with points, level-ups, and medals. The developer recommends students to always have their notebooks (analogue or digital) next to them when using the portal, to practice reporting their thought-process.

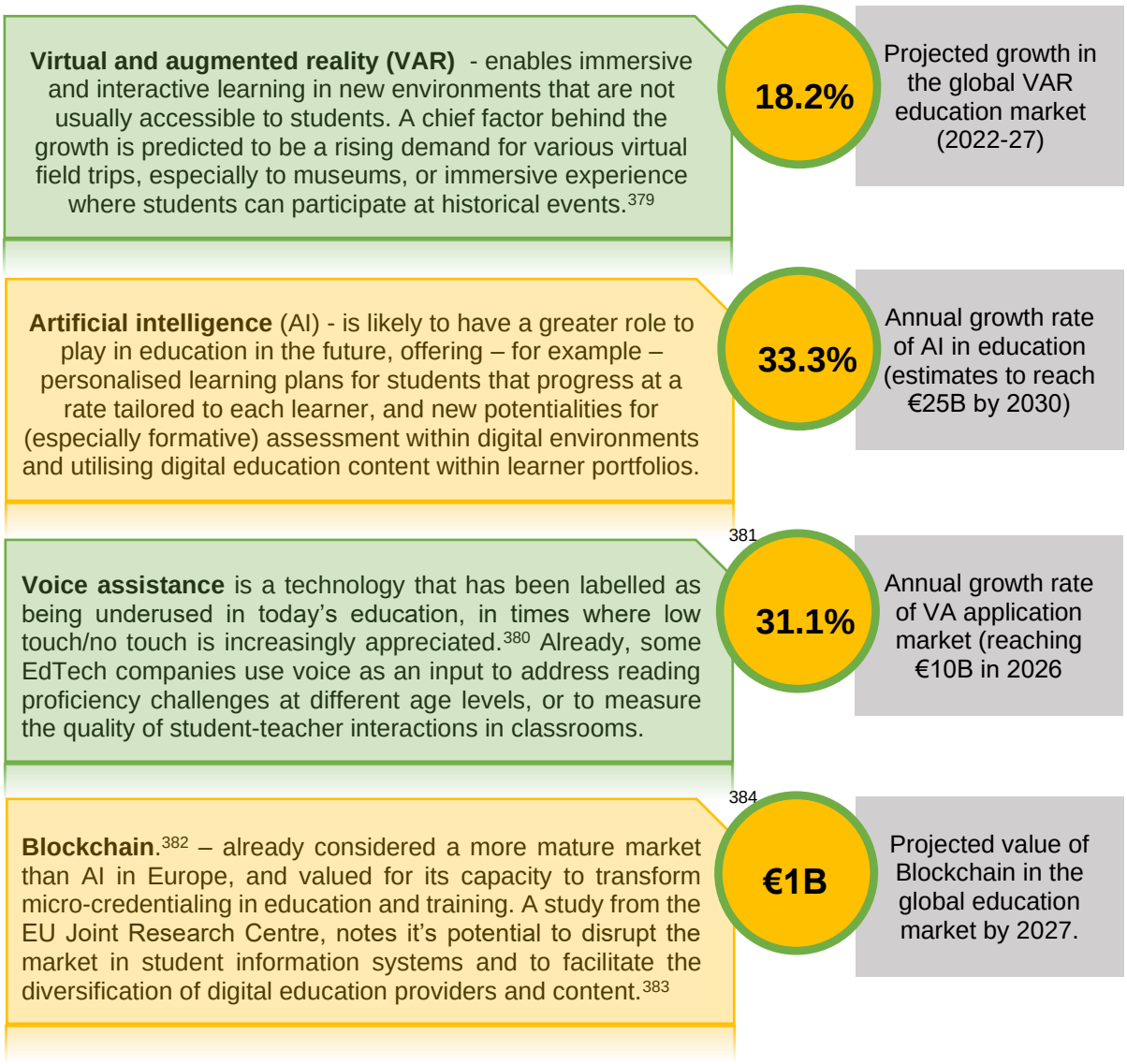
Source: Ecorys, 2023.

Integration of more advanced technologies in education is likely to occur in the context of ongoing trends rather than as a disruptive event.

[376] COUNCIL RECOMMENDATION on blended learning for high quality and inclusive primary and secondary education. Available here.
[377] Ibid.
[378] Blended learning in school education_European Commission_June 2020.pdf (schooleducationgateway.eu)

Figure 15 highlights projected growth of several technologies in the near future.

Figure 15: Advanced technologies and their potential for digital education content in Europe



Source: Ecorys, 2023

Responses to the DEC provider survey conducted for this study,[385] indicate that Artificial Intelligence (AI) and associated learning analytics are primary examples of technologies that may impact the DEC ecosystem. This includes 'generative AI' technologies, an area that has seen rapid development in last year, allied to an

[379] Market Research Future (2022) AR and VR in Education Market Anticipated to Grow at a CAGR of 18.2% During 2022 to 2027, June 07, 2022.
[380] Davis, J.D. (2021) Are Voice Assistants Ready for Education?, Jan 15, 2021. Available: https://www.bettshow.com/bett-articles/are-voice-assistants-ready-for-education [Viewed: 18.01.23]
[381] Ibid.
[382] For a relevant definition of blockchain, see p. 21 of OECD (2021), OECD Digital Education Outlook 2021: Pushing the Frontiers with Artificial Intelligence, Blockchain and Robots, OECD Publishing, Paris, https://doi.org/10.1787/589b283f-en
[383] Inamorato Dos Santos, A., editor(s), Grech, A. and Camilleri, A., Blockchain in Education, EUR 28778 EN, Publications Office of the European Union, Luxembourg, 2017, ISBN 978-92-79-73497-7, doi:10.2760/60649, JRC10
[384] Global Blockchain in Education Market Insight | Explained Pre & Post COVID-19 Impact | Estimated to Reach USD 1055.98 Mn (Growing at a CAGR of 43.94%) | During Forecast Period 2022-2027 - Digital Journal
[385] Results from Ecorys provider survey answered by 108 digital education content providers in the EU, carried out between February and March 2023. The survey was open to organisations that provide digital education content and / or associated services to the K12 (pre-school, primary and secondary education, including VET) and Higher Education sectors in Europe. The geographical scope included digital education content services provided for national education systems within the EU Single Market.

intensified debate on their appropriate role in learning environments. According to 60% of respondents, data analytics – a key element in AI technologies – will be the most impactful technology in education.

Virtual, augmented, and mixed reality technologies (XR) and their potential to support new forms of experiential learning and online collaboration, were considered by a large share of respondents to the provider survey as technologies that are likely to have a high impact on the market[386]. The potential of the use of AI, XR, and VR in education, furthermore, was highlighted by consulted stakeholders throughout the study.

Consultations, however, showed that **many of these technologies are in their early stages of application in education settings**, as the take-up of advanced technologies in education more generally remains limited, albeit gradually increasing. Challenges to the integration of emerging technologies in education include lack of evidence with regards to their relevance to achieve learning objectives, their cost, and the competences of education organisations and staff to use them safely and effectively. Consultees also noted differences in the way new technologies are integrated in teaching, learning and assessment at different education levels. For example, respondents suggested that higher education institutions were more likely to have the capacity to use more advanced technologies.

5.4 Key elements of a healthy and sustainable policy, practice and development of DEC in Member States

Effective policies, practices and development of DEC – the third area of the overall DEC ecosystem – are the ultimate aim of DEC policy and practice. Based on this analysis, we summarise key elements of a healthy and sustainable approach to governance and funding of DEC in the Member States below (see also Annex 5).

Policy

Our analysis reveals that **policy instruments are in place across all Member States, but not all have direct relevance to DEC.** In some instances these broad strategies focus on the enabling conditions (e.g. skills, infrastructure) for the use of digital content and tools, rather than the pedagogical relevance of DEC. In turn, this has an impact on the integration of digital resources in national curricula and in teaching, learning and assessment practices across education levels. The latter are still at an early stage of development, as **DEC is rarely formally mentioned in curricula.** Use varies across countries and education levels, and **remains rather sporadic and heavily influenced by overall high levels of school autonomy and whether educators are motivated, willing and capable** to integrate digital resources in their practice.

Practice

Effectiveness of DEC in teaching, learning and assessment processes depends on context and use. This autonomy – and teacher freedom of choice regarding specific content and methods – were identified by stakeholders consulted as important factors. Quality assurance frameworks, opportunities for teacher exchange, professional learning communities and collaboration have been highlighted as important tools.

Our analysis also points to the need to better integrate possible uses of DEC within curricular guidelines. In addition, more effective tagging and labelling of content to improve searchability may support dissemination of OER. Stakeholders consulted also highlighted the **importance of teacher and learner agency**, including opportunities to engage in policy design, implementation and evaluation.

Trends

Newer technologies as outlined in section 5.2 **have the potential to change or even disrupt education.** Take-up for many of these technologies (e.g. Augmented and Virtual Reality, blockchain, innovative and interactive DEC) has been slow. Other technologies – such generative AI – are already having an impact. Cost, regular engagement with stakeholders, research on impact, effectiveness and relevance of DEC (i.e. its valued

[386] 30 respondents mentioned AI and 8 mentioned XR

added) within different contexts, effective quality assurance processes and ongoing support for users are also key elements in the long-term take-up of DEC.

Looking forward

Addressing existing challenges within policy and practice requires Member States to further integrate DEC in their policymaking, to ensure clear strategic vision on its specific affordances and contribution towards teaching, learning and assessment practices. Greater understanding of DEC and its potential can also positively contribute to the broader digital transformation within education systems. Increased clarity at policy level may then lead to a systematic integration of digital education tools within national curricula, and better alignment between these and literacy, numeracy and skills strategies (including ensuring that educators and learners possess the necessary competences to make the most out of DEC's potential and make more informed decision about its use).

Strategies and curricula may need to be accompanied by greater efforts to measure, validate and certify the educational impact and value of digital education content, through validation processes to certify learning outcomes acquired through the use of DEC (e.g. linked to micro-credentialism).

At the same time, as this Chapter has shown, policy change in education has to go hand in hand with measures setting out a vision to navigate the transition to high-tech solutions and their fast penetration into our everyday life, including teaching, learning and assessment. This may require public investment in empirical research on the implication of technology for education and DEC, as well as stronger inter-institutional cooperation, and partnerships across the public and private sectors.

Box 41. Policies, practices and trends - key messages

Key messages

• **Most education systems across the EU have developed policy strategies for digital education**. These usually follow one of three routes: 1.) country-level digital transformation, including for education; 2.) national education priorities, including for digital education 3.) national vision for digital transformation in education, across all levels, or targeted to a specific level.
• Within these broad strategies, **policies may focus on improving access to digital resources, increasing DEC take-up by educators, supporting training for educators' digital skills, or promoting quality in DEC**. Increased access to and use of digital resources and tools by educators and learners are also emphasised**.**
• There are **key challenges to the systematic integration of digital education content**. Key elements may be missing, including:
  ○ Effective **strategies with clear governance structures and coordination between governance levels**: implementation strategies with specific action plans, sufficient funding and plans for monitoring and evaluation.
  ○ Communication based on a **shared understanding of what DEC** is and its potential added value.
  ○ Capacity to keep pace with **technological changes.**
• **Policy-level attention to effective pedagogical use of digitial education content is lacking**. In a minority of Member States (e.g. EE, FR, SE) strategies clearly promote the digital education content, or require education institutions to develop strategies to integrate digital learning (e.g. IE). The EU also plays an important role in supporting integration of digital technologies, including through the development of diagnostic frameworks and tools.
• **Enabling factors for the creation of high-quality DEC**, include: i) intentionally designed content, ii) the involvement and consideration of children, iii) content developed to support blended or flipped learning, and iv) the availability of diverse content.
• **Enabling factors for procurement**, include: i) the existence of intermediaries between digital content producers and end-users, ii) clear quality and protection guidelines, iii) structured dialogue with stakeholders, and iv) school leadership "buy-in". When it comes to use, identified enablers include: teacher

Key messages
motivation and creativity, teacher training and competence development, and a collaborative school environment. • **Integration of more advanced technologies in education is likely to occur in the context of ongoing trends rather than as a disruptive event**. AI and associated learning analytics are primary examples of technologies that may impact the DEC ecosystem. Furthermore, virtual, augmented, and mixed reality technologies (XR) and their potential to support new forms of experiential learning and online collaboration are likely to have a high impact on the market. Many of these technologies are in their early stages of application in education settings, as the take-up of advanced technologies in education is growing only gradually. • Challenges to the integration of emerging technologies in education include **lack of evidence with regards to their relevance to achieve learning objectives**, **their cost, and the competences of education organisations and staff** to use them safely and effectively. • Education policy will need to be based on an **overall vision on how to navigate the transition to high-tech solutions, including teaching, learning and assessment**. This may require public investment in empirical research on the implication of technology for education and DEC, as well as stronger inter-institutional cooperation, and partnerships across the public and private sectors.

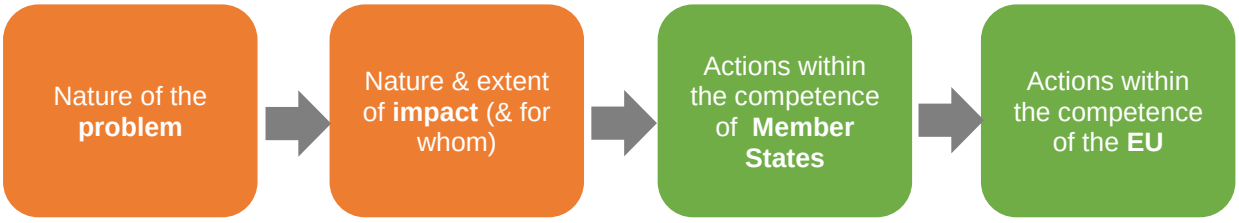
Source: Ecorys, 2023.

While many of these challenges fall under the competence of Member States, in chapter 6 we take stock of existing trends and bottlenecks, to identify potential areas for improvement and policy action at EU level.

6.0 Policy options and EU Added Value

The previous chapters have shown that EU Member States have encountered common challenges with DEC, despite the diversity of their education systems and policies. In this chapter, we consider possible areas of EU intervention to address these shared challenges and maximise the opportunities presented by Europe's DEC Ecosystem. The chapter starts with a problem analysis, identifying four key areas for action by the EU and ten specific problems with an EU dimension. This analysis draws on the study evidence, describing the challenges and their impacts. The chapter then goes on to consider policy options and to appraise their advantages and drawbacks. Finally, it presents a set of recommendations and three possible scenarios.

6.1 Problem analysis



The problem areas are presented in the table below, adopting a 360º approach. These were identified through the synthesis of study data and are cognisant of the various sets of stakeholder consultations. Each set of problems is analysed further in the tables that follow, supported with data and cross-referencing the main chapters. In every case, we consider the opportunities presented for EU action and rationale for intervention.

Table 16 – Problem categories and themes

Reference	Categories and themes	360º dimensions
Category 1	**Standardisation and EU dimension** Addresses the need for high quality definitions, principles, criteria and standards for DEC that are known and understood. It comprises of three problem areas relating to consistency of definitions and standards, interoperability, and system complexity.	
Problem 1	Consistency of definitions, guiding principles and quality criteria.	E, L, P, T
Problem 2	Interoperability and minimum standards for metadata.	L, P, T
Problem 3	Complexity within Europe's DEC ecosystem.	E, L, P, T
Category 2	**Smart and sustainable investment** Addresses the need for sustainable and coherent investment and expenditure in an ecosystem that is clear to stakeholders. It comprises of three problem areas relating to funding sufficiency and sustainability, procurement models, and data availability.	
Problem 4	Sufficiency and sustainability of funding for DEC.	E, L, P
Problem 5	Fitness of procurement models and processes.	L, E
Problem 6	Minimum data collection and benchmarking for DEC investments.	L, E, P
Category 3	**Access, equity and inclusion**	

Reference	Categories and themes	360º dimensions
	Addresses the need to realise an inclusive approach to the production, distribution and use of DEC, focused on end-user engagement. It comprises of three problem areas relating to agency, fundamental rights, accessibility, inclusion and diversity.	
Problem 7	Inclusive governance, teacher and learner agency.	P, L, E
Problem 8	Secure and ethical data processing, observing fundamental rights.	L, P, T
Problem 9	Access and inclusion for learners experiencing disadvantage.	P, L, E
Category 4	**Fair and responsible use** Addresses the need to promote the development of effective, responsible and reasoned uses of DEC across Europe. It comprises of one key problem area, focussed on copyright and IP dimensions of DEC for competent use and re-use.	
Problem 10	Meeting obligations for copyright and intellectual property.	E, L, P, T

Key to 360º dimensions

E = Economic, L = Legal, T = Technological, P = Pedagogical

6.1.1 Category 1: Standardisation and EU dimension

Problem 1: Consistency of definitions, guiding principles and quality criteria			
Nature of the problem	**Nature of impact**	**Strengths & opportunities**	**Case for EU action**
As DEC becomes established within Europe, this raises questions about how to find, select and use appropriate content. On the demand side, Covid-19 underlined that schools and teachers often lack confidence in appraising digital education content products and providers[387]. Many report finding it difficult to understand what solutions are available and the advantages and drawbacks of different DEC products[388]. Challenges are also presented to providers in validating their DEC offers[389], as proof requires use and applied research downstream, or co-design and applied research upstream. A DEC framework must consider: • What definitions of quality should cover, how and by whom they should be assigned, and the level at which they sit (a unifying taxonomy, technical standards, pedagogical criteria, learning scenarios). • How to achieve content that is educationally, legally and ethically appropriate, at all stages of the cycle. • How to form quality judgements encompassing the breath and range of DEC, from a single image to a sophisticated content package combining multiple formats, and covering education levels and sectors.	• Feedback shows that a lack of findability for DEC can result in teachers missing solutions that may have responded to their needs, or re-inventing solutions that already existed, but they were unaware of. • Poor confidence in DEC reduces the likelihood that educators will seek feedback or collaborate, with diminishing returns for building a shared evidence base. • A lack of training and applied use of DEC poses limitations for more widespread use, and acts as a barrier to the integration of DEC to teaching, learning and assessment. • Consistency issues arise in the absence of accepted standards to make DEC accessible, inclusive, relevant, exchangeable, and scalable, restricting levels of access and use by different end users across Europe. • Quality criteria for Open Education Resources (OERs) are contested, resulting in variations in material produced across the EU and levels of public funding support.	The consultations signalled a good level of demand among stakeholders for EU level criteria to help create, find and use the most inspiring, relevant and useful DEC for the context(s) within which it is to be applied. Studies also demonstrate the importance of clear criteria and guidance where DEC is concerned, and the importance of instructional resources to teachers' successes in the classroom[390]. A DEC framework can draw upon numerous promising EU practices. On the supply side these include creator frameworks[391], and vetting services. On the demand side, they include school guidance[392] and cataloguing systems. Elsewhere, testbeds bring these actors together to problem solve (SE[393], LU). The study shows demand among national stakeholders for sharing of good practices, studies and pilots, while leaving it up to the players to adapt their initiatives to the various levels.	**Good** The study evidence supports the case that guiding principles and criteria, applied consistently, would assist with further understanding what 'high quality' DEC looks like with different contexts, age groups and subjects. There is potential EU added value to be leveraged from adopting criteria that would improve the portability and comparability of DEC within Europe, and sharing evidence-based tools and frameworks where these exist.

[387] Hillman (2022) EdTech procurement matters: It needs a coherent solution, clear governance and market standards
[388] Kundu, A., Bej, T., & Rice, M. (2021). Time to engage: Implementing math and literacy blended learning routines in an Indian elementary classroom. Education and Information Technologies, 26, 1201–1220. Available online : https://link.springer.com/article/10.1007%2Fs10639-020-10306-0 [Accessed: 12.01.23]
[389] Andersson, P., and Mattsson, L-G (2019) Future digitalization of education after Covid-19.
[390] Tyton Partners (2022) Improving Instructional Resources to Enhance the Teacher Experience.
[391] https://www.researchgate.net/publication/236855764_An_Evaluation_Model_of_Digital_Educational_Resources
[392] In NL, Kennisnet publishes guidelines for schools to develop a ''content policy'' and selection process.
[393]For example, Swedish Edtest is a concept that aims to strengthens educators' digital skills to make more informed demands of the digital learning resources they need and use. It also aims to improve EdTech companies' understanding of real classroom needs and to adapt their services around these.

Problem 2: Technical standardisation: interoperability and metadata			
Nature of the problem	Nature of impact	Strengths & opportunities	Case for EU action
The EU digital education market is characterised by low levels of ICT standardisation. Historically, this is an under-regulated area of IT policy when compared with other aspects, such as data privacy (GDPR) and copyright. The EU ecosystem is comprised of a large number of proprietary tools and platforms, including those hosted by private organisations and publicly funded to host or distribute content for the education sector, and a multitude of organisationally-specific standards and data models[394]. There are variable levels of compliance with internationally recognised standards such as xAPI[395], ISO[396], and IEEE[397]. These standardisation issues are manifest in compatibility problems for DEC regarding: • Educational technology systems, software applications and platforms (interoperability); • Data standards used to describe and qualify educational resources within those systems (metadata), and • Schema used to describe attributes of learning objects for use and exchange by educators and educators.	• Non-standardisation presents obstacles to the transfer and scaling of DEC between settings and countries. This adds transactional costs and restricts availability of DEC to end users. • Teachers and students often need to access multiple services, each with their own LMS/DMS and sets of login credentials required by third-party suppliers. • As technical requirements are specific to individual countries, DEC providers can be 'locked-in' to multiple protocols and standards, resulting in data incompatibilities and technical issues in other markets. • New challenges are presented by advanced AI, and the potential impacts on how DEC is found and (re)used on proprietary platforms.	A new DEC framework provides momentum to tackle ongoing standardisation issues in the EU. Clearer standards and improved levels of interoperability have potential benefits for learner mobility, personalisation, improved access to high quality DEC, and removing technical (and sematic) barriers to educator collaboration[398]. There is good potential to build on work underway at European and national levels, including the Rolling plan for ICT Standardisation; the CEN / TC 353 initiative and national standards bodies[399] and the EU Digital Education Hub[400]. There is also potential to learn from other EU initiatives, including European open-source metadata frameworks[401]; solutions developed collaboratively with EdPub and EdTech providers (e.g. BG[402], IT[403]), and standardisation efforts within Europe's Higher Education sector[404].	**Good** While Member States have autonomy in prescribing standards and frameworks, there is a convincing case for further data standardisation to improve costs, access and equity. The mandate for developing EU level standards and technical specifications has been established with CEN/TC 353. The new DEC framework will need to align closely with this ongoing work and other relevant initiatives.

[394] Business Plan CEN/TC 355. *Standardisation of learning technologies*: https://standards.cencenelec.eu/BPCEN/580446.pdf
[395] An eLearning specification developed to collect standardised data about learning experiences and to facilitate data sharing between LMSs in a common format. See: https://xapi.com/overview/
[396] ISO/IEC 27001 is the international standard for information security, providing the specification for information security management:
[397] A schema that describes the metadata attributes of learning objects, to support their findability and reusability. See: https://ieeexplore.ieee.org/document/9262118
[398] CEN/TC 355. *op. cit.*
[399] Relevant objectives include, for example: increased interoperability across member states between digital learning content, learner related information, management systems; increased interoperability of European education technologies with international systems, and the creation of common multicultural and multilingual exchange formats.
[400] European Commission (2023) *A Vision for Educational Interoperability: Output of the EDEH Educational Interoperability Squad*.
[401] Europeana Data Model (EDM) https://pro.europeana.eu/page/edm-documentation. The model includes guidance for providers wanting to map their data to the EDM model, and to understand interoperability with other data models, with the objective of supporting European level common functionality.
[402] In Bulgaria, the student "digital backpack" integrates two of the main publishing houses platforms into the edu.mon.bg platform and respectively into the digital backpacks of the students, allowing for customisability in the textbook chosen for the particular school, subject and grade.
[403] Zaino Digital project: Zaino digitale is an online service launched by the Italian Publishers Association since 2017 that provides families, students, and teachers with a single gateway to digital contents (digital textbooks and supplementary resources) on publishers' platforms
[404] In Higher Education, inter-institutional collaboration on micro-credentials has seen a move towards improved standardisation to facilitate credit transferability.

Problem 3: Complexity within Europe's DEC ecosystem			
Nature of the problem	Nature of impact	Strengths & opportunities	Case for EU action
The study found wide differences between Member States in policy and governance arrangements adopted for the production, distribution and use of DEC, but also many shared challenges. The variations concern the degree to which DEC is made explicit within national educational plans and strategies; the ring-fencing (or otherwise) of core and discretionary budgets, and value propositions regarding the role of the private sector in education. This is apparent in the relative orientation towards an open data policy in some countries (promotion and facilitation of access to OERs, e.g. DE), and active market engagement in others (public-private partnerships, shared procurement with commercial providers, e.g. FR, DK). The differences are also cross-cut by structural variations between Member States regarding public educational expenditure; digital skills and connectivity; institutional, teacher and learner autonomy. There is also a regional dimension: Western and Northern Europe continue to dominate the EdTech marketplace, with Covid-19 gains reinforcing these divides[405].	At a fundamental level, differences in maturity present challenges for developing a coherent EU approach: • The ability for providers to operate transnationally in the EU is curtailed by the specificities of national markets, and by differences in curricula that pose a barrier to the portability of DEC offers and their pedagogical suitability[406]. • There is evidence that 'fragmentation' has constrained growth. Unlike in the US, actors in the European Single Market must navigate numerous procurement rules. It is estimated that 7-8 years is required on average to secure a return in the European EdTech market, leading to hesitation among potential investors[407]. • Equity considerations are presented by the disparities in access, choice, quality and available of DEC to learners across the EU27 depending on where they learn and live, and the need to scale and spread effective solutions between Member States and Europe's multilingual classrooms[408].	• Despite the complexity of the EU DEC ecosystem, Europe has championed legislation to promote fairness and transparency in the digital sphere and established a clear ethical framework, e.g. underpinned by the AI Act, GDPR, and Digital Services Act (DSA). • EU common values and principles give education in Europe it's distinctiveness and provide a reference point for a new common DEC framework, while leaving the initiative for voluntary implementation to the Member States. • At an EU level, there is a well-established infrastructure to build capacity (through EU funds, such as Erasmus+, Creative Europe and the Resilience and Recovery Fund) and to lever transnational cooperation. The Open Method of Coordination (OMC) provides a mechanism to connect countries with similar needs and characteristics.	**Good** The study shows a clear need and demand for collective solutions to common DEC challenges across Europe, without adopting a single solution and respecting the principle of unity in diversity among 27 EU Member States and their rich educational traditions. There is clear value in providing an EU level framework to offer support and challenge to Member States, foster peer learning, and to address market barriers with a transnational dimension.

[405] In 2021, for example, France and Denmark (plus the UK) accounted for three quarters of the "100 most promising" EdTech start-ups, while some countries and regions have very low levels of market development. Source: HolonIQ (2021) *Europe EdTech 100 - annual list of the 100 most promising EdTech startups from Europe*.
[406] 'Pedagogical and didactic challenges' was the single most prevalent challenge, reported by three quarters (75%) of surveyed DEC providers. Over half of providers reported problems with scalability and transferability of DEC when operating transnationally (58%). Providers referred to differences in curriculum standards among EU Member States, along with different levels of integration of digital tools and content within teaching, learning and assessment, and within teacher education programmes
[407] Anderson, J. (2020) 'The coronavirus pandemic is reshaping education'. March 9, 2020. Available online: https://qz.com/1826369/how-coronavirus-is-changing-education. [Viewed: 12.01.23]
[408] State-controlled portals, content and curricula with the sole availability of politically-charged content represent the lowest end of this spectrum.

6.1.2 Category 2: Smart and sustainable investment

Problem 4: Sufficiency and sustainability of funding for DEC			
Nature of the problem	**Nature of impact**	**Strengths & opportunities**	**Case for EU level action**
The study found that national budgets and support through EU programmes are crucial funding streams for the DEC market, and are essential support to DEC providers, regardless of their size or years in operation[409]. However, available data on public spending indicates that investment levels are generally low[410]. This has resulted in greater reliance on ad-hoc funding – through targeted programmes or grants at national or EU levels for specific initiatives or purposes, which often prioritise infrastructure and skills over content[411]. Part of this problem lies in the difference between investment budgets (for an impetus) and operating budgets, which would ensure greater legibility over time for suppliers as well as for purchasers and users. The study highlighted challenges relating to the efficiency and coherence of public spending and procurement processes and mismatched supply and demand, resulting in poor investment choices and limited preparedness for emerging technologies[412].	• Unwise or duplicated public service offers and lack of coordination between ministries represent a poor return on investment[413]. • Large procurements bundling educational equipment and DEC within the same supplier contract can devalue the content element and drive down quality[414]. • Low/insufficient investment means less spending available to education institutions and a reduced provider customer base[415]. • Time-limited funding serves as a disincentive for stakeholders to commit themselves in a sustainable and coherent way, and affects the transferability and scalability of DEC solutions. • New entrants can struggle to engage with a grants-based market due to a lack of know-how to bid for public funding and being locked-out of longer-term contracts.	The EU has committed to a range of funds, covering digital policy (e.g. RRF, Regio), education (e.g. Erasmus+, with K3 targeting public policies proposed by the Member States, and K2 inviting public-private cooperation), and those targeting suppliers to address specific challenges (e.g. Horizon Europe)..There is potential to optimise these by: • Aligning or targeting resources, for DEC-specific funding calls. • Adjusting conditionalities to allow for multi-year / repeat contracts. • Adjusting criteria to favour evidence-based solutions. The grants-based environment for DEC has fostered a culture of collaboration, partnerships and consortia[416].	**Good** While public budgeting falls under the competence of Member States, there is a case for further supporting legibility, coherence and effectiveness of EU financial support to Member States and the various EU players in their initiatives. A DEC Framework could support the definition of policy and investment priorities for the next Multiannual Financial Framework.

[409] The DEC provider survey shows that public funding from regional or national authorities and from the EU or associated agencies represent the second and third most frequently accessed funding streams respectively (at 42% and 29%), after self-funding. Propensity to use these sources of funding does not seem to differ substantially according to the length of time in operation.
[410] Eurostat data indicates that in the EU, government expenditure on education as a ratio to GDP only grew by 0.4% (from 4.7 % to 5.1 % of GDP) in the period 1995-2021. Education also only comes in as the fourth largest item of public expenditure, after social protection, health, economic affairs, and general public services.
[411] For example, available data on resource allocation in National Recovery and Resilience Plans indicate that digital skills and education has been a prioritised policy area with investments totalling €26 billion. See Recovery and Resilience Facility (europa.eu)
[412] OECD (2023), *Shaping Digital Education: Enabling Factors for Quality, Equity and Efficiency*, OECD Publishing, Paris, https://doi.org/10.1787/bac4dc9f-en
[413] These issues were highlighted in the workshops and stakeholder survey, as a principal challenge to making effective use of public funds.
[414] The stakeholder interviews highlighted examples where the DEC element might be required as an add-on to public contracts for educational devices (e.g. bundling with “200 free images”).
[415] The DEC provider survey shows that direct sales to schools, higher education institutions and other educational institutions represent the highest overall proportion of digital education content sales, with 42% of surveyed EdPub and EdTech companies indicating that direct sales to schools, higher education institutions and other educational institutions make up for between 61-100% of their sales. Free-text answers to the crowdsourcing exercise showed that educators see spending for education as a low priority for public authorities.
[416] The DEC provider survey shows that the 70% of providers engage in partnerships or consortia, doing so either sometimes (45%) or often (25%). Providers operating at a national level described regularly applying for core and special budgets, tailoring their consortia to fit, while those operating at an EU level listed collaborations for funds such as Horizon 2020 and Erasmus+, or bids through national partners.

Problem 5: Fairness and transparency in procurement models and processes			
Nature of the problem	Nature of impact	Strengths & opportunities	Case for EU level action
The study found that national procurement frameworks for DEC have developed in contrasting ways across Europe, with Member States implementing different models. At one end of the spectrum in a centralised model, state agencies acquire digital content on behalf of education institutions[417]. In contrast, education institutions often have more autonomy In decentralised systems[418], albeit with a varying role for municipalities[419]. In any scenario, openness, and a variety of procurements of different sizes and types are important for a healthy marketplace. A lack of expertise or evidence-based criteria means that public procurements are not always based on clear quality criteria, and technical costs are underestimated in calls for services. Moreover, the bundling of contracts for hardware and software with DEC can result the downgrading of the content element[420].	• The market advantages of larger and well-established companies can mean that SMEs and start-ups face additional challenges. These include: a lower profile with public procurers, inappropriately scaled contracts, and limited access to well-established consortia[9]. In some countries, this is compounded by 'lock-ins' to long-term supplier arrangements[421]. • It can be prohibitively costly for providers to operate between Member States, due to differences in public budgets[422], qualification criteria, technical requirements, access to procurement information, and demand-side data[423]. This can present barriers to providers who wish to operate at a transnational level in the EU Single Market[424]. • While school autonomy often means budgetary autonomy, technical expertise is required to carry out procurement and to navigate a confusing range of offers[425]. Lack of technical expertise or confidence in procurement may impact acquisition and, therefore, the quality of purchases and levels of usage.	The EU has already adopted a number of key directives regulating public procurement and promoting core principles of equal treatment, open competition, sound procedural management and transparency[426]. This provides a clear legal framework. In the context of a DEC framework, opportunities exist to service a wide range of procurement models across the EU by providing guidance and platforms for peer-learning, tools, templates and advice. Some countries in Europe have already developed sophisticated DEC procurement models and frameworks, offering learning for others to build upon and adapt[427].	**Fair** The implementation of existing EU directives and regulations falls within the remit of Member States, but the potential remains for EU action. Although new legislation is not necessary in this regard, a DEC framework could help stakeholders across Europe to access shared models for writing and implementing contracts, and the use of definitions and criteria that are common and transparent to all.

[417] In countries with centralised arrangements (e.g. BG, EL), a "secondary" B2C market aimed at parents can benefit DEC providers left out of the primary market, but with low levels of regulatory oversight.
[418] OECD (2023), *Shaping Digital Education: Enabling Factors for Quality, Equity and Efficiency*, OECD Publishing, Paris, https://doi.org/10.1787/bac4dc9f-en
[419] Some Member States (DK, SE, FI and NO) allow municipalities in to launch joint public procurement framework procedures to provide educational content. This can provide schools with more agency on their material purchases (including DEC) since they can take part in the procurement process.
[420] An issue reported in the stakeholder workshops, DEC provider survey, and key stakeholder interviews.
[421] According to the DEC provider survey, newer companies (0-9 years) are the most likely to report difficulties arising from unfavourable procurement conditions within the DEC marketplace.
[422] See for example: European Committee of the Regions (2019) Network of Regional Hubs for EU Policy Implementation Review Implementation Report First Consultation on Public Procurement. Available online: https://cor.europa.eu/en/engage/Documents/RegHub/report-consultation-01-public-procurement.pdf
[423] For example, according to the OECD, even in an integrated market such as the European Union, where less than 4% of the value of contracts in the EU is awarded to firms from another Member State. See OECD Brochure, Public procurement for sustainable and inclusive growth. https://www.oecd.org/gov/ethics/Public-Procurement-for%20Sustainable-and-Inclusive-Growth_Brochure.pdf
[424] Wischenbart, R. (2014). Global Trends in Publishing 2014: An overview of current developments and driving forces in the transformation of the international publishing industry. Available here.
[425] OECD (2023), *Shaping Digital Education: Enabling Factors for Quality, Equity and Efficiency*, OECD Publishing, Paris, https://doi.org/10.1787/bac4dc9f-en
[426] See Directive 2014/24/EU of the European Parliament and of the Council of 26 February 2014 on public procurement; Directive 2014/25/EU on procurement by entities operating in the water, energy, transport and postal services sectors; and Directive 2014/23/EU on the award of concession contract.
[427] Examples include France, Belgium (Flanders) and Sweden.

Problem 6: Minimum data collection and benchmarking for DEC investments			
Nature of the problem	Nature of impact	Strengths & opportunities	Case for EU level action
The study found that no reliable overview exists for DEC funding and expenditure at an EU level. Decision making on funding for DEC resides at different levels within Member States, ranging from centralised public service DEC offers to those based on public-private partnerships for procurement at various levels, and those where decision-making is devolved principally to municipalities or schools. In addition, the B2C market is strong in Europe, entailing that public authorities do not have oversight of data on private purchases of DEC. This resides with providers in their commercial accounts, alongside statistics on usage and performance of DEC. Furthermore, disaggregated data on public education expenditure is highly variable[428]. Reporting systems rarely allow for itemisation by type of expenditure, or indicate amounts spent on digital tools and content to support digital learning[429]. Spending for digitalisation usually falls under ''capital expenditure'' (i.e. infrastructure), or is classified as ''expenditure on other resources'', which includes expenses on various types of supplies, including learning materials. In addition, tailored programmes and/or subsidies for the acquisition of content often allow education institutions to re-allocate resources to priorities other than learning materials (e.g. tools and equipment)[430].	The sum of these challenges is that no reliable overview exists for DEC funding and expenditure at an EU level: • Lack of disaggregated data on supply and demand for DEC (usage) presents a challenge to the EU and to Member States for policy development, as it negates a better understanding of need, sufficiency, and value for money of investments in different types of DEC products and services across the EU. • While the study found a widely held view that EU funding (e.g. via the RRF) has disproportionately supported infrastructure over quality DEC, monitoring arrangements do not allow for this hypothesis to be tested. • While confidence in public investment in infrastructure and digital education was fair among surveyed DEC providers (58% and 52%), trust in the adequacy of investment in education (39%) was considerably lower. Hard financial data is needed to substantiate these sufficiency debates.	The EU already oversees relevant data collection, e.g. with the Digital Economy and Society Index (DESI)[431] and monitoring of public investment and use of EU funding through European Semester.[432] It also monitors spend via the EU programmes and Recovery and Resilience Fund (RRF). Stakeholders consulted for the study concurred that these data, while useful, lack the granularity and consistency to provide an EU-level view. Additional data on spending, triangulated with existing datasets (e.g. educational attainment, infra-structure), would provide a clearer indication of the volumes and share of funding allocated to DEC and what types of products and services are being paid for. However, the structuring, collection and sharing of data is the responsibility of each Member State and partners.	**Fair** It in the mutual interest of Member States and the EU to agree on a minimum level of data collection, analysis and sharing to better assess the impact of DEC expenditure and policies. The challenge is to identify a model that would incentivise the sharing of all or part of the data between stakeholders, providing sufficient visibility to increase the confidence of players and the consistency of spending. A pilot would be needed, to agree a framework acceptable to all, and to progress step by step.

[428] European Commission/EACEA/Eurydice (2019), Digital Education at School in Europe, Eurydice Report. Luxembourg: Publications Office of the European Union, https://eurydice.eacea.ec.europa.eu/publications/digital-education-school-europe

[429] OECD (2023), *Shaping Digital Education: Enabling Factors for Quality, Equity and Efficiency*, OECD Publishing, Paris, https://doi.org/10.1787/bac4dc9f-en

[430] For example, in Ireland, one of the main sources of funding for digital education content is the ICT Infrastructure Fund, a national initiative supporting the development and use of digital technology in education. Annual funding is provided to schools on a per student capita basis. An average total of EUR 40 million has been provided to over 3,000 primary schools and 650 post-primary schools. However, schools have discretion on how funding is spent between ICT infrastructure, equipment, training or digital education content. See https://www.gov.ie/en/circular/e1f8e-grant-scheme-for-ict-infrastructure-20212022-school-year/

[431] See https://digital-strategy.ec.europa.eu/en/policies/desi

[432] See https://commission.europa.eu/business-economy-euro/economic-and-fiscal-policy-coordination/european-semester_en

6.1.3 Category 3: Access, equity and inclusion

Problem 7: Inclusive governance, teacher and learner agency			
Nature of the problem	**Nature of impact**	**Strengths & opportunities**	**Case for EU level action**
The engagement of key stakeholders from all stages of the DEC lifecycle is an important dimension of governance. Effective coordination structures can bridge supply and demand sides, based on transparency, balanced interests and European Values[433], and set the conditions for research and investment[434]. Despite the existence of such partnerships, however, the study highlighted two main challenges: • A first issue is that such partnerships have often struggled with: 1) their representativeness (e.g. perceived accessibility to SMEs and start-ups), 2) their effectiveness (in connecting geographical scales and stakeholders to provide clear DEC standards and pathways), and 3) their independence from political interests and control. • A second dimension is the variable participation of teachers (and students) in the public commissioning of DEC, in the design or co-design of DEC, or in the qualification and evaluation of DEC. Barriers to engagement go beyond the existence of formal cooperation spaces to include a lack of compensation for learners and educators where their feedback is sought, and the time-limited nature, without transparent results[435].	• Governance arrangements have not always realised their full potential, resulting in the exclusion of key partners, lack of clarity and trust in decisions about the production, distribution and use of DEC in some Member States. • The role of commercial providers remains contested within Europe's national education systems and some countries favour a strategy based on OERs[436]. • Under-representation of the interests of educators and learners in how DEC is produced and used has both equity and fundamental rights dimensions[437]. • The separation of key stakeholder functions can result in mismatched expectations of supply and demand for DEC, and reproduce gaps in key competences and mutuality of technologists and educators[438].	At an *EU level*, there is a strong legislative framework underpinning teacher and learner agency, including the EU Charter, Conventions and Strategies[439]. The DELTA group and Digital Education Hub offer communities of practice to support effective and inclusive governance for DEC, while EU associations have played an important role[440]. At a *national level*, Member States have piloted numerous governance models, bringing together supply and demand side actors to problem-solve and co-create[441]. The EU can support practice exchanges and pilots, but the responsibility for governance arrangements sits with the Member States.	**Fair** While the composition of decision-making bodies overseeing education at a national level remains the preserve of Member States, there is a clear demand for evidence and peer learning on effective governance, where the EU has a role to play. A case can be made for the EU to leverage existing or establishing new structures for peer learning and exchanges, and to champion teacher and learner rights within DEC through EU representative stakeholder groups (e.g. OBESSU, ETUCE).

[433] European EdTech Alliance (2020) *Necessary Foundations for Sustainable Public-Private Partnerships that Enable Effective Digital Education Solutions*.
[434] According to the DEC provider survey, the majority of respondents mentioned partnerships as a key feature of education governance arrangements: whether cross-sectoral partnerships with national or regional public authorities, or participation in in EU or national level networks or associations.
[435] OECD (2022), *Education at a Glance 2022: OECD Indicators*, OECD Publishing, Paris, https://doi.org/10.1787/3197152b-en.
[436] The model currently adopted in Germany, for example.
[437] For children (learners), this relates both to UNCRC Article 12 (right to be heard), and the updated General comment No. 25 (2021) on children's rights in relation to the digital environment.
[438] The importance of enabling frameworks that can bring developers closer to end-users, in order to understand their needs and concerns is documented in: Selwyn, N. (2021). *Ed-Tech Within Limits: Anticipating educational technology in times of environmental crisis. E-Learning and Digital Media*, 18(5), 496-510.; and, Cuban, L. (2009). *Oversold and underused*. Harvard University Press.
[439] Such as the EU Strategy on the Rights of the Child and the European Convention on Human Rights.
[440] Examples include the Public European EdTech Map, hosted by the European EdTech Alliance, and open source European publishing sector statistics, curated by the Federation of European Publishers.
[441] In Latvia, an 'EdTest' project launched by the Ministry of Education aims to strengthen the collaboration between 16 EdTech providers and 136 schools. In Luxembourg, the Ministry has established a working group of teachers, to check and adjust DEC developed in other country contexts for LU, while Swedish EdTest enables multiple stakeholders to co-produce digital resources.

Problem 8: Secure and ethical data processing, observing fundamental rights			
Nature of the problem	**Nature of impact**	**Strengths & opportunities**	**Case for EU level action**
Robust data governance is essential to understand DEC performance and usage, guide smart investment and procurement, and to drive personalisation. The growing sophistication of DEC has generated vast quantities of data on educators, learners, their habits and behaviours, used by a variety of actors for different purposes. This situation presents significant ethical and data protection challenges[442]: • On the supply side, incidences of data breaches have been documented for EdTech companies and publishers in the EU, involving large volumes of data gathered from students, parents and teachers, and resulting in privacy violations and fraud[443] Providers' ethical codes for the processing of children's data have been scrutinised, as their education data governance practices are subjected to independent research[444]. Particular concerns relate to biases and inequalities reproduced by AI algorithms[445]. • For schools in Europe, a lack of standardisation in data governance practices between and within Member States presents legal and technical complexity when faced with a myriad of products and providers. The study consultations pointed towards unresolved ethical issues around how 'learning records' (the data generated by the use of digital education content) are stored, managed and re-accessed, and regarding teachers' preparedness for digitally processed data generated from AR/VR enabled learning environments.	• For educators, a lack of competence for safe and legal data processing presents real challenges when navigating an increasingly diverse range of DEC products and providers, and opens educators and schools to new liabilities while posing risks to learners in how their data is used[446]. Fear of litigation can deter investment and usage, creating a negative cycle. • For providers, data is a key source of information to tailor products, but a lack of common standards for metadata is an increasing challenge[447]. Adding to this complexity, educational records and qualification data are increasingly stored in digital wallets and ledgers, while data analysis and storage are outsourced. • For public authorities, increasingly complex technology collecting vast datasets represents a policy, legal, and technical challenge. Infrastructure will need updating. Regulation must balance protection with burden, with breaches possibly becoming harder to detect[448].	The EU regulatory and policy framework provides a sound basis for leveraging accountability for ethical data processing, and observing fundamental rights: • The processing of personal data is governed throughout the EU by the GDPR, underpinned by the EU Charter on Fundamental Rights, and is subject to the transparency measures in the Digital Services Act. • National and EU legislation outlines responsibilities for data controllers and processors, and rights of data subjects, require careful considerations with regards to data ownership, transparency and ethical use of datasets. • EU guidelines also protect children in the online environment, and provide guidance on the use of technology for education.	**Good** The case for EU action is strong. However, the regulatory framework already exists and the challenge is principally one of implementation and monitoring and taking action to ensure compliance in the context of DEC becoming more sophisticated and multi-faceted. The study is not proposing new regulatory action in this regard. A new DEC Framework would add value by fostering a shared understanding of ethics and fundamental rights in the use of educational tools and data and offering practical tools to strengthen transparency and to support ethically informed practice.

[442] Williamson, L. (2020) *Big Data in Education: The digital future of learning policy and practice*. UK: Sage Publications.
[443] This reflects a wider international context. For example, the 2021 *Threat Landscape Retrospective* research report by U.S cybersecurity company Tenable, Inc., found that nearly 13% of worldwide data breaches had occurred within the education sector, often causing disruption to schooling, alongside data loss.
[444] L., Livingstone, S., and Pothong, K. (2022). *Problems with data governance in UK schools: the cases of Google Classroom and ClassDojo*. Digital Futures Commission, 5Rights Foundation
[445] OECD Digital Education Outlook 2021: *Pushing the Frontiers with Artificial Intelligence, Blockchain and Robots*. OECD Publishing, Paris, https://doi.org/10.1787/589b283f-en
[446] Examples of promising practices from Member States include Ireland, where guidance on data protection is provided to educators through the GDPR4Schools website; and Luxembourg, where the National Committee for Data Protection has set up a Digital Education Working Group to raise awareness around data protection amongst children, teenagers and adults.
[447] Ecorys (2023), DEC provider survey.
[448] According to the DEC provider survey, 56% of respondents agreed that data analytics will have a 'high' impact on the future of the DEC market, both in relation to usage and content and usage performance (e.g. to optimise content searching and personalisation, and to assess content use and effectiveness).

Problem 9: Access and inclusion for learners experiencing disadvantage			
Nature of the problem	**Nature of impact**	**Strengths & opportunities**	**Case for EU level action**
DEC provides an important avenue to leverage educational inclusion, as digital content can be tailored to learners' needs and capabilities,[449] and to level the playing field for traditionally marginalised learner groups[450]. Assistive technologies can support SEND-learners to access education; multilingual digital learning resources can help migrant learners to better integrate into education systems; and support remote learning for rural or isolated learners[451]. Despite these potential benefits, Member States have seen mixed progress. Challenges include: • Poor scalability and updatability of linguistic and culturally appropriate DEC solutions[452]. • Gaps in availability and affordability of DEC to low socio-economic status (SES) learners, compounded by digital divide issues[453]. • Gaps in educator competences for adopting inclusive practices utilising DEC solutions[454].	• Fully adaptive multilingual resources and support for learners with SEND are not routinely offered / can be complex for the end user, perpetuating inclusion and attainment gaps. • Linguistic and cultural minority learners and those in remote or isolated areas are routinely under-served, posing an equity challenge for access to high quality DEC and exacerbating inclusion and attainment gaps. • While public authorities may foresee investments for social inclusion more broadly,[455] specific ring-fencing for accessible DEC is lacking[456]. This is compounded by accountability gaps and unclear roles and responsibilities[457].	The EU benefits from strong and well-established laws and policy frameworks aimed at inclusion and tackling disadvantage, which underpin production, distribution and use of DEC: • Equal opportunities and non-discrimination are horizontal principles for the implementation of EU funds under Cohesion policy. The EU Accessibility Act[458] sets overarching rules to improve the functioning of the internal market for accessible products and services. • Furthermore, the EU has adopted policies and strategies to support marginalised groups and promote inclusive education[459], while Member States have taken their own actions to address equity, accessibility and affordability issues[460] and many providers take their own steps[461].	**Good** As with ethics and fundamental rights, above, an EU framework exists to set minimum standards for inclusion more widely and accessibility in particular. The question is one of monitoring and taking action to ensure compliance. A new DEC Framework has clear added value in setting out criteria for inclusive DEC funding, governance, and usage meeting the needs of all learners, with a focus on access (content-related as well as equipment and infrastructure), and accountability (where digital divide or inclusion issues are stated but go unaddressed).

[449] European Commission, Directorate-General for Education, Youth, Sport and Culture (2021) Melstveit-Roseme, M., Day, L., Fellows, T., et al., *Enhancing learning through digital tools and practices : how digital technology in compulsory education can help promote inclusion*: *final report.* Available at: https://data.europa.eu/doi/10.2766/365846
[450] See https://unesdoc.unesco.org/ark:/48223/pf0000370936
[451] See https://op.europa.eu/en/publication-detail/-/publication/b12644c4-315c-11ec-bd8e-01aa75ed71a1
[452] Resta,P., Laferrière, T., McLaughlin, R., Kouraogo, A. (2018) *Issues and challenges related to digital equity: An overview.*
[453] Melstveit-Roseme, et. al., 2021, *op. cit.*
[454] An issue raised in the workshops, stakeholder interviews, and surveys of educators and learners.
[455] See https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Government_expenditure_on_social_protection#Expenditure_on_.27social_protection.27
[456] OECD (2023), *Shaping Digital Education: Enabling Factors for Quality, Equity and Efficiency*, OECD Publishing, Paris, https://doi.org/10.1787/bac4dc9f-en
[457] Macgilchrist, F. (2021). What is 'critical' in critical studies of edtech? Three responses. Learning, Media and Technology, 46(3), 243-249.
[458] See https://ec.europa.eu/social/main.jsp?catId=1202
[459] For example, see: *Council Recommendation of 22 May 2018 on promoting common values, inclusive education, and the European dimension of teaching*,
[460] For example, In Italy, the Ministry of Education issues annual decrees to regulate the price of educational resources (including printed, blended, and digital content). Prices are fixed by the Government at primary school level and vouchers are made available to all families for the purchase of education materials. For secondary education, price caps are established, and financial support is foreseen for disadvantaged students.
[461] DEC provider survey: over two thirds (67%) of organisations reported offering adaptive solutions for learners with SEND, with well over half offering multilingual content and services (58%).

6.1.4 Category 4: Fair and responsible use

Problem 10: Meeting obligations for copyright and intellectual property			
Nature of the problem	Nature of impact	Strengths & opportunities	Case for EU level action
Copyright and licensing arrangements for DEC present challenges to producers, facilitators and end users alike. This is a complex area, where ownership combines considerations of the author's rights, the exploitation rights of the DEC 'product', and copyrights relating to individual digital assets embedded within it (e.g. where content is aggregated from different sources). Project-based funding creates a situation where ownership rights for DEC created and hosted may be unclear after the funding has expired. This complexity has increased with the emergence of more sophisticated DEC offers, aggregating not only editorial content into proprietary platforms but also cross-media contents (e.g. sources from museums, research institutions, foundations or digital channels[462]). AI-suggested or generated content presents further challenges for copyright, where rights and responsibilities are not fully tested.	For educators, legal frameworks on copyright and licensing have a number of consequences: • Learner and teacher agency may be undermined when their intellectual property rights for DEC they have created are infringed. • Conversely, risks are encountered in the event of a legal challenge, where educators routinely use aggregated content without licensing. • Complexity and fear of litigation can disincentivise the use of DEC, despite efforts to facilitate the use of CTA in formal education and devices. • Copyright issues have a particular dimension for learners with disabilities. The Marrakesh Treaty[463] established exceptions, allowing for the adaption of copyrighted content for visually impaired learners, but there are gaps in implementation in the EU[464]. • In Higher Education, challenges are amplified by the higher levels of autonomous study. They are encountered where professors or students work with content hosted by third parties within their own LMS under different licensing conditions, or when accessing MOOCs or EdEx via external platforms.	Alongside the EU legal framework[465], some EU institutions provide practical support to educators and learners. The European Union Intellectual Property Office Observatory (EUIPO) – hosts and maintains a Frequently Asked Questions (FAQs) web page on copyright matters to navigate copyright protected content in the education and training sphere[466]. Some key stakeholders have also taken action at a Member State level, establishing advisory committees on copyright and legal aspects of education and training, or crating FAQs for institutions and learners (e.g. FR[467], FI[468]). These examples would be valuable to spotlight within the DEC framework.	**Good** There is a clear demand from key stakeholders for better information about copyright and licensing, to provide assurances about accessing and using DEC legally. This need can be supported by the EU in creating opportunities to share learning between Member States and ensuring that existing legislation is transparent and well explained. The copyright dimensions are also integral to the guidance to be provided within a new EU DEC framework.

[462] Article 14 of the EU Copyright Directive was provided as an example. The Article states that: "*reproductions of works of visual art that are in the public domain cannot be subject to copyright or related rights, unless the reproduction is an original creative work*". This was reported to have been open to interpretation, where photographs of museum collections were digitally reproduced.
[463] Refer to: https://www.wipo.int/treaties/en/ip/marrakesh/
[464] Stakeholder consultation evidence.
[465] The Directive on Copyright in the Digital Single Market (formally known as the Directive (EU) 2019/790 of the European Parliament and of the Council of 17 April 2019 on copyright and related rights in the Digital Single Market) provides an amendment to Directives 96/9/EC and 2001/29/EC.
[466] Refer to: https://euipo.europa.eu/ohimportal/en/web/observatory/faq-for-teachers
[467] In France, CFC hosts a website offering plain language information for teachers and professors to exercise their responsibilities for copyrights:
[468] In Finland, FAQs have been published on the subject of copyright for teachers and students. The aim is to empower teachers and schools and pupils to use data more freely.

6.2 EU Added Value

Overall, the problem analysis shows that there is a good case for EU level action to support Member States with their efforts to widen access to high quality DEC and to realise the potential benefits for their national education systems. While Member States have distinctive needs and characteristics, the problems discussed have a transnational dimension and are reflective of EU geographies and markets (including the operation of the EU Single Market), shared EU regulatory and policy frameworks, and EU common values.

In the following section, we consider the competence of the EU, including the roles and limits of action that might be taken. We outline the main areas of Added Value from addressing the identified problems. We then examine the extent of complementarity with existing EU policy frameworks, and synergies with existing EU policy tools and initiatives, to locate a new common DEC framework within the wider EU policy landscape.

6.2.1 Competence of the EU

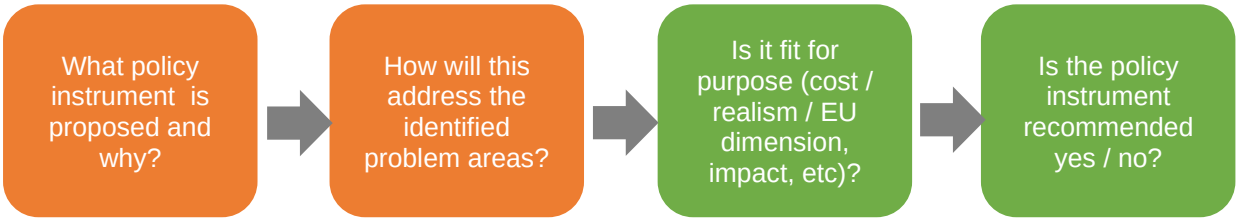
With its competence, the EU has a role to play in:

- Setting direction for DEC at a policy level (EU-level 'strategic vision').
- Incentivising EU Member States to adopt a collective response to the challenges and issues at stake
- Providing guidance to support common EU standards, principles and quality criteria, and assisting with technical standardisation.
- Providing an infrastructure for transnational collaboration and peer learning.
- Supporting innovation, evidence generation, and addressing research gaps.

The limits of EU action sit with observing the principles defined by TFEU, and specifically Article 165.1 regarding the self-determination of EU Member States for education matters. EU action should observe the principles of healthy competition within the EU Single Market and take into account the existing policies, legislation and practices undertaken by Member States and other stakeholders to support the production, distribution and use of DEC. The EU should support voluntary adoption along the lines of comparable EU initiatives (see below).

Given the technological, pedagogical, economic and legal dimensions to be considered, any policy actions initiated by the European Commission DG EAC should observe the competences of the respective European Commission Directorate-Generals where these are implicated within a new EU DEC framework (e.g. DG GROW for procurement matters, DG CNECT for digitalisation and cyber security). It is also important to maintain correspondence with the guiding principles for 'quality' in DEC that were developed in conjunction with the Stakeholder Consultation Group through the study. These include that EU level quality criteria for DEC should avoid burden, avoid censorship, maximise choice, and maximise equity and inclusion (see also Chapter 2).

6.3 Appraisal of policy instruments



In the previous sections we defined the problem areas to be addressed and examined the case for EU level action. In the following section we cross-reference the areas of action with the policy instruments that are available to the EU. The section shows that some can be discarded, others need to be linked with existing policies or initiatives, and others deserve to be developed and combined. The section concludes by signalling

the most promising instruments, indicating how they might be combined within a common EU DEC framework, and their potential contribution towards the adoption and implementation of the CRs on digital education. The figure below provides the cross-referencing, identifying which instruments might be considered as a means of addressing each problem area. This is followed by an explanation for the initial filtering of options.

Figure 16: Selection of policy instruments to address the identified problem areas

Problems to be addressed		A No action	B New EU Council Recommendation	C Market intervention	D Guidance, tools and standards	E Research and evaluation	F Open Method of Coordination (OMC)	G Incentives & utilisation of EU funds	H Policy alignment & mainstreaming
1	Consistent definitions & quality criteria	X	X	X	√	√	√	√	√
2	System complexity	X	X	X	√	√	√	√	√
3	Interoperability problems	X	X	X	√	√	√		√
4	Funding sufficiency & sustainability	X	X	X	√	√		√	√
5	Procurement fairness & transparency	X	X	X	√		√	√	
6	Data gaps & areas of shortfall	X	X	X	√	√		√	
7	Inclusive governance	X	X	X	√	√	√	√	√
8	Secure and ethical data processing	X	X	X	√	√	√		
9	Access and inclusion for all learners	X	X	X	√	√	√	√	√
10	Meeting copyright & IP obligations	X	X	X	√	√	√	√	

6.3.1 Discarded policy instruments

In the study context, it is possible to rule out a number of courses of action to allow for a more focussed exploration of the best options. These are presented in the table below, cross-referencing Figure 16 above.

Table 17 – Discarded policy instruments

A	**No action** - As there is a published commitment to an EU Digital Education Content Framework in Action 3 of the DEAP and study supports the case, the 'no action' option can be removed.
B	**A new EU Council Recommendation** – a new Recommendation would provide strategic impetus at an EU level to leverage policy action within Member States towards equity, inclusion and ethical responsibility within Europe's DEC ecosystem, accompanied with an EU monitoring framework and basket of indicators to track and report on implementation with an EU27 comparative dimension. On balance, however, the study indicates a greater need for technical, legal, economic and pedagogical guidance, alongside better data and evidence and opportunities for peer exchanges. The overall strategic direction for a new DEC framework remains anchored to the DEAP. As such, the study concludes that a new CR is not the most appropriate way to address the specific challenges and bottlenecks presented at an EU level.
C	**Market intervention** – the study tested the evidence base regarding the existence of an EU marketplace for DEC. Based on the gathered evidence, we conclude that no such marketplace exists in a way that can be defined and measured objectively with reference to existing market studies and definitions. The technical definitions of DEC implicate multiple technology markets, within which DEC is a component, but not always monetised (e.g. OERs) or apportionable within expenditure on tools or infrastructure. T he findings support the need for better data to quantify demand, to account for public expenditure, and to account for OERs. In the absence of data to objectively size the market, however, the study recommends caution in prescribing measures at an EU level to simulate a marketplace or initiating market interventions.

6.3.2 Policy instruments within scope

Having set the above options aside, the main focus resides on a combination of measures. These are presented in the table below, before going on to consider how they might be combined and turned into specific actions.

Table 18 – Policy instruments within scope

D	**Guidance, tools and standards** – a new DEC framework provides a natural orientation towards achieving EU level standardisation with informational tools and guidance. This encompasses all of the problem areas and to all extents and purposes would comprise the core of the 'framework'. The EU Added Value resides in the specificities of the guidance and toolkit, which are outlined below. The study also showed a demand for EU minimum standards and specifications for interoperability and metadata, while navigating any overlaps with ongoing work on the standardisation of learning technologies at a European level through the CEN / TC 353 initiative and the work of the European national standards bodies within Member States.
E	**Research and evaluation** - the existence of evidence gaps is apparent throughout the study. The policy options might therefore include additional research at an EU level. New or existing surveys could be used to establish an EU baseline against which to measure trends over time with regard to the role of DEC within teaching, learning and assessment. A feasibility study would help to establish what type of common data collection is feasible at a Member State level on DEC funding and expenditure, while policy studies and evaluations might delve further into topics such as school-and classroom-level strategies for different types of DEC, and professional development needs and priorities for creators, procurers and users.
F	**Open method of coordination (OMC)** - activation of effective policies among Member States would be greatly supported with continued cooperation between Member States and other key stakeholders operating in the DEC ecosystem, to navigate a complex and highly technical policy area. The options in this regard centre on peer learning, peer counselling, networks and exchanges using the OMC, at policy and practice levels, and linking with established forums such as the DELTA group and Digital Education Hub. The Stakeholder Consultation Group showed a high demand for learning from others on shared DEC challenges.
G	**Incentives and utilisation of EU funds** – there is clear potential for targeting EU funds to address evidence gaps and to pilot and scale new frameworks and practice models from the 'bottom-up'. The problem analysis showed the importance of bridging divides between providers, facilitators and end users to identify needs, problem-solve and to co-create DEC to meet diverse needs, circumstances and learning environments. EU sandboxes or testbeds for policy experimentation provide an option in this regard, fostering collective action and providing safe spaces to explore solutions to copyright, licensing, and interoperability issues.
H	**Policy alignment and mainstreaming** - the importance of inter-service cooperation shines through. DEC encompasses legal, economic, pedagogical and technological dimensions, and connections are important to maintain with the remit of other Directorate-Generals, so that the ongoing development of the framework is cognisant of regulatory and policy reforms beyond the remit of DG EAC. Equally, some of the problem areas falling within EAC's competence link closely to policies and programmes that already exist, where the embedding new DEC quality criteria is likely to prove an effective route alongside initiating new actions.

6.3.3 Specific policy options

Having conducted an appraisal of the main types of instruments available to the EU, we concluded that No action, A new EU Council Recommendation and Market intervention were non-viable options. Instead, the most promising areas for EU action reside with: Guidance, tools and standards; Research and evaluation; the Open method of coordination (OMC); Incentives and utilisation of EU funds, and Policy alignment and mainstreaming.

We now go on to present a number of more specific policy instruments under these five headings. The purpose is to make it clearer what EU intervention might look like and how it would address the problems. For each, we

consider their aims, responsibilities for implementation, the substance of the intervention, and suggestions for monitoring and evaluation.

6.3.3.1 Guidance, tools and standards

Policy option 1	DEC guidelines, toolkit and reference materials
Aims	To support key stakeholders within Europe's DEC ecosystem to create, find, select and use DEC effectively. Building on the study, the guidelines would outline a set of common definitions, key principles and quality criteria with supporting checklists for Member States to cross-reference, adapt and update to use in their work. The supporting toolkit might incorporate tailored guidance for key stakeholders, according to their market roles: • Content creators and providers (producers and distributors). • Purchasers of content and facilitators / assigners. • Content users/evaluators (teachers, students, trainers, inspectors, researchers). The toolkit could be further complemented with diagnostics (self-assessment) to facilitate benchmarking against the quality criteria, and to aid self-reflection. A standard version might incorporate PDF documents, hosted on a website and adopting a modular format so that the toolkit is updated periodically to maintain its relevance. A more advanced Web version might updatable functions (e.g. in a Wiki format), to facilitate sharing of user-generated content, supported with fact-checking, with editing functionality overseen by designated representatives for Member States and technology experts. The aim would be to strive for maximum interactivity.
Responsibilities	The resource would be maintained and curated by the European Commission with appropriate suppliers, with documents and supporting information published on a web page. This might be hosted on the existing Digital Education Hub platform. Where possible, the Commission might wish to gather user metrics, feedback, and surveys.
Overview	The guidance materials might include: • **Accepted definitions and taxonomies**, to facilitate a shared understanding of DEC, to frame policy and practice development and to support a strong EU dimension, including a clear definition of DEC, and shared terminology (Glossary). • **Quality criteria** to guide actors in creating, procuring and using DEC legally and ethically sound DEC, with supporting tools and checklists covering the whole cycle (creators, procurers / facilitators, and end users / evaluators). The work with the SCG during the study identified 11 areas for a generic set of quality criteria and these might be subdivided into criteria that apply to: **Compliance Standards/Guidelines** ○ Legal & Safety standards/guidelines for production, procurement and use. ○ Technical standards/guidelines for producing, procuring and using DEC. **Ethical Standards/Guidelines** for production, procurement and use. **Procurement Guidelines and Models** ○ Examples of what is possible and sample documentation, where possible **Evidence of Impact** ○ Examples of how DEC impact can be captured and shared ○ Learning scenarios/vignettes • **Example tools** to enhance the digital competence of key stakeholders: the creators, procurers and users. This could entail factsheets, examples of specifications and professional development frameworks, or short video-based tutorials. The existing DigCompEdu Framework (Area 2, Digital Resources) recognises this competency

Policy option 1	DEC guidelines, toolkit and reference materials
	area already for educators. Careful cross-mapping would be needed to secure appropriate alignment. Building upon a core set of materials, a more ambitious next step might include developing new modules targeted at other actors such as: Those that create DEC: **a)** Traditional publishers. **b)** New EdTech companies. **c)** Freelancers/developers. Those that procure DEC: **d)** Ministries. **e)** Regional or Municipalities. **f)** Schools or institutions. • **Case studies, evidence papers or briefings** – covering topics such as: **a)** Strategies to facilitate the use of DEC within teaching, learning and assessment, including pedagogical and didactic guidance, examples of learning scenarios. **b)** Strategies for the ethical use of data in its many forms, from commercial to technical, assessment, user feedback and learning outcomes, and metadata required to store, share and retrieve DEC learning objects or artefacts. **c)** Inclusive and effective governance and accountability models, including public-private partnerships, learning from those that are working well. **d)** Guidance on fairness, transparency, efficiency and sustainability of financing arrangements for DEC and corresponding procurement models. • **Specimen tools / protocols** developed by Member States that have proven effective within their context. For example, a small number of Member States have developed sophisticated processes to engage with the private and public sector to commission and create such content, and there is an opportunity to collect and share these approaches across the EU. This may include procurement models that: **a)** Identify different models or approaches to such competitive processes. **b)** Share sample tender documents. **c)** Share sample evaluation documentation. **d)** Share sample monitoring documentation. Member states could then use these templates to inform or create their own procurement processes. A credit-based system might be considered, to incentivise sharing and exchange and to maintain interactivity. • **Technical and legal updates and factsheets** – to improve the visibility and awareness of existing and forthcoming EU regulations and frameworks pertaining to copyright, data protection (GDPR), transparency (DSA, DMA), emerging technologies (European Approach to AI) interoperability, metadata enrichment, digitization, and rights statements. This might entail e-bulletins or alerts.
Monitoring & evaluation	To be monitored with sign-up and usage metrics, user feedback (service satisfaction), task or content-specific feedback (e.g. ratings for individual guidance or tutorials). The European Commission may also consider commissioning an independent evaluation.

Policy option 2	EU content tagging or labelling system
Aims	A feasibility exercise to establish the potential for developing a new EU content labelling or tagging system for DEC, to enhance and complement the provision of common EU definitions, quality criteria and guidelines, as well as operationalizing the key principles within the framework regarding the portability of DEC. Specifically, this would aim: • To help providers more easily catalogue and share resources. For example, common EU labels and ontological tools, to source and use DEC aligned with the

Policy option 2	EU content tagging or labelling system
	correct reading levels, age-appropriateness, skills, languages, knowledge levels, learning scenarios or environments, pedagogical use. • To help end users find, select and use the best quality DEC for specific contexts, in a more granular format, and to combine, use and re-use DEC to enhance teaching, learning and assessment, working across different EU country contexts, and different Learning Management Systems (LMS). • To identify gaps, and good practices regarding use and adaptation of DEC; develop transnational communities of practice to collaborate on content creation and sharing, and to understand improved learning experiences and outcomes.
Responsibilities	The system would be aligned with other tools and guidance developed as part of a new DEC framework package, overseen by the European Commission.
Overview	A dedicated project should be set-up to conduct the feasibility study. This should be overseen by the European Commission, convening a suitable group of legal, technological, and pedagogical experts. This project team should undertake full consultation with EU 27 designated representatives from public authorities, along with providers, academia and end users, at project inception (what do key stakeholders want from a content tagging system, and what needs are to be addressed?), and prior to finalization (which model is desirable, feasible, pragmatic and impactful?), with the aim of building consensus as far as possible. This phase of work should aim to conclude on: **1.** The technical feasibility of a new EU content tagging and labelling system. **2.** The conditions for opting in / out of such a system. **3.** The level at which it would reside. **4.** The costs associated with adaptation of publicly funded and commercial IT systems (e.g. switching to open LMS where investments have been sunk in closed systems). **5.** The costs and acceptability to providers of more comprehensive tagging and descriptors for sub-units of DEC[469]. Options could include the following, in descending order of ambition: **a)** **A dynamic EU (Global) metadata schema** for use by procurers and end users in their everyday search and selection of DEC within their context, mapped to local schema to make available unified structured DEC for all. **b)** **A centralized EU data tagging and archiving service and repository**, focused on the retrieval of content from local LOM / LMSs to make available at an EU level, e.g. using 'crosswalks' to map and convert metadata from participants. **c)** **A set of EU principles to advocate for openness and interoperability**, stopping short of metadata standardisation. The FAIR Guiding Principles[470]

[469] An interesting solution is the model deployed by Europeana for their open source cultural and heritage digital platform. To share data with 4,000 European providing institutions, a network of aggregators is deployed to collect items and related data, perform checks, and enrich with geo-location data and thematic tags.
[470] Wilkinson, M. D., Dumontier, M.; Aalbersberg, J. A. et al. (2016). The FAIR Guiding Principles for scientific data management and stewardship. Scientific Data. 3 (1): 160018.

Policy option 2	EU content tagging or labelling system
	adopted globally to facilitate improved transparency data offer a point of comparison[471]. The feasibility study would be critical to inform which (if any) of the above routes are to be taken. Ultimately, a poorly supported LOM system would offer diminishing returns, as this is contrary to the principle of the 'network effect' governing interoperability[472].
Monitoring & evaluation	To be monitored with usage metrics, user feedback (satisfaction). The European Commission may also consider commissioning an independent evaluation of the EU DEC framework, which would include policy option #2 if selected.

6.3.3.2 Research and evaluation

Policy option 3	Survey data collection or polling
Aims	A representative survey, to gather cross-national data on key stakeholder views towards and participation in the design, procurement, distribution and use of DEC in the EU27. The survey would aim to establish an EU baseline against which to measure trends over time with regard to the role of DEC within teaching, learning and assessment. It would therefore assist with addressing gaps in the evidence base regarding demand and usage of DEC. It would allow for a more current and targeted exploration of these themes than is captured periodically through longer-running studies such as TIMMS, PISA, and ICILS. It would also complement other surveys such as the EC Survey of Schools on ICT in Education (2011-2012 and 2017-2018).
Responsibilities	Overseen by the European Commission, conducted by an independent contractor.
Overview	The survey could be designed and conducted as a stand-alone exercise, providing a means of gathering data using the new definitions, quality criteria and standards for the DEC framework. Alternatively, the option of accessing panels via the Eurobarometer might be considered, whether as an ad-hoc exercise in the first instance (a 'Flash' thematic Eurobarometer), or adopting a longitudinal design to elicit data on trends.
Monitoring & evaluation	The survey constitutes a feedback mechanism of itself, and would be a means of gathering opinion-based data from large and representative EU populations. The design and sampling could be reviewed and adjusted periodically to boost response.

Policy option 4	Feasibility study on financial modelling
Aims	To undertake a feasibility or piloting exercise, to better understand what type of common data collection is feasible, useful and realistic, regarding DEC funding and expenditure at a Member State level.

[471] The model adopts the principles of findability, accessibility, interoperability, and reusability. It is widely endorsed, including (in an EU educational context) by the Association of European Research Libraries.
[472] European Commission (2023) A Vision for Educational Interoperability, *op. cit.*

Policy option 4	Feasibility study on financial modelling
	The results would aim to establish potential future data collection specifications, to estimate the sources and value of public funds invested at a Member State level in the creation and procurement of various types of DEC; strategies and organisation of responsibilities, enabling EU27 comparisons and trend monitoring.
Responsibilities	Overseen by the European Commission, conducted by an independent contractor.
Overview	This would take the form of an exploratory study or task undertaken with Ministries across the EU27, to establish the (actual and potential) availability of financial data on DEC. This could be commissioned as a stand-alone piece of work, or managed via the DELTA group. The aspirations of this policy action would be to find a route to measures (or proxies) for: What public funds are invested by Member States in the creation of DEC through approaches, such as: • Competitive tenders to create commissioned content. • Innovative DEC competitions to address gaps in provision. • Grants to public institutions to create DEC (i.e. museums, libraries, NGOs etc.). • National portal content development projects. The central availability of data on how budget is spent on procuring DEC by a range of stakeholders: • Central procurement of DEC at the national, regional or municipality level. • Grants to schools/institutions to procure DEC. • Procurement of DEC outside of school and other institutions by parents, students. The headings against which funding and expenditure might be reportable, an assessment of completeness, comparability, and areas where proxies or estimates might be possible. This would inform a subsequent secure data gathering request.
Monitoring & evaluation	The request would constitute a means of assessing data availability across the EU; better understanding and responding to gaps, and gathering statistics that may be helpful in estimating DEC expenditure as a % of spend within national budgets.

Policy option 5	Studies and evaluations
Aims	The aim of these studies and evaluations would be to collect and analyse data (including traces of use and traces of learning embedded in the DECs themselves), and thus strengthening the evidence base on digital education in terms of the acquisition, access and use of DECs in teaching and learning. This may include, but is not limited to: • School-and classroom-level strategies and implementation of different types of DEC, and on how these contents can be used to support classroom-based formative assessment, and to improve learning outcomes. • The didactic use of technology and new innovative methodologies. • DEC performance and exchange capabilities, how teacher and student data DEC is generated, stored and shared, and the possibilities and risks this presents. • Professional development needs and priorities for creators, procurers and users.

Policy option 5	Studies and evaluations
Responsibilities	To be addressed through future studies commissioned via the European Commission's multi-service frameworks, the EU networks of experts in education, JRC research, or through EU funded Research and Innovation programmes such as Horizon 2020. There could also be potential to add conditions to research calls under Erasmus+.
Overview	A range of possible formats and durations, which might include some combination of: • **Smaller controlled studies** – rapid-cycle testing and feedback on methods or pedagogies incorporating DEC where researchers engage with both learners and teachers who have direct experience in the use of digital tools and DEC to provide insight on potential impact. • **Mapping –** understanding strategies for teaching and learning with DEC across Europe's education systems; categorisation by levels of education (primary, secondary, vocational) by technology type (VR, AR, AI, Machine Learning etc.). • **Cohort studies -** systematic and longitudinal research on the use and learning experiences with DECs among students of varying profiles and school levels. • **Lived experience research –** (digital) ethnography with learners and educators. • **Evaluation framework development –** validating suitable tools and metrics.
Monitoring & evaluation	Monitoring through standard grant or consultancy reporting arrangements; transparent methods; publication and dissemination of findings from completed studies.

6.3.3.3 Open method of coordination (OMC)

Policy option 6	Support for networks and transnational exchanges between EU Member States
Aims	To provide opportunities for Member States and other key stakeholders (e.g. networks and associations) to engage and interact in relation to DEC issues; sharing knowledge, good practices, and problem-solving using the Open Method of Coordination (OMC).
Responsibilities	Coordinating responsibilities would be held by the European Commission, also utilising suppliers engaged on pre-existing policy frameworks and forums.
Overview	The OMC provides a range of potential channels for peer learning. These might include: • **Peer Counselling –** tailored country-to-country support, where Member States are actively identifying and addressing gaps in the creation and provision of DEC for specific contexts in their country or region (e.g. the VET school content in Flanders, OERs in Germany, or Generative AI content in France). This could involve peer advice from other countries grappling the same issues, with expert inputs. • **Expert Groups –** a strengthened focus on DEC within the forthcoming Mandates for the EU Expert Groups (e.g. DELTA, the EEA Working Groups), continuing exchanges initiated with members during the study period. • **EU Digital Education Hub -** the potential migration of the community of practice established during the study (the Stakeholder Consultation Group) to form a sub-group within the existing Hub, as a means of supporting longer-term engagement. A key consideration is to ensure that private sector and research institutions are part of this dialogue process, as key stakeholders for the DEC ecosystem. This might mean organising an extended consultation activity to reach additional experts and consultees, even if the activities build on the established EU Working Groups or Expert Groups.

Policy option 6	Support for networks and transnational exchanges between EU Member States
Monitoring & evaluation	Activities and learning to be monitored through regular channels established for the various Groups, e.g. minutes, flash reports and Peer Learning Activity (PLA) reports.

6.3.3.4 Utilisation of EU funds

Policy option 7	Leveraging EU funds to strengthen the EU DEC ecosystem
Aims	To build system capacity and resilience within Member States, supporting cross-sectoral and transnational partnerships; policy experimentation, accelerating the progress of solutions from testing to market, scaling-up proven adaptive learning strategies.
Responsibilities	Oversight and fund administration performed by the European Commission.
Overview	To be operationalised by issuing calls for projects through the Erasmus+, Horizon 2020 and Creative Europe programmes, and / or new EU funding conditionalities requiring clearer financial reporting within Resilience and Recovery Plans (RRPs). Alternatively, this might entail the coordination of various funds for 'DEC creation fund'. Including: • Support for cross-sectoral (public private / multi-professional) partnerships. • Professional development programmes facilitating didactic uses of technology. • Capacity building and recruitment of digital pedagogues in and around schools – coaching, privacy issues, data-driven teaching and learning. • Establishing independent peer-reviewing systems for DEC. • Multilingual and transnational content solutions; inclusive and adaptive tech for learners with special educational needs or disabilities (SEND). • Support for DEC data labs or Sandboxes, bringing stakeholders together to develop and test pedagogical or technical solutions within a safe space.
Monitoring & evaluation	Monitoring through grant reporting schemes (e.g. ESF monitoring), potential for independent evaluation of selected programmes in receipt of EU funds.

6.3.3.5 Policy alignment and mainstreaming

Policy option 8	Inter-service cooperation on emerging technologies
Aims	To undertake cooperation between EAC, other DGs and the EU Agencies on shared policy agendas intersecting with a new EU DEC framework, in the interests of establishing synergies, avoiding duplication and navigating the regulatory landscape. This work would centre on emerging technologies (e.g. AI, XR/VR), where economic, technological, legal and pedagogical requirements are evolving the most quickly and unpredictably.
Responsibilities	DG EAC, working with other relevant DGs in accordance with their areas of competence as these relate to the development of a DEC framework, including for example on procurement (DG GROW), digital policy (DG CNECT), and with the Joint Research Centre on the impact of AI and emerging technologies through its Observatory.
Overview	This might take the form of a Joint Committee or Steering Group, or more ad hoc points of engagement at key stages in the development and set-up of the DEC framework.

Policy option 8	Inter-service cooperation on emerging technologies
Monitoring & evaluation	To be managed internally, at the discretion of the European Commission.

6.3.4 Ranking the policy options

The last step for draft final reporting stage was to undertake an appraisal of the shortlisted options. A scoring framework was developed for this purpose, using Likert scale classifications to rate each option according to six criteria: 1) importance, 2) EU dimension, 3) impact, 4) costs, 5) realism, and 6) existing action. This assessment was conducted by the study team and independent experts. Feedback was then invited from the Stakeholder Consultation Group (SCG) to sense-check the options and to make suggestions for refinement. The ranking is presented below, with the scoring further detailed in Annex 7 of the Technical Report.

Table 19 – Scoring and ranking of policy options

Policy options		Options appraisal criteria[473]						
		C1	C2	C3	C4	C5	C6	Total
Rank		Importance	EU dimension	Impact	Cost effectiveness	Realism	Existing action	
#1	DEC guidelines, tools and materials	**3***	**3**	**3***	**2**	**3**	**2**	**+22**
#2	Studies and evaluations	3*	2	2*	2	3	2	+19
#2	Peer learning, networks and exchanges	3*	3	2*	2	3	1	+19
#4	Incentives and utilisation of EU funds	2*	3	3*	1	2	1	+17
#5	EU content tagging or labelling system	2*	3	3*	1	1	1	+16
#5	Survey data collection	2*	3	1*	2	3	2	+16
#7	Inter-service collaboration: emerging tech.	1*	3	1*	3	2	2	+14
#8	Feasibility study on financial modelling	1*	2	1*	3	1	3	+13

Source: Ecorys 2023

The ranking underlines the clear front-runner status (#1) for the **DEC guidelines, tools and reference materials**. Ultimately this policy measure combines the bundle of actions that were in greatest demand among key stakeholders, and which provide a mechanism for the realisation of the DEC framework. A centralised bank of guidance materials provides a means for operationalising the quality criteria, covering all stages of the DEC lifecycle and connecting key stakeholders across the system with supports for their role. The updating of these materials in a modular format and also attention to their accessibility (including language considerations) are also factors that would enhance their usability and impact, although with some trade-off for cost effectiveness.

The costs could also be adjusted to reflect the functionality – a lighter variation might see the standards, guidance and tools hosted a simpler web-based repository, whereas a full-service variation would user-led dimension (e.g. adopting Wiki principles). Key decisions would need to be taken in terms of where these

[473] An asterisk denotes that a weighting of *2 was applied to the criteria of 'importance' and 'impact'. This decision was taken on the basis that these dimensions provide the strongest results-orientation.

resources are best located, including whether the DEC framework might reside within a designated space in the existing Digital Education Hub platform, potentially realising efficiencies from existing hosting arrangements.

The options for **studies and evaluations**, and for **peer learning, networks and exchanges**, scored joint second place in the scoring and ranking process (#2). These would provide a continuum of support for the core framework – ensuring that research priorities relating to DEC receive adequate prioritisation on the one hand, and putting communities of practice on a firmer footing on the other by benefiting from the interactivity that comes from the Open Method of Coordination (OMC). This is an impactful way of keeping DEC on the agenda of Ministries and EU stakeholders through the Expert Working Groups and networks.

These options are also very scalable and relatively cost effective – budgets for studies and evaluations are already accounted for to a certain extent via the funding ring-fenced for the European Commission multiple service frameworks. Similarly, the EU already coordinates groups such as DELTA and runs policy networks, as an obvious constituency.

The **provision of incentives and utilisation of EU funds** ranks in joint fifth place (#5).This option provides the resources underpinning investment in DEC. As there is already substantial funding in the system, the option rates lower on existing action. The real added value lies in how these funds (e.g. Erasmus+, Horizon 2020, RRF) are targeted and the role that this could play in incentivising EU Member States' ambition towards DEC, mobilising cross-sectoral partnerships and stimulating innovation.

Funding conditionalities also provide a means of exerting influence over the sufficiency of budgets assigned to DEC (relative to spend on hardware and infrastructure), while pooling existing funds into a 'DEC creation fund' offers potential economies of scale. This option is affiliated with a feasibility study on financial modelling (#8) to monitor and measure investments.

The other joint fifth ranked option; the development of a potential **EU content tagging or labelling system**, performs quite a specific purpose, being the most directly targeted at the problem relating to interoperability issues. This scores very highly on Importance, EU dimension, and impact. The cost category is somewhat higher risk, given the potential magnitude of this task and its technical nature, and therefore also the degree of realism. Nonetheless, this option provides a technical solution that would not be served by the other types of policy tools.

As indicated above, a thorough technical scoping and feasibility stage would be needed with a representative group of experts, coordinating with other EU initiatives tasked with improving ICT standardisation and interoperability to avoid duplicated effort, and in close consultation with Member States to align with their needs.

The option of **inter-service collaboration on emerging technologies**, scores lower overall (#7), owing to the reliance on cooperation beyond the immediate brief for DEAP Action 3, and the fact that there is already a degree of cooperation between the EC and other EU stakeholders on this theme (e.g. the extensive consultations relating to the DSA and DMA, ai Act, and so forth). This would be recommended in any of the scenarios, because the reach and effectiveness of an EU DEC framework is highly contingent on the acceptability of common standards to key stakeholders, and their complementarity with other EU policies.

6.3.4.1 Stakeholder acceptability

The options were tested with the Stakeholder Consultation Group (SCG), to seek feedback on their importance and relevance in addressing Europe's DEC challenges. Overall, this exercise largely endorses the proposed options, and perhaps unsurprisingly so given that that the problem analysis and options formulations also drew on SCG feedback elicited during the workshops and Delphi consultations at two earlier points in the study.

The stakeholder ranking outcomes approximate, but do not precisely mirror, the outcomes from the assessment by the study team and independent experts. On balance, incentives and utilisation of EU funds was considered the most important, followed by studies and evaluations, and DEC guidelines, tools and reference materials. The options of peer learning, networks and exchanges, and EU content tagging or labelling system received a somewhat lower prioritisation. Some optimism bias might be anticipated within such a consultation exercise, regarding the need for additional investment and EU funds, where such an option is posed to stakeholders.

The stakeholder comments highlight a common thread, regarding a need for common EU definitions and guidelines to balance standardisation with flexibility, so that criteria do not impose thresholds that penalise start-ups who may require support to achieve desired levels of quality. A similar point was made regarding the need for quality criteria to acknowledge the huge variety of DEC creation and production processes that cannot be generalised. The need for evidence also shines through. Stakeholders noted that the production of high-quality DEC is contingent on high-quality research to address gaps and to inform smart commissioning decisions.

The *how* question was also viewed as critical to implementing the study recommendations. There was a central theme of 'collaboration', with stakeholders valuing continued access to networks and communities of practice as a means of developing a DEC framework. Synergies with existing EU and national policies were also considered important, as well as adequately testing *demand* for tools and products curated at an EU level. It was noted that previous investments at an EU level aspiring towards shared infrastructures for learning resources have had varying uptake, with Member States and their partners often preferring their own national initiatives. An element of ongoing co-creation was seen as one way to mitigate against this risk.

A content tagging system received mixed feedback, being perceived as necessary and transformative by some; in allowing DEC providers and users clearer about the types of content to be ordered and exchanged without miscommunication, and a riskier proposition by others; due to the associations with interference, and a perceived risk that Europe's DEC ecosystem may lack the maturity to take this direction at the present time.

6.3.5 Operationalising the policy options

A final consideration is how to combine and operationalise the favoured options. A strategic approach is needed, to set the vision for a new DEC framework and to ensure that any policy response is more than a bundle of individual interventions. This will require a combination of guidance, evidence and incentives for Member States to act within their competence to engage with an EU agenda, along with support for cooperation using the OMC.

Ultimately, new definitions and quality criteria will only address issues of coherence and consistency if they are adopted at scale by stakeholders within Europe's Digital Education Ecosystem. When determining the approach, it will be important to map and connect with other EU level initiatives that intersect with a new EU DEC framework, identifying areas of complementarity and avoiding supplication.

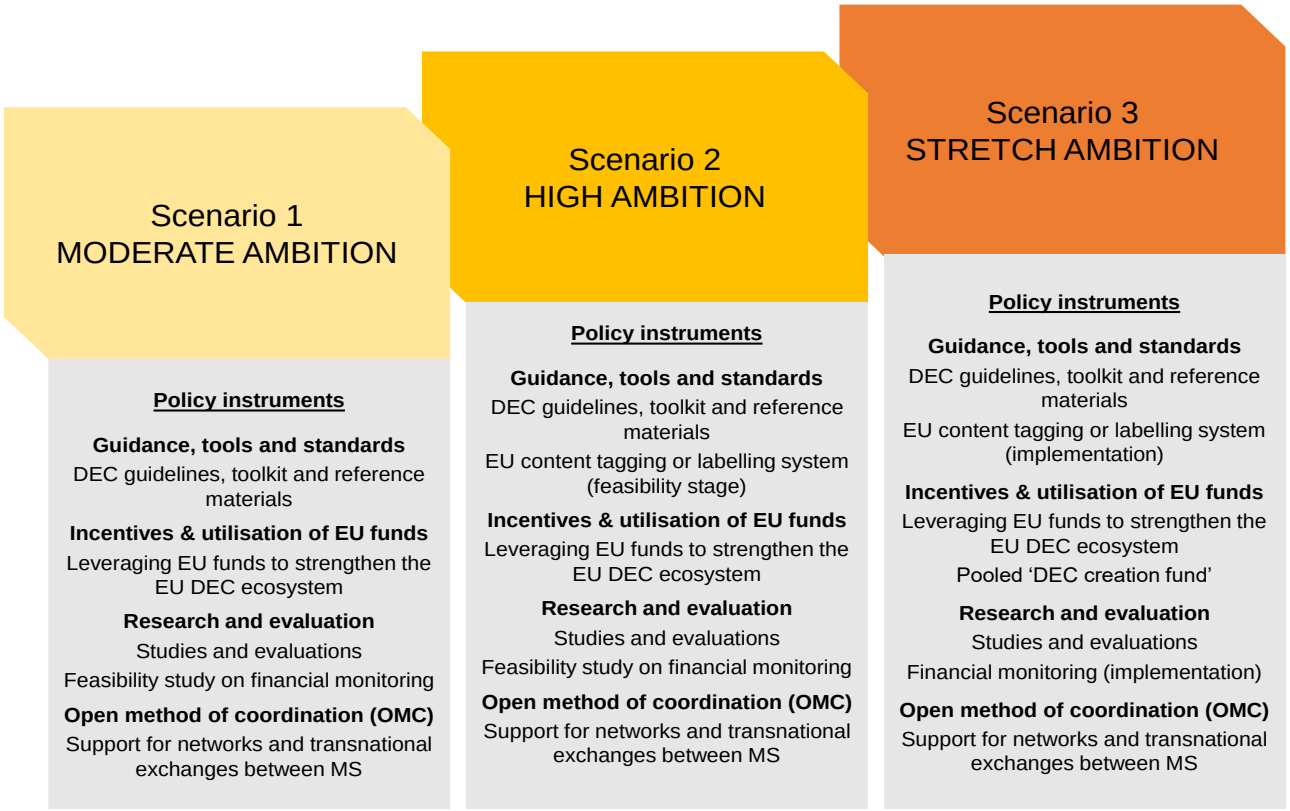
DigiCompEdu and SELFIE have an existing legacy and could provide a focal point for rolling out new DEC standards and guidelines to accelerate their take-up. The skills certification initiative (DEAP), general guidelines of the 2030 Plan, and 2040 School of the Future also represent significant EU policy initiatives shaping the digital education landscape where connections should be made.

As accountable authority, EAC will ultimately have the final say on the selection. It is beyond the scope of this study to prescribe or calculate precise costs, and indeed most of the options are scalable to at least some degree. For example, this will depend on the complexity of the toolkit, the (technical and linguistic) formats of the guidance, hosting arrangements, and the frequency of the updates; the size and number of studies and evaluations funded; the extent of collaboration that takes place between Member States and other key stakeholders, and whether or not this is managed via existing forums. The development of technical specifications would fall under the subsequent DEC framework design and implementation phase.

6.3.5.1 *Potential scenarios for EU action*

Taking these considerations into account, the figure below sets out three potential scenarios for EU action, which offer EAC a sliding scale of ambition, cost and complexity. These are summarised further below.

Figure 17: Potential scenarios for EU action



Source: Ecorys, 2023.

The three scenarios in the figure can be explained as follows:

- In the **first scenario** (moderate ambition), EAC develops a set of EU guidelines and a toolkit, working with a representative group of experts from the supply and demand side, and galvanising common standards, quality criteria, case studies and sample protocols. EU funds would be used to support cross-sectoral and transnational partnerships and policy experimentation, with a focus on the programmes (Erasmus+, Horizon 2020 and Creative Europe), and to fund studies and evaluations to strengthen the evidence base. Cooperation would centre around the DELTA working group and EU Digital Education Hub, alongside ad hoc arrangements to complete specific tasks.

  These governance arrangements would be reviewed to facilitate inputs from providers, end users and academia. At this level of ambition, EAC might also commission the work to address standardisation in financial monitoring and reporting on DEC, gathering statistics that may be helpful in estimating DEC expenditure as a % of spend within national education budgets (with funding breakdowns) alongside other key indicators of DEC maturity.

- The **second scenario** (high ambition) would be a suitable point at which to initiate a feasibility study for a new DEC tagging and labelling data infrastructure (an EU-wide taxonomy encompassing educational, pedagogical, technological, and legal structures). Subject to feasibility, this option would perform a specific function; presenting or discovering, disseminating or sharing DEC. As the CEN TC 353 framework is already in play as a mirror of the national commissions and ISO, there is good potential to

explore the production and use of metadata in the guidelines and standards, and to assess how or whether a tagging function might build on this. The actions outlined in the first scenario would also apply.

- In the **third scenario** (stretch ambition), EAC builds on the feasibility study and Impact Assessment to proceed with the development of a new DEC tagging and labelling data infrastructure. This would represent a high profile and ambitious IT project, aspiring towards a shared data language for DEC in Europe, and connecting local and global data systems to widen access to high quality, multilingual DEC for schools, educators and learners. EAC might also go beyond using the existing EU programmes to consider a new DEC Creation Fund as a catalyst for innovative DEC solutions led by Member States and their partners. This would require higher levels of investment than scenarios 1 and 2, offset with stronger leverage.

6.3.6 Summary

This chapter has presented an analysis of the problems and bottlenecks identified through the study, identifying areas for possible action by the EU and considering the case for EU action alongside the competence of Member States. It concludes that the array of problem issues encountered across Europe for the production, distribution and supply of DEC each have a transnational dimension, arising from Europe's shared Single Market and EU level policy and legal frameworks. Although EU Member States exhibit a wide range of policies and practices and demonstrate varying levels of DEC maturity, EU action is clearly needed to improve transparency, coherence, to reach agreement on shared definitions and criteria, and to boost levels of interoperability.

The appraisal of policy instruments concludes that 'no action' is non-viable, given both the clear level of need for support and guidance at an EU level, and the stated policy commitment under the DEAP. It also finds no grounds for market or legal instruments or a new CR. Instead, the analysis, backed by the evidence gathered from stakeholders throughout the study, recommends a strategic approach; combining DEC guidelines tools and standards with leverage over EU funds (incentives), research and evaluation, and support for networks and transnational exchanges under the OMC (e.g. via the DELTA Expert Group and EDEH). The chapter concludes that further exploratory work is needed before committing to standardised financial monitoring, or to the development of an EU content tagging or labelling system, which should guide the level of ambition.

7.0 Conclusions

This report has presented the findings from a study: **'Digital education content in the EU – state of play and policy options'** (EAC/02/202). In the previous chapters, we examined key definitions, introduced the concept of the DEC lifecycle and the key stakeholders and their roles and interactions at each stage. We then presented the findings from the market analysis, considered the 'state of play' in terms of governance, policy and funding across the EU, and focussed on pedagogical challenges and opportunities as well as the implications of emerging technologies. We then went on to present the findings from the problem analysis and to appraise the appropriate policy options to form the basis of an EU Digital Education Content Framework. In this final Chapter, we draw together the evidence from the study to provide an overall set of reflections.

7.1 Overall reflections

The study has explored the current landscape of DEC within the EU, lifting the lid on arrangements at European and Member State levels to understand the production, distribution and use of DEC in its many forms. It approached this task both through the lens of *geography*, with attention to challenges and opportunities that are specific to Member States and those that have a common European dimension, and *time*, by examining the DEC landscape before, during, and after the Covid-19 crisis, with attention to emerging trends.

Towards a shared vocabulary

The research has underlined the importance of a shared vocabulary and terminology for DEC, and of the need to make a diverse array of types of content accessible and usable. The literature and consultations showed that there is no widely shared definition of DEC, and that terms such as 'digital education resources' and 'digital learning materials' are often used interchangeably with the tools and technologies with which they are associated. This lack of consistency presents significant challenges in accurately defining, labelling, and therefore finding and selecting quality DEC, and in reaching a shared understanding of different types of content.

The challenge presents dimensions that are at once legal (data rights, intellectual property, safety), economic (value for money, procurement and pricing models), pedagogical (learning scenarios, competences, didactics), and technological (types and modes of content, interoperability of tools and platforms, metadata standards).

The study proposed a definition of DEC, and what it is and what it is not, and "validated" this with a broad set of stakeholders. This can facilitate a more productive dialogue across countries and sectors, as well as complementing country-specific definitions to set in place effective quality assurance, monitoring and evaluation of progress at all stages of the DEC lifecycle.

A quality framework can greatly assist EU Member States and their partners with checks and challenges to address value for money in DEC investments, avoiding substitution of content that is readily available from the market, and moving commissioning decisions towards evidence-based practice. The consultations and literature also underlined the importance of *context* when applying quality judgements. Guidance, tools, and standards are much needed to service the different needs of content creators and providers, purchasers of content and assigners, and content users/evaluators (teachers, students, trainers, inspectors, researchers).

The EU can add value by making available tools and templates and supporting Member States to complement guidelines with specimen DEC content strategies, service specifications, pedagogical tools and learning scenarios. In this way, the concept of quality is understood as combining the competences and scenarios required to activate DEC, alongside technical judgments required to assess the properties of DEC resources.

Opportunities and limits of standardisation

While showing a demand for tools and guidelines, the study also sounds a note of caution. Numerous examples were cited of efforts to produce classifications or inventories of DEC products and services during the Covid-19 crisis, which were found to be prohibitively complex and time consuming. The sheer breadth and diversity of commercial offers and the pace with which these have evolved, and the explosion of uncertified user-generated

content pose challenges in this regard. The study has shown how rapidly DEC offers have evolved in response to technological advances, personalisation and competency-based education frameworks within the EU. The rise of AI stands to be a game-changer. Viewed in this context, a DEC framework needs to be agile and adaptive, and to avoid imposing an infrastructure that risks becoming outmoded.

Nonetheless, smart forms of technical standardization are clearly needed to make DEC more findable and usable in granular and adaptive formats. The new framework provides an opportunity to tackle problems with interoperability and technical standards. The policy options in this report include a recommendation to scope how this might be achieved as a voluntary and collaborative endeavour, with regard to legacy arrangements within Member States and established local metadata schema. The report has also highlighted how a new DEC framework will need to connect with efforts that are already underway at an EU level, building on the critical infrastructure established by the Rolling Plan for ICT Standardisation, and the CEN / TC 353 initiative.

Sizing and evaluating the marketplace

From a market perspective, the report provides a strong message that better data is required to understand the supply and demand for DEC within the EU, and to assess the sufficiency, effectiveness and sustainability of funding allocated to the DEC component of public expenditure by Member States. Indeed, consistent and comparable data is lacking across Europe on the sources and volumes of funding allocated to DEC, in formats that can be disaggregated from other areas of digital education expenditure such as hardware and services, and on the demand and usage of different types of content by educators and learners.

The complexity of national procurement arrangements poses a barrier in this respect, while at an EU level, DEC remains somewhat hidden within wider budget envelopes (such as RRF) and tied to projects (such Erasmus+, Creative Europe). Adding to this complexity, data on revenues would require cooperation by providers operating within and across the Business to Business (B2B), Business to Consumer (B2C) and Business to Market (B2M) segments.

The study indicates that a collaborative effort is needed, working with public authorities, suppliers and partner organisations to conduct a stock-take and to determine what proportionate data collection arrangements might look like. Without doing so, there is no obvious means of understanding market dynamics at an EU level. This poses a risk of access and equity issues or inefficiencies within public procurements going unaddressed.

Healthy and resilient DEC ecosystems

In its overview of the state-of-play, the study found that the maturity of DEC ecosystems varies across, and even within, Member States. The report made suggestions on what countries at different stages of development may do to strengthen their systems, with these actions summarised and listed under the ‘recommendations’ section towards the end of this chapter (section 7.2.2). It also identified potential elements of high-performing DEC ecosystems and proposed a number of indicators, with the ultimate aim of supporting better outcomes for learners in primary through higher education, with a strong focus in particular on school-level developments (Annex 5).

At the same time, the analysis suggests that countries may have different aims for DEC, including how this is positioned in relation to curricula, levels of autonomy for institutions and end users, approaches to quality assurance, and relationships between the state and the private sector. While some Member States have simulated a national marketplace for DEC with active private sector engagement, others have largely abstained from such exercises, or invested more heavily in OERs.

At the current inflection point, therefore, it is important to take stock of what countries are aiming to achieve, where they are now, and the enablers and bottlenecks they have /will encounter along the way, and whether common EU data collection via surveys or studies would be helpful to support this process. This option is included among the policy options for consideration.

Technologies new, old and emerging

The report presents a juxtaposition between new and old technologies, and traditional and emerging digital education content and learning scenarios. At one level, familiar types of content are still very much at the fore in Europe - digital media (graphics, images, documents, audio and video) represent a core part of offers routinely in demand. In other respects, however, this picture masks a more rapid process of transformation. AI, along with data analytics, tops the list of technologies anticipated by DEC providers in the EU to have the most significant impact on the market in the next two years. Sophisticated blended offers are already found in education systems and classrooms in Europe, with examples ranging from AI-powered tools and dashboards to assist learner self-assessment, to speech training applications, and AI-enriched searchable repositories.

Mirroring these changes, the literature, surveys and interviews attest to the growing sophistication of DEC offers and supply chains, with widespread subcontracting, partnerships and consortia. While more traditional models and service lines were still found, providers commonly described performing multiple roles, as content developers, curators, and distributors, and providing wraparound support. The study also gave an indication of a thriving freelancing and specialist SME industry, with content authors, developers, and editors in high demand. Combined with the growth in end user generated content and OERs, this makes for a complex landscape.

Collectivism and collaboration

The study underlines that partnerships and consortia feature prominently within the DEC ecosystem in Europe. This trend reflects a diversification of DEC product lines and supply chains, and the need to achieve the requisite blends of expertise for individual educational offers. These partnerships fall into two main clusters of activity.

The first relates to the time-limited consortia that are required in the context of bidding for ring-fenced EU and national funds. The survey paints a picture of more experienced, procurement-savvy providers, who routinely engage in multiple bids for research, innovations and test beds, and newly established and smaller players who often report frustrations with their ability to access and participate cost effectively in this procurement landscape.

The ‘grants culture’ within the marketplace presents both challenges and opportunities, representing an important source of funding and a stimulus to R&D activities, while at the same time adding a layer of complexity with overlapping time-limited special projects across Europe. The study elicited feedback around the need for better and more coordinated use of EU and other funds to ensure that knowledge is shared, scaled and applied to benefit the sector, and more democratic fund administration to bring smaller players (such as SMEs), educators and end users to the table in designing and developing solutions.

A second – and distinct - area for partnership working concerns the governance arrangements for digital education within individual Member States. Providers have, to a varying degree, engaged in fora established by public authorities within the countries where they operate. However, arrangements vary considerably. There was a strong message from providers about the need for greater trust and support for the professionalization of the digital education content market from public authorities; stronger public-private partnerships that make better use of consultation with the sector to avoid duplication, and the negotiation of contracting and procurement arrangements of core service offers that reflect the need of funding stability (including multi-annual licensing).

For educators and end users also, under-representation in partnerships and forums established to govern DEC presents a challenge. The separation of supply and demand side involvement in the production distribution and use of DEC was identified as a problem area resulting in lower use and satisfaction with DEC among end users, and reproducing gaps in key competences. Good practice examples of test beds, sandboxes and other co-creation methodologies were found by the study, but are far from being the norm. The research indicated that further work is needed to learn from effective examples and to support with transfer and scaling.

Maintaining spaces for stakeholder dialogue

The mapping of DEC governance and funding arrangements, policies, curricula, pedagogies, and trends has provided not only a snapshot of the state-of-play, but has also allowed the identification of bottlenecks and enablers in different systems. It has also uncovered promising practices that may be adapted in other country contexts, and clear opportunities for “policy learning” across countries, including lessons not only from what has worked, but also what has not worked.

There was a strong appetite for this policy learning and dialogue, which should not be underestimated in the development of a DEC framework. Key stakeholders wanted clear standards and operational guidance, but also communities of practice within which to embed them. While Ministries provide a critical point of engagement within Member States, policy dialogue must also be extended to encompass stakeholders at all stages of the DEC cycle, including providers and end users.

Understanding and responding to shared challenges

The report has highlighted the complexity of the DEC ecosystem in Europe, spanning 27 EU Member States and the legal, technological, pedagogical and market complexity that this entails. Nonetheless, the problem analysis shows that many of the problems encountered have a transnational dimension and are reflective of EU geographies and markets, shared EU regulatory and policy frameworks, and EU common values. Barriers relating to low interoperability of IT systems and hardware, different technical and metadata standards, legal complexity presented to educators and end users (including copyright and licensing issues), and concerns about ethical and data protection challenges are apparent throughout the report.

Alongside the aforementioned procurement and funding challenges, equity and inclusion were also a shared area of concern. Fully adaptive multilingual resources and support for learners with SEND are not routinely offered across Europe, while relevant legislation is not always understood or implemented. This picture is combined with highly variable levels of access to multilingual resources across the EU and digital divide issues.

The uneven geography of Europe's education technology and education publishing markets further contributes towards inequity challenges, with large variations in how and where DEC is created and monetised. At the same time, these barriers have challenged funders and providers to innovate, and fostered a culture of resilience and adaptation to operate across different sub-markets and national frameworks, and to tailor offers of DEC tools and services.

7.2 Recommendations for action

The study supports the case for an EU DEC framework, and has gathered evidence and provided signposting to identify how such a framework could add value to the work of EU Member States. This clearly supports the overall DEAP priorities, and in particular Priority 1: Fostering the development of a high-performing digital education ecosystem, and Priority 2: Enhancing digital skills and competences for the digital transformation.

The timing of this study has been important to EU Member States and their partners. Following emergency remote learning at height of the Covid-19 pandemic and shift to online learning, the introduction of the CR on blended learning, the accelerating developments of AI and implications for education have all drawn attention to the need to improve the development, use and monitoring of DEC.

In this final section, we sum-up the recommended next steps to build on the study. We consider first the next steps for the European Commission, EU Member States and their partners within their areas of competence.

7.2.1 For the European Commission

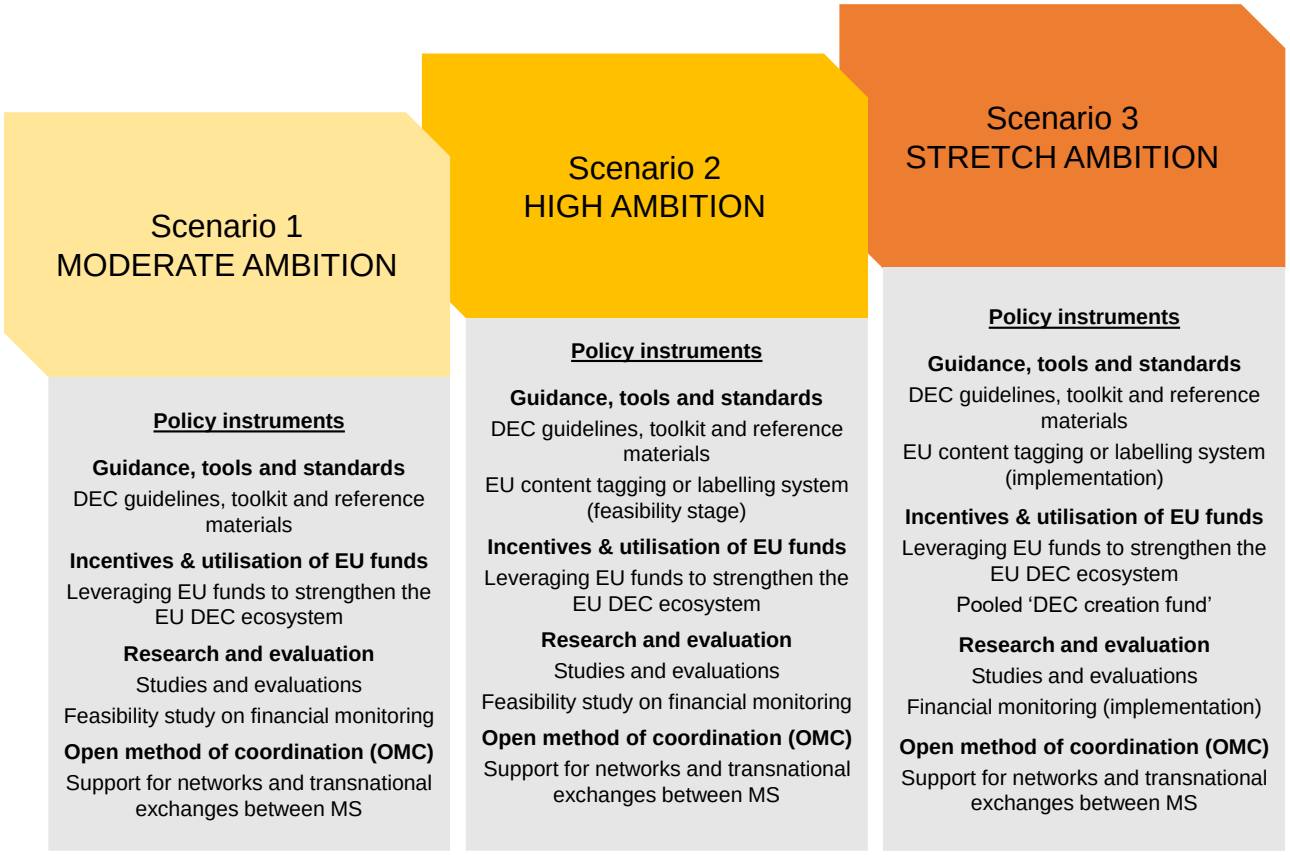
The study has considered the case for EU level action, building on an analysis of the challenges and bottlenecks encountered within Europe's DEC Ecosystem. These analyses, alongside the extensive consultations with key stakeholders during the study, demonstrate a strong case for EU intervention to address shared challenges with a transnational dimension relating to the need for high quality definitions, principles, criteria and standards for DEC that are known and understood; sustainable and coherent investment and expenditure in an ecosystem that is clear to stakeholders; an inclusive approach to the production, distribution and use of DEC, focused on end-user engagement, and the development of effective, responsible and reasoned uses of DEC across Europe

The options appraisal concludes that a strategic approach is required, beyond simply making additional funding available to Member States. It recommends that EAC should combine EU-level guidelines, tools and standards to improve clarity and coherence, with research and evaluation to address evidence gaps, while leveraging EU funds to incentivise action and stimulate innovation. It recommends making optimal use of EU networks and

exchanges to scale and embed these policy actions, including the DELTA Expert Group and EU Digital Education Hub, while making DigiCompEdu and SELFIE a focal point for rolling out new DEC standards and guidelines to accelerate their take-up. It further recommends tracking and connecting with other significant EU policy initiatives shaping the digital education landscape so that the framework remains agile and responsive.

As detailed in chapter 6, three potential scenarios are presented for EU action, which offer EAC a sliding scale of ambition. The recommendations for EAC in each scenario are summarised and explained below.

Figure 18: Potential scenarios for EU action



Box 42. Summary of scenarios for EU action

Scenario 1 (moderate ambition)

Moderate cost, moderate risk, high potential impact.

- To develop EU guidelines and a toolkit, working with a representative group of experts from the supply and demand side, and galvanising common standards, quality criteria, case studies and sample protocols.
- To utilise EU funds to support cross-sectoral and transnational partnerships and policy experimentation, with a focus on the programmes (Erasmus+, Horizon 2020 and Creative Europe).
- To fund studies and evaluations to strengthen the evidence base.
- To cooperate with the DELTA working group and EU Digital Education Hub, alongside ad hoc arrangements to complete specific tasks, and to review governance arrangements to facilitate inputs from providers, end users and academia.
- To commission a feasibility study, assessing the extent to which it is possible to improve standardisation in financial monitoring and reporting on DEC, gathering statistics that may be helpful

in estimating DEC expenditure as a % of spend within national education budgets (with funding breakdowns) alongside other key indicators of DEC maturity.

Scenario 2 (high ambition)

Medium cost, medium risk, higher potential impact.

- To implement the recommendations outlined for Scenario 1, and in addition:
- To initiate a feasibility study for a new DEC tagging and labelling data infrastructure (an EU-wide taxonomy encompassing educational, pedagogical, technological, and legal structures), as a means of presenting or discovering, disseminating or sharing DEC. This would require EAC to further:
    - Map the production and use of metadata in EU and national guidelines and standards, and assess how or whether a tagging function might build on this.
    - Scope the technical and legal specifications required.
    - Explore synergies with the CEN TC 353 framework and work mirrored at the level of the national commissions and ISO; and, subject to feasibility.
    - Conduct an EU Impact Assessment for the resulting implementation of this new initiative.

Scenario 3 (stretch ambition)

Highest cost, highest risk, highest potential impact.

- To implement the recommendations outlined for Scenarios 1 and 2, and in addition:
- To build on the feasibility study and Impact Assessment and proceed with the development of a new DEC tagging and labelling data infrastructure. This would represent a high profile and ambitious IT project, aspiring towards a shared data language for DEC in Europe, connecting local and global data systems to widen access to high quality, multilingual DEC for schools, educators and learners.
- To go beyond using the existing EU programmes and to launch a new DEC Creation Fund as a catalyst for innovative DEC solutions led by Member States and their partners.

7.2.2 For Member States and their partners

Actions to be taken by EU Member States and their partners will vary according to their level of DEC maturity, policy aims and organisation of responsibilities for DEC creation, distribution and use. Even so, a number of potential areas for DEC system strengthening are proposed, for consideration at a national level. These map to the areas identified in the problem analysis and could serve as a checklist to guide policy development.

Box 43. Areas of DEC system-strengthening for consideration by EU MS and partners

Action on educational governance

- Clarify and put in motion a strategic vision for DEC, based on extensive consultation with supply and demand side actors.
- Support cross-sectoral collaboration and public-private partnerships.
- Map roles and responsibilities across levels of education and geographical levels of decision-making responsibility, define how and by whom need is to be identified.
- Address governance on data and clear roles for all stakeholders; a universal push for cybersecurity and data rights for all children as they learn in digital environments.

Quality assurance and accountability

- Follow EU recommendations and frameworks for interoperability, metadata enrichment, digitization, rights statements.
- Monitor the implementation of EU regulation within national markets, take remedial action where EU laws and guidelines are not upheld.
- Establish robust performance management linked to public procurement exercises.
- Take coordinated action on interoperability, adoption of open standards.

Financial stability and sustainability

- Sufficiency in budgets assigned to the design, production, distribution and use of digital education content, prioritising high quality pedagogically appropriate resources.
- Funding stability and continuity; longer term commitments and robust monitoring and evaluation.
- Training and guidance to ensure best practices in the procurement and allocation of funds.
- Ensure funds are targeted to address needs of disadvantaged or under represented learners and families, including adaptive content for learners with SEND, multilingual content, digital divide.

Pedagogical alignment, recognition and validation

- Evaluate to ensure high quality educational materials, in formats best serving both students and teachers, and connected with related certifications.
- Set in place high quality guidance for schools and educators to get the best out of adaptive learning resources; strengthened teacher education and Continuing Professional Development (CPD), with attention to copyright and Intellectual Property (IP) issues.
- Map digital education content pathways, and linked with national literacy and numeracy strategies, to align content with (digital) competence development for educators and learners.
- Conduct periodic reviews of content in widespread use to identify and replace obsolete materials and technologies; continuous updating, developing, upgrading and maintaining content and related digital repository / delivery services.

Democratization, freedoms and choice

- Ensure appropriate freedoms for educational institutions to determine how DEC funds are spent, and the pedagogical application of content: how they create the learning experience, how they grade, framed by clear standards and expectations.
- Create opportunities for providers to work with schools and educators to experiment and build customer centred products; support end users to participate at all stages in the digital education content cycle.

Appendix 1: Glossary

Table A. 1 – Glossary of terms

Term / Concept	Definition
5G networks	The fifth generation of mobile network operations. It is characterised by lower latency (i.e. the delay between sending and receiving information), greater stability, and the possibility to connect more devices and share more data at once and at a faster speed. (Our definition)
Accessibility (of digital education content)	Access to resources and material in multiple formats, using platforms for collaboration, accessing tools for inquiry-based pedagogies and sophisticated online software, using applications for video conferencing or streaming, especially for disadvantaged people and minorities, and people with disabilities (European Commission, 2020)
(Teacher/Learner) Agency	Teachers' agency is shaped by their sense of purpose, and beliefs about their professional roles and entails their ability to take action or to choose what action to take in their day-to-day routine, planning and judgment. For learners, agency is a combination of choice and voice, and entails opportunities to meaningfully share their opinions and views on their education. Furthermore, both for teachers and learners, agency goes beyond empowerment in the (physical or virtual) classroom but entails opportunities to engage in policymaking related to education, including the use of digital technologies. (Our definition)
Angel investor	Angel investors are private individuals, who directly invest part of their assets in new and growing private businesses. Angel investors can invest individually or as part of a syndicate where one angel typically takes the lead role. (European Commission, 2016)
Animation	In the context of education, animations are animated images, drawings or pictures produced for the specific purpose of fostering learning. (Our definition)
Application	An application (app) is software that can be installed and operated on various electronic devices, primarily mobile or computer-based. Apps typically serve specific functions and can be native, web-based, or hybrid. They are commonly found on smartphones and tablets, often connecting to web services for data processing and storage. (European Data Protection Supervisor, 2016)
Artificial intelligence (AI)	An AI system is a machine-based system that can, for a given set of human-defined objectives, make predictions, recommendations, or decisions influencing real or virtual environments. AI systems are designed to operate with varying levels of autonomy. AI system lifecycle phases involve: i) 'design, data and models'; which is a context-dependent sequence encompassing planning and design, data collection and processing, as well as model building; ii) 'verification and validation'; iii) 'deployment'; and iv) 'operation and monitoring'. These phases often take place in an iterative manner and are not necessarily sequential. The decision to retire an AI system from operation may occur at any point during the operation and monitoring phase. (OECD, 2019)

Term / Concept	Definition
AI bias	AI (or algorithmic) bias describes systematic and repeatable errors in a computer system that create unfair outcomes, such as favouring one arbitrary group of users over others. Bias can emerge due to many factors, including but not limited to the design of the algorithm or the unintended or unanticipated use or decisions relating to the way data is coded, collected, selected or used to train the algorithm. Bias can enter into algorithmic systems as a result of pre-existing cultural, social, or institutional expectations; because of technical limitations of their design; or by being used in unanticipated contexts or by audiences who are not considered in the software's initial design. AI bias is found across platforms, including but not limited to search engine results and social media platforms, and can have impacts ranging from inadvertent privacy violations to reinforcing social biases of race, gender, sexuality, and ethnicity. (European Commission, 2020)
Augmented Reality (AR)	AR is an interactive experience where real-world environments and objects are supplemented by computer-generated 3D models and animated sequences which are displayed as if they are in a real-world environment. AR environments can employ AI techniques. (European Commission, 2022)
Authoring Systems	Systems that allow users to create their own software to edit multimedia objects. In relation to DEC, this refers to systems supporting educators to develop their own educational materials. (Nagata, S., 2017)
Auxiliary Digital Education Content	Pre-existing content, repurposed, re-animated or re-applied to support educational models. (Our definition)
Big data	Big data refers to data sets that are too large and complicated to be analysed using simple algorithms and require more complex data analytics or machine learning to understand. (NESTA 2019)
Big Tech	The largest and most influential technological companies in in the IT industry, such as Google, Apple, Amazon, and Microsoft. (Our definition)
Blended Learning	A blending of a school site and other physical environments away from the school site […]; or a blending of “different learning tools that can be digital (including online learning) and non-digital” (Council of the European Union, 2021)
Blockchain	Fundamentally, blockchain is a combination of already existing technologies that together can create networks that secure trust between people or parties who otherwise have no reason to trust one another. The marriage of these technologies gives blockchain networks key characteristics that can remove the need for trust, and therefore enable a secure transfer of value and data directly between parties. Specifically, it utilises distributed ledger technology (DLT) to store information verified by cryptography among a group of users, which is agreed through a pre-defined network protocol, often without the control of a central authority. You can think of a ledger as a record book: it records and stores all transactions between users in chronological order. Instead of one authority controlling this ledger (like a bank), an identical copy of the ledger is held by all users on the network, called nodes. Along with its own hash, each block stores the hash of the block before it. A hash is a unique string of letters and numbers created from text using a mathematical formula. Blocks are therefore “chained” together, making the ledger (almost) immutable or unable to be changed. (OECD, 2021)

Term / Concept	Definition
Bring Your Own Device (BYOD)	BYOD reflects a pragmatic response to the reality that today's students are likely to have one or more internet-connected devices available to them for their exclusive personal use (smartphone, laptop, and tablet). By allowing students to use such devices for study purposes during their attendance at school (or tertiary education institution), a one-to-one (one device per student) regime can be achieved without the need for the organisation itself to make costly investments in similar devices. (Conrads et al., 2017)
Business model	A business model is the way in which private and public sector employers structure and organise their activities. It refers, for example, to aspects such as design and production or service provision (in house, outsourced or in collaboration with other entities), innovation, internationalisation and involvement in supply chains. (Eurofound, 2021)
Business to Business (B2B)	Business-to-business or B2B is a business model where one company makes a commercial transaction with another. (Our definition)
Business to Consumer (B2C)	Business-to-consumer or B2C is a business model where one company makes a commercial transaction directly with consumers. (Our definition)
Certification of content	This is related to the establishment of quality standards for digital education content, and providing confirmation in the form of a certification that the standards have been met. (Our definition)
Chatbot	A program that communicates with people through text or voice commands in a way that mimics human-to-human conversation. In education, chatbots can be virtual advisors for learners and in the process adapt to their learning pace and so help personalise their learning. Their interactions with students can also help identify subjects with which they need help. (European Commission 2022)
Cloud-based solutions	In the context of education, cloud-based solutions are systems that allow users (e.g. learners, educators) to access learning platform and resources regardless of their location, as long as they have an internet connection. This type of solutions does not require learners to install hardware or software on their systems. (Our definition)
Cloud Computing	Cloud computing services are generally regarded as falling into three separate categories or levels: The lowest level is sometimes known as infrastructure as a service (IaaS). Here customers can rent basic computing resources such as processors and storage, and use them to run their own operating systems and applications. Platform as a service (PaaS) is the next level up and enables customers to install their own applications using a platform specified by the service provider. The highest level of cloud computing service is known as software as a service. Not only is the data stored in the cloud but the application is too, with the user requiring only a web browser. (UNESCO, 2010)
Content Management System (CMS)	Software application that streamlines the process of designing, testing, approving, and posting content on Webpages. (E-Learning Glossary, Kaplan-Leiserson)
Content parity	In the context of digital education, content parity involves the goal of ensuring that the same educational content is available and experienced consistently, across different devices and access points including mobile or desktop versions. (UK Gov, 2022)

Term / Concept	Definition
Continuing Professional Development (CPD)	In-service, formal and non-formal professional development activities, which may, for example, include subject-based and pedagogical training. (Eurydice, 2019)
Copyright	Copyright refers to a range of rights granted to authors and performers, producers and broadcasters. It includes economic rights, allowing rights-holders to control how their work and other protected material is used, and to receive payment for it. These rights normally authorise or prohibit making and distributing copies, as well as communication to the public, and are harmonised across the EU. Furthermore, it also includes moral rights, including the right to claim authorship of the work and the right to object to any derogatory action in relation to the work. (European Commission)
Core Digital Education Content	Digital content *created* with the intention of supporting educational activities. (Our definition)
Creative commons	A creative commons (CC) license is a license issued by the copyright owner to allow anyone in the world to use his or her copyright work in any manner consistent with that license. Creative Commons licenses are essentially standard form license agreements which can be attached to a work to enable its use under certain circumstances without the need to contact the author or negotiate terms of use. The Creative Commons form licenses are particularly useful for people who want to share their work as broadly as possible on the Internet. There are several types of Creative Commons licenses. Each license differs by several combinations that condition the terms of distribution. (Copyright Alliance 2023)
Creative open-source software	Software where the user creates the content. (Skolverket 2021)
Data analytics	The collection, transformation, and organization of data in order to draw conclusions, make predictions, and drive informed decision making. (Coursera, 2023)
Data controller	Any natural or legal person, public authority, agency or other body which, alone or jointly with others, determines the purposes and means of the processing of personal data. (GDPR, 2016)
Data governance	Data governance is a term used on both a macro and a micro level. On the macro level, data governance refers to the governing of cross-border data flows by countries, and hence is more precisely called international data governance. On the micro level, data governance is a data management concept concerning the capability that enables an organization to ensure that high data quality exists throughout the complete lifecycle of the data, and data controls are implemented that support business objectives. The key focus areas of data governance include data availability, usability, consistency, integrity, and sharing. It also regards establishing processes to ensure effective data management throughout the enterprise such as accountability for the adverse effects of poor data quality and ensuring that the data which an enterprise has can be used by the entire organization. (European Commission, 2020)
Data intermediaries	Mediators between those who wish to make their data available and those who seek to leverage that data. (European Parliament, 2022)
Data privacy	Data privacy or data protection means the protection of personal data. (Our definition).

Term / Concept	Definition
Data processor	Any natural or legal person, public authority, agency or other body which processes personal data on behalf of the controller. (GDPR, 2016)
Data Protection Officers (DPOs)	They ensure, in an independent manner, that an organization applies the laws protecting individuals' personal data. The designation, position and tasks of a DPO within an organization are described in Articles 37, 38 and 39 of the EU's General Data Protection Regulation. (European Parliament, 2016)
Data trusts	Data trusts provide independent, fiduciary stewardship of data by protecting, managing, and overseeing data on behalf of people. (UNICEF, 2021)
Deep learning	Deep learning techniques are part of machine learning methods and are based on artificial neural networks. They are applied in different tasks, e.g., to recognize objects in images or words in speech. In education, deep learning AI systems have the potential to predict minute aspects of educational performance which can aid in the development of strategies for personalised learning. (European Commission 2022).
Demand	Consumers' willingness or desire to purchase a product or a service on the market. (Our definition)
Demonstrative tools	Materials to support educators to explain learners how to complete a task. (Our definition)
Desktop publishing software	A software allowing users to create and design documents and materials on a personal computer. (Our definition)
Digitalisation	While digitisation commonly describes the mere conversion of analogue into digital information, the terms digital transformation and digitalisation are used interchangeably and refer to a broad concept affecting politics, business, and social issues. (Collin et al., 2015; Gimple and Röglinger, 2015; Kane et al., 2015)
Digital assessment tools	Digital tools designed to assess educators to test the knowledge and skills of learners. These can allow for data to be analysed to monitor trends and drive progress. (Our definition)
Digital commons	Digital commons specifically refer to resources such as data, information, culture, and knowledge that are generated and managed online. They are part of a broader concept of commons, which are comprehensive social institutions governing resource production and distribution through legal, socio-cultural, economic, and institutional means. Digital commons are shared in ways that avoid their enclosure and allow everyone to access and build upon them. (Dulong de Rosnay & Stalder, 2020)
Digital competence	This is defined broadly as the confident, critical and creative use of ICT to achieve goals related to work, employability, learning, leisure, inclusion and/or participation in society. (Vuorikari et al., 2022)
Digital tools	Technology used to support specific (pedagogical) aims. (European Commission, 2021)
Digital content	Digital content is content created from '*chunks'* of digital data (i.e. text, images, video, audio etc.) and they can be combined or '*chunked'* together to create digital content (i.e.

Term / Concept	Definition
	webpages, digital texts, digital movies etc.). There is a subset of this content that can be designed specifically for education (see definition of ''Core Digital Education Content above); or digital content that may not have been designed specifically for education but can be used for such purposes (see definition of 'Auxiliary Digital Education Content'' below). (Our definition).
Digital content creation	In the DigComp 2.0 framework, this is the third of five competence areas and includes four competences: to create and edit digital content in different formats; modify, improve and integrate digital information and content; understand and apply intellectual property rights and licences; produce creative expressions, media outputs and instructions for a computing system programming/coding). (Vuorikari et al., 2016)
Digital divide	The gap between individuals, households, businesses and geographic areas at different socio-economic levels with regard both to their opportunities to access information and communication technologies (ICTs) and to their use of the Internet for a wide variety of activities. (OECD, 2001)
Digital education	This entails ensuring the use of digital technologies in education and training systems to support teaching, learning and assessment, in parallel with supporting learners and educators to develop digital competencies and skills. (Our definition)
Digital Education Content	Data/material that is produced, organised, categorised, structured, distributed and presented in a way that aims to meet an educational objective, made available in a certain format and style by digital tools. (Our definition)
Digital Education Content certification	Process through which an individual or an organisation verify that digital education content has met or achieved a minimum set of technical and/or quality standards or criteria. (Our definition).
Digital Education Content ecosystem	This term comprises all stakeholders, processes, and dynamics revolving around the production, development, decision-making, procurement, and use of Digital Education Content. (Our definition)
Digital Education Content educational effectiveness	This term refers to the extent to which digital materials, resources and tools contribute to the achievement of learning outcomes. It can be use interchangeably with ''educational value''. (Our definition).
Digital Education Content governance	Refers to the roles and responsibilities of public authorities with regards to policy, regulatory, and funding decisions for DEC. It comprises of ''core governance'' (setting up policy priorities and objectives, curricula, allocating public funding, and organising the procurement, provision and dissemination of DEC), and ''peripheral DEC governance'' (to regulatory approaches to key areas of relevance for the safe use of DEC, namely copyright and licensing, privacy and data rights, interoperability, metadata, and accessibility). (Our definition)
Digital Education Content infrastructure	In the context of this study, ''DEC infrastructure'' or ''infrastructure for digital education content'' refers to platforms, services and tools to produce, distribute, and access digital content for teaching, learning and assessment. This should not be confused with general digital infrastructure, which refers to the necessary conditions (e.g. connectivity; ICT equipment; software and hardware) to be able to access the online environment, including digital learning resources. (Our definition)

Term / Concept	Definition
Digital Education Content lifecycle	A sequence of stages and sub-stages related to the design, creation, production, acquisition, distribution, use, monitoring and evaluation of digital education content. (Our definition)
Digital Education Content provider	A natural or legal person, public authority, agency or other body that develops a digital education product or service or that has a digital education products or services developed by a third party with a view to placing it on the market or putting it into service under its own name or trademark, whether for payment or free of charge. (Our definition)
Digital Education Content solution provider	A legal person, agency or other body that designs and develops custom e-learning content solutions for education providers and/or public authorities. (Our definition)
Digital equity	This involves equitable access to hardware, software and connectivity to the Internet; access to meaningful, high quality, culturally relevant content in local languages; access to creating, sharing, and exchanging digital content; access to educators who know how to use digital tools and resources; access to high-quality research on the application of digital technologies to enhance learning. (Resta et al., 2018)
Digital footprint	Traces of data left by individuals using the internet, including websites visited, emails sent, and other information shared. A digital footprint can be used to track an individual's online activities and devices. (Our definition)
Digital hardware	Any physical component of a computer system containing circuit board, ICs, or other electronics. It consists of tangible digital devices, such as computers, tablets, smartphones, and cameras, to list a few. (Our definition)
Digital instruction	Any instructional practice that effectively uses technology to strengthen a student's learning experience. (SETDA, 2019)
Digital instructional materials	These include all digitally supported learning materials from snippets of video to full-year textbooks in a digital format along with all the video, audio, text, animation, simulations, and assessments in between. (Fletcher, G., Schaffhauser, D, & Levin, D, 2012).
Digital learning games	Digital environments where the student takes part in an area of knowledge by, for example, solving various challenges and collecting points or the like. (Skolverket, 2021)
Digital learning/teaching resources	Instructional materials in digital format created to assist students and teachers in the teaching and learning process. Often these materials reside in an electronic repository or digital library for access by educator. (SETDA, 2019)
Digital learning/teaching object	A digital resource used with an educational purpose in mind. Students might use DLOs in class, face-to-face, online or in blended learning. Digital resources can include a camera, photographs online, a text, slideshows, podcasts, videos of lectures, TED talks, games or simulations. (Ministry of Education ES, 2009, Ministry of Education NZ, 2015)
Digital literacy	Digital literacy is defined by the Digital Competence framework as the ability to articulate information needs; to locate and retrieve digital data, information and content; to judge the relevance of the source and its content; and to store, manage, and organise digital data, information and content. It is the first of the five competence areas of digital

Term / Concept	Definition
	competence (i.e. being digitally literate is part of being digitally competent). (European Commission, 2020)
Digital media	Web-based products such as podcasts, film, apps, newspaper journalism and social media. (Our definition)
Digital maturity	The ability to respond, adapt, integrate and take advantage of ongoing technological developments and digital change. (Our definition)
Digital pedagogy	Digital pedagogy refers to the use of innovative digital tools and conceptual approaches. It is intended to support adaptive and personalised learning and contribute to the design of new creative modes of learning, enrichment of learning experiences and improvement of learning outcomes. UNESCO notes that digital pedagogy values open education, including open educational resources. (UNESCO, 2022, Unit of Digital Pedagogy and Learning Materials)
Digital sobriety	An approach that aims to reduce the impact of digital technology, consisting of designing more sober digital services and moderating one's daily digital uses, by moving from an instinctive or even compulsive digital world to a controlled digital world that chooses its directions: in view of the opportunities, but also in view of the risks. (The Shift Project, 2020)
Digital storytelling	Combines the art of storytelling with the use of digital tools and software to create a digital story. (Our definition).
Digital teaching aids	Online tools that can be used in educational work, and which have been developed with the intention of supporting learning activities. (Porubčinová, 2019).
Digital textbooks	Digital version of printed books.
Digital tools	Technology that can support specific (pedagogical) aims. (European Commission, 2021)
Disinformation	False or misleading information that is created, presented and disseminated for economic gain or to intentionally deceive the public and may cause public harm. (European Commission, 2020)
Drill and practice software	A software allowing learners to work learn new content or to review content, exercise and receive feedback. (Our definition)
Drill programmes	Various forms of self-correcting programmes that can be used for the purpose of rehearsing and consolidating knowledge. (Skolverket, 2021)
E-books	See the definition of ''digital textbooks'' above.
EdTech	EdTech, short for educational technology, indicates the industry that combines education and technological advances as well as the scientific field which involves the interdisciplinary knowledge informing the use of technological tools and devices, processes and procedures, resources and strategies to improve learning experiences in a variety of learning settings. (European Commission, 2020)
EdTech brokers	Intermediary actors between schools and the EdTech industry. (Our definition)
Educational apps	Mobile applications to facilitate learning. (Our definition)

Term / Concept	Definition
Educational data mining	Analysing data on learning processes, contexts and institutions. (Our definition)
Educational games	Games designed for an educational purpose, to support learners to acquire knowledge on a given subject or assist them in learning a skill through play. (Our definition)
Education platforms	A wide array of resources including: digital textbooks, learning management systems, digital tutoring systems, MOOCs, school networks, adaptive educational content platforms, and digital test platforms. (Our definition)
Educator	The operative term throughout our study to refer to teachers and trainers across all education levels. (Our definition)
Edutainment	A combination of entertainment with education. It is the technological implementation of modern forms of entertainment with educational benefits. Edutainment can be conducted in the cafe, park, museum, office, and gallery, club, where you can obtain information on any informative topic in a relaxed atmosphere. (Anikina & Yakimenko, 2014)
E-learning/online/web-enhanced resources	All forms of electronically supported teaching and learning, especially the web-based and computer-based acquisition of, and engagement with, knowledge and skills. It may take place in or out of the classroom. (Our definition)
Emerging technologies	A wide range of applications and services that take advantage of Artificial Intelligence (AI), Virtual and Augmented and Mixed Reality, wearable technology such as head mounted displays and sensors, social robotics and the Internet of Things enabled by the ultrafast 5G mobile standard. (JRC, 2020)
Exploratory learning environments	Learners are offered multiple representations that help them identify their own routes to achieving the learning goals. (Our definition)
Extended reality (XR)	XR is an umbrella term describing an existing set of immersive technologies which enhance reality and our senses by adding digital information to the real world or creating a new digital environment altogether, as well as future immersive technologies. (Ecorys, 2021)
Facilitator	In the context of DEC, facilitators are those that procure and arrange for the creation of digital education content and are in between the creators and the users. (Our definition)
Flexbooks	Digital publications that educators and students can update because they are published with open licenses. (SETDA, 2019)
Flipped Classroom	A classroom which reverses traditional instruction by delivering content that is typically taught in the classroom at home via the internet (Conrads, J., Rasmussen, M., Winters, N., Geniet, A., & Langer, L., 2017)
Formative writing assessment	Learners are provided with regular automatic feedback on their writing/assignments. (European Commission 2022)

Term / Concept	Definition
Gamification	The strategic attempt to enhance systems, services, organizations, and activities by creating similar experiences to those experienced when playing games in order to motivate and engage users. (Hamari, 2019)
GDPR	Refers to the General Data Protection Regulation, the EU's data privacy and security legislation. (Our definition)
General AI	An AI system that can do many tasks as well as a human. General AI does not yet exist and is unlikely to exist in the near future. (NESTA 2019).
Generative AI	Generative AI (GenAI) is an Artificial Intelligence (AI) technology that automatically generates content in response to prompts written in natural language conversational interfaces. Rather than simply curating existing webpages, by drawing on existing content, GenAI actually produces new content. The content can appear in formats that comprise of texts written in natural language, images (including photographs to digital paintings and cartoons), videos, music and software code. While GenAI can produce new content, it cannot generate new ideas or solutions to real-world challenges, as it does not understand real-world objects or social relations that underpin language. (UNESCO 2023).
Graphic software	A software which captures, creates, and changes images that are available on the web, e.g. for the purpose of presentations. (Negata, S., 2017)
Instructional Design	The theory and practice of designing, developing, using, managing and evaluating processes and resources for learning. The instructional design process goes beyond simply creating teaching and learning materials and it is based on carefully analysing how students learn and what content, methods and tools will most effectively help them achieve a specific set of learning outcomes. It consists of determining the needs of the learners, defining the learning outcomes and objectives of instruction, organising and planning assessment tasks, and designing teaching and learning activities to ensure the quality of instruction. (European Commission, 2020)
Interactive books	Learning resources where text is combined with multimodal and interactive functions. (Skolverket 2021)
Internet of Things	A network of interconnected physical objects (things) that are embedded with sensors, software, and other technologies so that they can connect and exchange data with other devices and systems over the internet. In education, IoT connected devices can provide learners better access to everything from learning materials to communication channels and provides teachers with the ability to measure student learning progress in real-time. (European Commission 2022)
Interoperability	Within this study, interoperability is intended as the property that facilitates unrestricted sharing and use of data or resources between disparate systems via local area networks (LANs) or wide area networks (WANs). There are two types of data interoperability - syntactic interoperability, which is a prerequisite to semantic interoperability and enables different software components to cooperate, facilitating two or more systems to communicate and exchange data; and semantic interoperability, which refers to the ability of computer systems to exchange meaningful data with unambiguous, shared meaning. (HEAVY.AI, 2022)

Term / Concept	Definition
	However, at its most basic level, interoperability means “the ability to work together with other systems or pieces of equipment”[474]. The term is also used in relation to the digital economy and here is it defined as “effective interoperability between networks, devices, applications, data repositories and services”[475].
Labelling	See definition for ‘‘tagging’’ below.
Learners	The operative term throughout our study to refer to students and pupils across all education levels. (Our definition)
Learning analytics	The measurement, collection, analysis, and reporting of data about learners and their contexts, for purposes of understanding and optimizing learning and the environments in which it occurs. (Karaoglan Yilmaz, F. G., & Yilmaz, R., 2022)
Learning environment	The operative term throughout our study to refer to classrooms, VET settings, virtual classrooms, and any type of space where formal teaching or learning is taking place, including virtual learning environments and pedagogical platforms, across all education levels. (our definition)
Learning Management System (LMS)	A web-based solution that allows lecturers and students to share instructional materials, submit course assignments, communicate with each other, and make important class announcements online. (Lohn, S., & Teasley, 2009; Ulker & Yilmaz, 2016)
Learning Object Metadata (LOM)	Learning Object Metadata (LOM) is a data model, usually encoded in XML, used to describe a learning object and similar digital resources used to support learning. The purpose of learning object metadata is to support the reusability of learning objects, to aid discoverability, and to facilitate their interoperability, usually in the context of online learning management systems (LMS). (Wikipedia)
Learning outcomes	Learning outcomes are statements of what an individual should know, understand and/or be able to do at the end of a learning process, which are defined in terms of knowledge, skills and responsibility and autonomy. (Council of the European Union, 2017)
Learning repositories	A learning object repository (LOR) typically act as repositories of educational materials aligned with the national curriculum. They often serve as the primary hub for accessing learning resources in countries with centralised education systems. These portals are commonly established as part of national initiatives to incorporate information and communication technology (ICT) in education. Funding for these portals often comes from local, national, or EU sources, with support from Ministries of Education (MoE) or local authorities. (Megalou & Kaklamanis, 2014).
Licensing	A license is an agreement through which a licensee leases the rights to a legally protected piece of intellectual property from a licensor (the entity which owns or represents the property) for use in conjunction with a product or service. (Licensing International)

[474] https://dictionary.cambridge.org/dictionary/english/interoperability
[475] https://www.jipitec.eu/issues/jipitec-8-1-2017/4531

Term / Concept	Definition
Lifelong learning	All learning activities undertaken throughout life, with the aim of improving knowledge, skills and competences, within a personal, civic, social and/or employment-related perspective. (European Commission, 2001)
Machine learning	The ability of a computer system to learn, extract patterns and change in response to new data, without the help of a human being. In education, machine learning is a form of personalised learning that is used to give each student an individualised educational experience. Learners are guided through their own learning, can follow the pace they want, and make their own decisions about what to learn based on system prompts. (European Commission 2022a)
Market	A system where supply and demand influence the production and sale of products and services. (Our definition)
Market size	The size of a market is defined by the maximum total number of sales and the resulting revenue. (Our definition)
Math problem solving software	A software supporting learners to solve mathematical problems and analyse solutions. (Our definition)
Metadata	Metadata is information used to describe, reference, contextualise or characterise a data file such as a web page, image, video, document, or file. It is data that describes data, but it isn't the data itself. (European Commission, 2022a)
Microlearning	Microlearning focuses on relatively small learning units and short-term learning activities (European Commission, 2022b). Microlearning often breaks down complex topics down into short-form, stand-alone units of study that can be viewed as many times as necessary, whenever and wherever the learner has the need. These modules target specific skills or knowledge gaps, making them particularly suitable for skills training and offering highly focused, bite-sized exercises.
Mobile learning	Mobile learning is learning that occurs in or outside of a classroom or formal education setting, is not fixed to a particular time or place, and is supported by the use of a mobile device. (UNESCO 2012).
Mobile learning apps	See definition for ‘‘educational apps’’ above.
Multilingualism	The use of a diversity of languages. (Our definition)
National curriculum	The official programmes of study issued for schools by top-level education authorities. The national curriculum may include learning content, learning objectives, attainment targets, syllabuses or assessment guidelines, and it may be published in any type or any number of official documents. In some countries, the national curriculum is contained in legal decrees. (Eurydice, 2019)
Narrow AI	An AI system that can do one human task. (NESTA 2019)
Neutral networks	Neural networks are a form of AI inspired by the structure of the human brain. They are made up of processing nodes (artificial neurons) which are connected in layers. Each node receives data from nodes above it and passes this down to nodes below it. Data has ‘weight’ attached to it by the nodes, which attribute value to the data. If the data doesn’t pass a certain threshold, it is not passed on. As an example, neural networks in

Term / Concept	Definition
	education can be used to build models of individual students in Intelligent Tutoring Systems. (NESTA 2019)
Open Education	A way of carrying out education, often using digital technologies. Its aim is to widen access and participation to everyone by removing barriers and making learning accessible, abundant, and customisable for all. (European Commission, 2016) See also definition of ''digital commons'' above.
Open Educational Resources	Teaching, learning or research materials that are in the public domain or released with intellectual property licenses that facilitate the free use, adaptation and distribution of resources. (UNESCO, 2021a)
Pedagogical use of technology	The purposeful use of technology for teaching and learning. Technologies in this context are used as means to achieve defined learning outcomes. (European Commission, 2019)
Personal data	Any information relating to an identified or identifiable natural person ('data subject'); an identifiable natural person is one who can be identified, directly or indirectly, in particular by reference to an identifier such as a name, an identification number, location data, an online identifier or to one or more factors specific to the physical, physiological, genetic, mental, economic, cultural or social identity of that natural person. (GDPR, 2016)
Platformisation	The number of connection points between students and learning that have been converted into operable data within a platform. This dimension is continuous: more points of contact, more students, and more connections between those points of contact imply increasing levels of platformisation. (UNESCO, 2021b)
Procurement (of Digital Education Content)	Acquisition and/or access of/to appropriate goods, services or works from an outside source with the best possible cost to meet the needs of the acquirer in terms of quality, quantity, time, and location. (SETDA, 2019)
Production (of Digital Education Content)	The production phase involves content creators, producers, and EdTech companies and experts. The stages of the production process include initial generation of ideas, development and testing, and creation of the final product. (Our definition)
Public-private partnership	Large-scale, cross-industry coalitions bringing together public authorities (e.g. governments, ministries, public agencies), private sector representatives (e.g. publishers, infrastructure providers), as well as education professionals to address "common educational goals". (Our definition)
Quality assurance	A process designed to achieve or maintain a high level of performance in a specific area. It involves the systematic and critical analysis of a defined area based on established policies, procedures and practices. The collection and analysis of relevant data is usually part of the process. The quality assurance process usually leads to a judgement on the level of performance attained and/or recommendations for improvement. (European Commission, 2019)
Reference software	A software which provides access to resources such as thesauruses, encyclopaedias, atlases, and/or dictionaries. (Nagata, S., 2017)

Term / Concept	Definition
Revenue	Income generated by businesses and calculated as the average sales price times the number of units sold. (Our definition)
Robots	A robot is a physical machine with sensing, computing and actuating capabilities, able to carry actions automatically. Often robots can make autonomous decisions and can adapt these decisions based on prior knowledge and sensor input. In education, most robots used are “social robots” that interact with learners (OECD, 2021). Robots in education largely fall into two categories: robots that are used to teach and enthuse children about STEM subjects, and the more recent application of robots as teachers. (Belpaeme, T. et al., 2018).
Self-regulated Learning (or Autonomous Learning)	Self-regulated and personalised learning approaches refer to the ability of a learner to prepare for his/her own learning, take the necessary steps to learn, manage and evaluate the learning and provide self-feedback and judgment, while simultaneously maintaining a high level of motivation (McLoughlin, Lee; 2010). Digital technologies are often used to support these learning approaches, e.g. learning platforms. (Conrads et al., 2017)
Semi-open resources	Open teaching, learning and research resources available to a limited group of persons. (National Study of English Learners and Digital Learning Resources, 2018)
SEND learners	Learners with special educational needs and disabilities that may require specific measures to ensure the accessibility of digital platforms, repositories, services and learning materials. (Our definition)
Serious games	Games designed for a primary purpose other than pure entertainment. (Djaouti, 2015)
Simulation programmes	Programmes that can be used to visualise a process or to build a model, for example. (Skolverket 2021)
Software	A set of instructions, data or programs used to operate computers and execute specific tasks: this tells “hardware” what to do. (Our definition)
Special needs software	Software supporting teaching, learning and assessment for students with special education needs. (Our definition)
Summative writing assessment	AI is used to evaluate and grade learners’ written work automatically. AI and machine learning techniques identify features such as word usage, grammar and sentence structure to grade and provide feedback. (European Commission 2022).
Supply	The amount of a resource, product or specific service that is available to consumers on the market. (Our definition)
Tagging	In education, tagging refers to using descriptive labels, known as tags, to provide information about an object. These tags help organize and retrieve similar items effectively. Tagging is commonly seen in social bookmarking tools and social media platforms. It can be freestyle, where users create their own tags, fostering a flexible and evolving system, or it can be constrained by predefined tags. Freestyle tagging allows for a broader representation of knowledge and enables topics to develop organically over time, free from authoritative restrictions and influenced by evolving information and social trends (Dennen, Bagdy, & Cates, 2018). Also refers to the process of adding tags to raw data, indicating to target responses to be used in a machine learning model.

Term / Concept	Definition
Terms of sale	Terms of Sales refer to agreements between buyers and sellers, covering aspects like price, quality, delivery, and special conditions, defining when the seller fulfils their obligations. Special conditions can include limitations of liability, refund policies, and intellectual property rights. (International Trade Administration, 2023)
Terms of use	Terms of Use (ToU) are essential legal agreements between a service provider and users. These terms set rules for users' behaviour, responsibilities, consequences for breaches, and include legal disclaimers, intellectual property rights, and copyright information. Users must agree to these terms before using the service. In E-commerce, the ToU on the website should be clear and explain how information on the provider, client, products and/or services will be stored. (European Commission 2023b).
Turnover	The total revenue of a company comprising of the total sales of products and services combined. (Our definition)
Tutorial software	A software allowing users to create interactive tools for others to learn. (Our definition)
User	In the context of DEC, users are those that use the content (educators, families, commercial organisations etc.) to achieve an educational outcome. (Our definition)
User-generated content	This includes content created by education end-users themselves, including learners, individual educators and/or teachers associations. (Our definition)
Utility software	A software supporting its users to manage and maintain their operating systems. (Our definition)
Venture Capital	Provision of capital by an investor to start-ups and small companies with significant growth potential. (European Commission, 2017)
Verification of digital content	The checking and confirmation of the authenticity of digital content. (Our definition)
Virtual Learning Environments (VLE)	In the most general case VLE refers to a learning situation that is supported by Internet-enabled technologies to provide tools for students to learn specific content, communicate and submit work, while providing components for an instructor to manage the learning process, collect input, and provide feedback to students. The concept is called virtual because students use computer programs and tools while working from remote locations to accomplish activities that would otherwise be done in real locations such as a school or classroom. (European Commission, 2020)
Virtual Reality	A 3D environment in which a person can become immersed, using a dedicated headset, powered by a computer, game console or smartphone. The VR experience can be enhanced thanks to 3D audio sounds and by using haptic devices that use sensors to transfer body movement into the virtual space. (Ecorys, 2016)
Voice technology/assistance	The ability of a digital device to receive, recognize, and interpret spoken commands---and carry out such commands using sound input as an interface. (Caparas, 2020)

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Appendix 2: Case study samples

Table A. 2 – DEC ecosystem in Sweden

Case study - SWEDEN
OVERVIEW
As an EU frontrunner in digital education, **Sweden hosts favourable conditions for the uptake and use of digital education content (DEC).** Digital skills levels among learners remain significantly above the EU average,[476] and access to digital resources is very high throughout the education system.[477,478] On the supply side, **Swedish EdTech constitutes a substantial market that is rapidly growing**[479]. While hardware is still the market segment with the highest value (€265 million), followed by services for administration (€85 million), services for teaching (€50 million) has seen a particularly strong growth in recent years[480]. Similarly, at policy level, attention within the Swedish education system has largely shifted away from access and hardware, to **focus on when and how digital content should be used for learning and teaching**[481]. While the National Ministry of Education and Research sets the overarching policy agenda, the 290 Swedish **municipalities have the central responsibility** of translating these objectives into sound procurement and ensure the dissemination of DEC across local schools[482]. To facilitate this process, Adda (under the Swedish Association of Local Authorities and Regions), has launched a specific **framework agreement (FWC) for digital teaching material** (as of February 2023)[483]. Standard framework agreements are also offered by the Legal, Financial and Administrative Services Agency, encompassing software and services from preschool to higher education. The digital education objectives set by the Ministry are further operationalised by the National Agency for Education and other **key national agencies that provide frameworks, capacity-building and support directly to educational institutions**. Lastly, a number of different types of content providers operate in the Swedish market. The **Swedish EdTech sector is highly diverse in terms of size**. On the one hand, 1 in 5 Swedish EdTech companies have a turnover of over €10 million (e.g. Kognity, the online teaching and learning platform with interactive content)[484]. On the other, many providers are also small; 6 out of 10 have a turnover of less than €1.5 million, and 40% have less than 5 employees[485].

[476] Education and Training Monitor. (2022). Sweden Country report. European Commission. Available here.

[477] 90% of Swedish pupils are enrolled in highly digitally equipped and connected schools at primary school level For more, please see: Eurostat. (2019). Households - level of internet access. Available here.

[478] At lower secondary school level, 93% of the students have access to a virtual learning environment at school (EU average 54%), and 99% have such access outside of schools (EU average 89%). For more, please see: Education and Training Monitor. (2020). Sweden Country Report. European Commission. Available here.

[479] Education and Training Monitor. (2020). Sweden Country Report. European Commission. Available here

[480] Swedish Edtech branchrapport (2022). Swedish Edtech Industry. Available here.

[481] National Digitalisation Strategy for the School System (2023-2027). Available here.

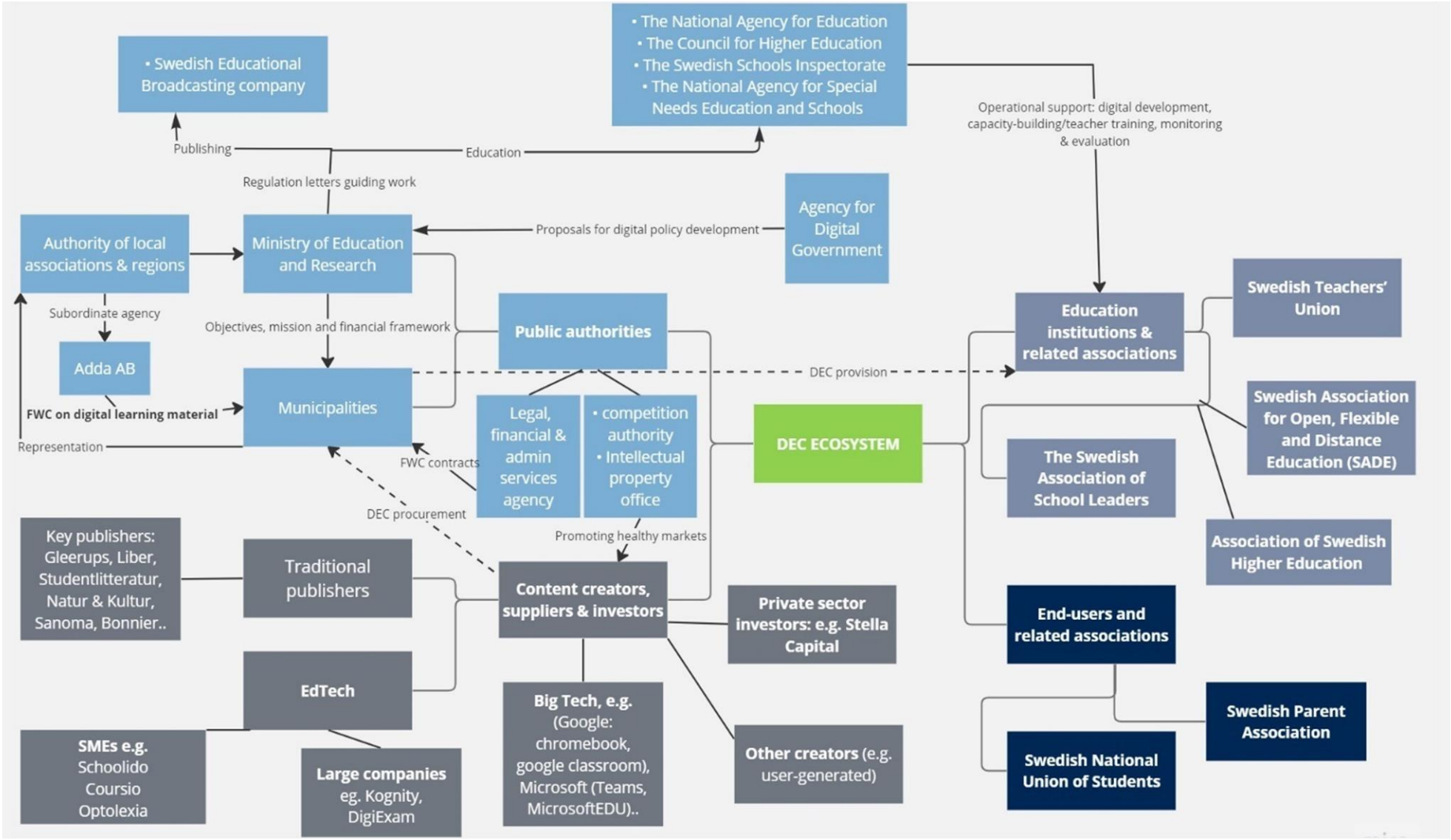
[482] Across all compulsory level schools and also, in a number of cases, upper secondary schools.

[483] https://www.adda.se/upphandling-och-ramavtal/ramavtal-och-avtalskategorier/utbildning-och-larande/

[484] https://kognity.com/

[485] Swedish-Edtech-Branschrapport-2022.pdf (swedishedtechindustry.se)

SNAPSHOT OF KEY PLAYERS IN THE DEC ECOSYSTEM



KEY CHALLENGES AND OPPORTUNITIES

STRENGTHS

- **Excellent access to digital infrastructure & tools**; high digital competence levels and a strong 'digital culture' in schools.
- As a country large in size, **Sweden has a tradition of using distance education,** especially in HE (pre- COVID).
- **Digital content generally has a high standard due to**: competent and proficient publishing houses; publishers often collaborating with skilled writers (typically teachers); teachers having agency in choosing resources; publishers have adapted well to digital education.
- **Healthy competition in the DEC marketplace,** with a diverse range of actors, leading to lower prices and higher quality products/services.
- **High autonomy of teachers:** In some municipalities, technical solutions allow teachers to choose the DEC they use in the classroom. (e.g. Skolon, interactive webshop of Gothenburg region). Autonomy and (relatively high) competences allow teachers to choose resources based on needs.
- Strong role of **intermediary agencies**, including the national agency for education, can be further leveraged to help guide teachers and other stakeholders in selecting appropriate, high-quality DEC.
- Possibility to build on existing initiatives (e.g. **Edtech Testbeds)** to bring teachers, developers and researchers together in driving innovation.

DRAWBACKS

- **Lack of systemic regulation and quality control for DEC**
- **Insufficient scientific evidence** regarding 'what works' and when. As a result, DEC is being questioned at both policy and school levels.
- **Lack of common standards.** Third party services often require teachers and students to use their own authentication and login credentials. Competing standards turn some schools and teachers away from using digital tools.
- **Suppliers sometimes also attempt to "lock-in" in their products/services in schools**, making other solutions incompatible. Municipalities/ schools may not be able to prevent this as they lack the knowledge/purchasing power and size.
- **Procurement of DEC require substantial administrative resources** in order to comply with national procurement rules and European legislation (e.g. GDPR). This is an issue especially for smaller municipalities.
- **Insufficient competition among digital platforms.** There are only 5-6 leading platforms, with financial and legal risks associated with developing DEC discouraging small players/start-ups.

KEY MESSAGES

1. **New regulation may be beneficial to ensure the equal and effective uptake of DEC**. Procurement processes vary across municipalities and schools, with a need for a clearer distribution of responsibility, while ensuring involvement and influence of end-users. Regulation may also make purchases of DEC conditional on its proven effectiveness and ensuring the rights of the procurement party to influence standard setting required by the provider.
2. **Expand practical research and testing of DEC in learning environments.** The current lack of scientific evidence on what work means DEC is being questioned at both policy and school levels.
3. **Teachers in Sweden would likely benefit from a narrower selection of quality DEC resources,** as it would help teachers to better navigate the vast DEC and ensure that only services of serious providers are used.
4. **Smaller municipalities may need more support and guidance,** as they are more vulnerable when negotiating procurement agreements with providers that may supply them with "lock-in" solutions. Smaller municipalities may also need additional support in view of the adoption of the common standard SS12000:2020 which will be required for the digital national tests that will be introduced in 2024.
5. **Provide guidelines on how to best harness data analytics**. Already today, solutions are available that only collect anonymous data of students and teachers that would allow for insights from big data analytics. Knowledge generated from this may be used to make education services more relevant and tailored, while promoting improved teaching methods and learning outcomes.

Source: Ecorys, 2023.

Table A. 3 - DEC ecosystem in France

Case study - FRANCE

OVERVIEW

France is a strong performer in the DEC landscape, with digital resources being included across policy and funding strategies. The Digital Education Strategy 2023-2027[486] includes priority interventions directly linked to on DEC, including the creation of **a digital education content pass or voucher for teachers** (compte ressources), with the objective to promote teachers' autonomy in the selection, purchase and use of DEC[487]. In terms of digital skills, **France performs above the EU average for basic and above basic digital skills, as well as for digital content creation skills,** while digital connectivity, despite improvements, presents some shortcomings in relation to the roll-out of fibre and broadband to all households[488].

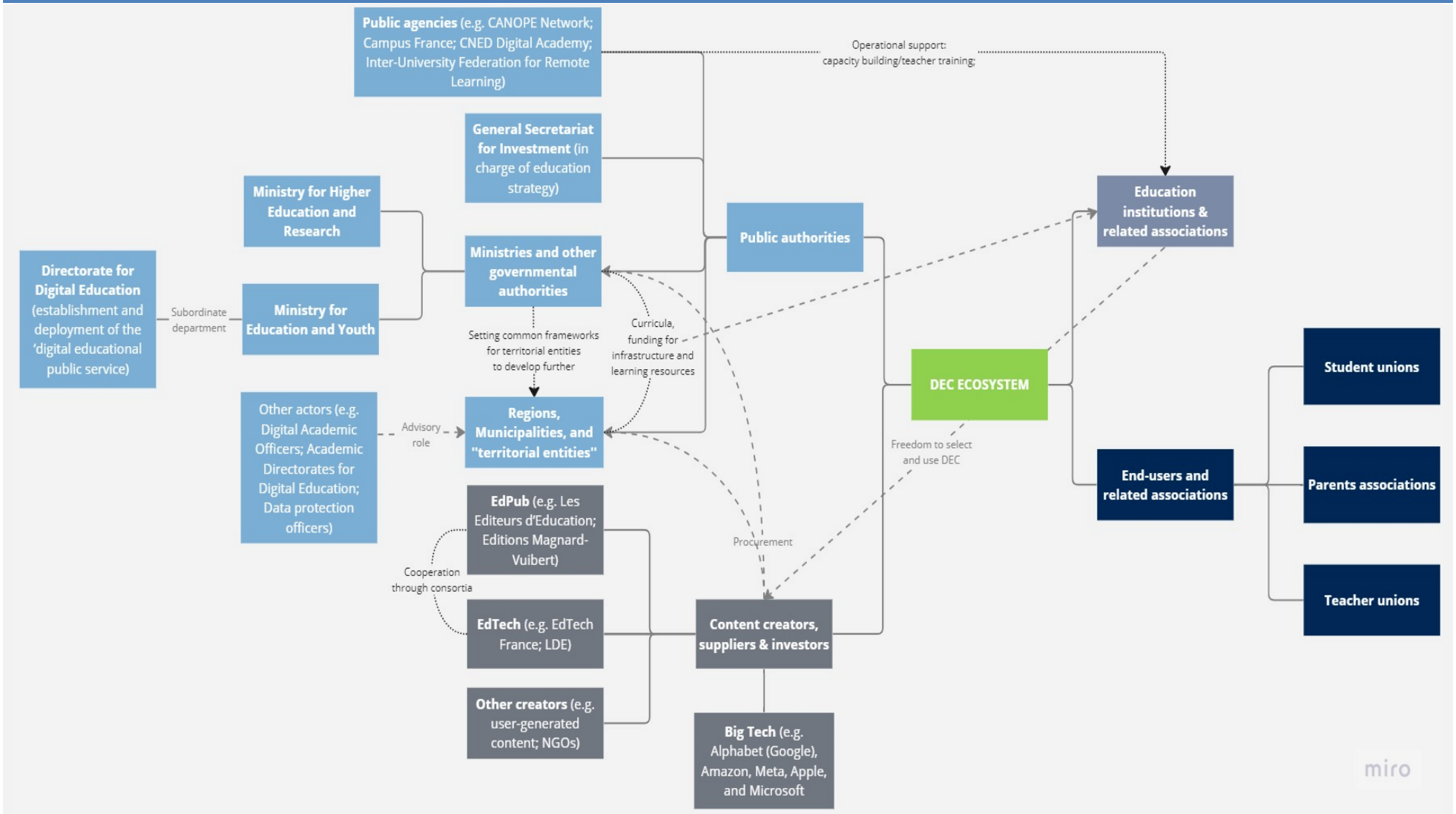
While ministries provide overarching strategies and policy frameworks, **responsibility for curricula, funding for infrastructure and the purchase of learning resources, as well as public procurement, is split between the State and ''territorial entities''** (i.e. local and regional authorities, as well as education institutions), depending on the level of education[489]. Public procurement sees the active participation of EdTech and EdPub companies, often cooperating through consortia. Procurement usually entails 3-year contracts, renewable for another two. Resources then are either taken down or become accessible through the payment of a fee. French authorities have been exploring new public procurement models and ways to enhance teachers' agency. For example, through the Innovation Partnerships for AI,[490] a competition for the creation of DEC to support French and Mathematics teachers was launched: several consortia were allowed to move through the different stages, each focused on further tailoring their offer. The system allowed for several companies to be selected as suppliers.[491] Furthermore, the upcoming 'compte ressources' will allow educators to purchase their own resources (within a certain amount),[492] avoiding procurement.

Lastly, **the EdTech sector is relatively well developed in France**, with its 500 companies, 13% of which are exclusively dedicated to education[493]. Many providers are rather small, with 60% of companies having 10 employees or less, and record a turnover of less than EUR 500.000[494]. Some companies, however, stand out as big market players: for example, LDE[495], a company with a long history in the sector, recorded a EUR 70 million turnover in 2020. There is also **strong State support for EdTech companies**: not only more than 45% of EdTech companies received public funding,[496] but support for the EdTech industry is also foreseen within policy strategies[497].

The figure below provides a snapshot of the current French DEC ecosystem.

[486] Minsitère de l'Education et de la Jeunesse (2023), 'Numérique l'éducation 2023-2027 pour La vision stratégique d'une politique publique partagée'
[487] Ministère de l'Education et de la Jeunesse (2023), 'Numérique l'éducation 2023-2027 pour La vision stratégique d'une politique publique partagée',)
[488] https://digital-strategy.ec.europa.eu/en/policies/desi-france
[489] 'Organisation and governance', Eurydice, available at: https://eurydice.eacea.ec.europa.eu/national-education-systems/france/organisation-and-governance
[490] https://primabord.eduscol.education.fr/partenariat-d-innovation-et-intelligence-artificielle-p2ia
[491] https://eduscol.education.fr/1911/l-intelligence-artificielle-pour-accompagner-les-apprentissages-des-fondamentaux-au-cycle-2
[492] Ministère de l'Education et de la Jeunesse (2023), 'Numérique l'éducation 2023-2027 pour La vision stratégique d'une politique publique partagée', p.25.
[493] 'L'innovation au service de l'enseignement scolaire : Annonces des premiers lauréats Ed Tech de France 2030', Secrétariat Général pour l'Investissement website, Available at : https://www.gouvernement.fr/l-innovation-au-service-de-l-enseignement-scolaire-annonces-des-premiers-laureats-ed-tech-de-france#:~:text=Dot%C3%A9e%20de%20594%20millions%20d,au%20long%20de%20la%20vie.
[494] J. Fabry, 'Etude filière Edtech 2021 : l'année du milliard, enjeux et perspectives d'une accélération inédite'.
[495] LDE (2022), 'A short presentation of LDE, our products, our aim', European Commission.
[496] J. Fabry (2022), 'Etude filière Edtech 2021 : l'année du milliard, enjeux et perspectives d'une accélération inédite', EY Parthenon
[497] For example, see '(Dossier) Numérique éducatif rentrée 2022 : état des lieux des projets en cours et des nouvelles initiative', Agence Nationale de la Cohésion des Territoires, Labo Société Numérique.

SNAPSHOT OF KEY PLAYERS IN THE DEC ECOSYSTEM



KEY CHALLENGES AND OPPORTUNITIES

STRENGTHS

- **Strong institutional support** both in terms of policy and funding has been crucial to continue to invest in DEC and digital education, and creating a thriving DEC ecosystem. This has resulted in innovative policy and procurement solutions (e.g. *compte ressources* and Innovation Partnerships).
- **Rich DEC offer**: France's DEC supply is characterised by a diverse and tailored offer, developed bottom up. This offer was developed in response to un-met needs of teachers who were keen on using digital education content but could not find in the existing market any solutions that would respond to these needs. This however can result in difficulties in scaling up/re-using resources in other contexts.
- Linked to the above**, a wide range of public and private providers** not only results in a large DEC offer but also acts as a stimulus for innovation.
- **Teachers' involvement in developing DEC solutions is a key success factor** to their being adapted to the needs of the users. Stakeholders on the demand-side went further and considered this involvement a necessary condition to the development of quality solutions. This could potentially open up opportunities to involve students and their families in co-creation, to overcome potential mismatches between the needs of families, students teachers. However, teachers' involvement is often dependent on their own interest (i.e. outside of normal work hours), without formal recognition.
- **Great enthusiasm from key stakeholders** (teachers, students, families) for the integration of digital education solutions in teaching, learning and assessment.

DRAWBACKS

- **Differing needs**, as enthusiasm among stakeholders does not necessarily translate into high take up, due to a mismatch between what teachers want (e.g. home study support) and what parents are after (principally access to information about their children's progress).
- **Low readability of the market:** teachers find it difficult to understand what solutions are available for them and what their comparative advantages are, in particular in relation to their specific needs. This results in teachers either missing on using solutions that could have responded to their needs or teachers re-inventing solutions that already existed elsewhere but that they were not made aware of. In addition, in the absence of a central platform which would host or map content, it is difficult for potential users to know what is available and what could meet their needs
- **Mismatch** between available resources (content), provision of adequate support (training) and infrastructure (hardware).
- **Heterogeneity and complexity of purchasing models,** with traditional procurement benefitting larger players with the needed technical know-how, and affecting resource accessibility due to 3+2 contract formula.

KEY MESSAGES

1. **Addressing the current perceived mismatch between end-users' needs and the DEC offer**, which results in lower use rates, through the establishment of needs assessments to assess the extent to which the use of digital education content is desirable and relevant in a given content. Such needs assessments would ensure better alignment between supply and demand's real needs.
2. **Better recognition of teachers' crucial role in the development of DEC** and ensuring their involvement does not result in a high cost in (personal) time and/or resources, making co-creation unsustainable, and it is better structured, formalized and recognized.
3. **Improved public procurement procedures** that allow for fair competition, paired with increased guidance to understand relevant regulatory frameworks (e.g. GDPR, public procurement rules). This would allow smaller players, who are closer to the ground and therefore might be better positioned to develop solutions relevant to the specific needs of teachers and families to have a fair chance in public procurement processes.
4. **Continued investment in infrastructure and teachers' training** as key conditions for the uptake and development of DEC.

Source: Ecorys, 2023.

Table A. 4 – DEC ecosystem in Germany

Case study - GERMANY

OVERVIEW

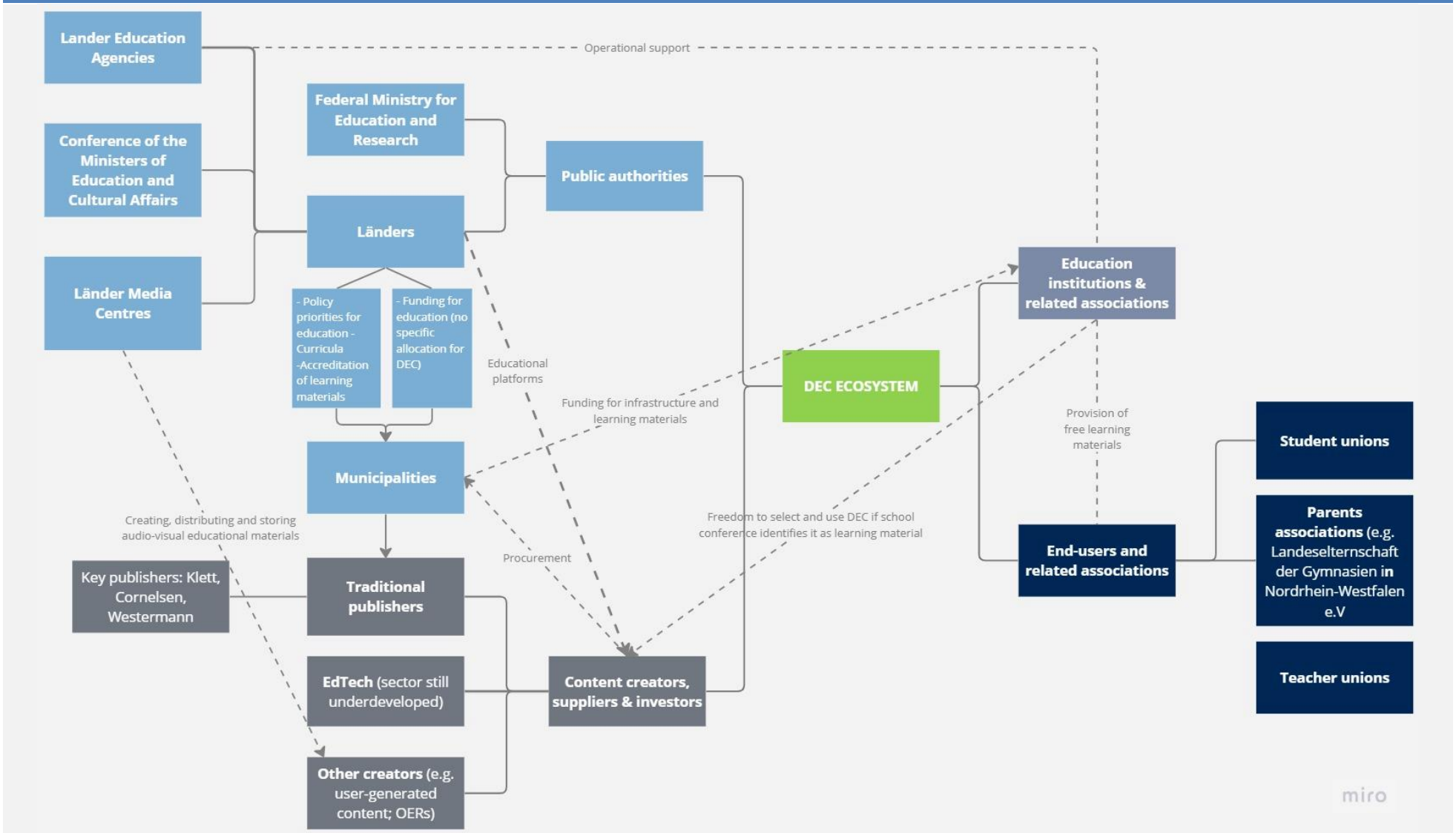
Germany has made some positive progress towards the digital transformation over the past few years, overall performing well on connectivity, and showing a renewed push towards digitalisation within policy making and funding. The 2016 'Education in a digital world' strategy was updated in 2021 to include new recommendations on 'teaching and learning in a digital world' at the end of 2021[498]. Furthermore The 2021 Digital Pact for Schools (DigitalPakt Schule)[499] provides over EUR 2 billion to be invested in building digital infrastructure and supporting the digital transformation in education institutions[500]. The federal government and the Landers will invest EUR 5 billion in the implementation of the Pact between 2019 and 2024. Furthermore, the digitalisation of education feature as a key priority area within Germany's National Recovery and Resilience Plan (NRRP), with **EUR 630 million to be invested in a new national education platform on digital learning**, bringing together all existing platforms in the country[501]. **Furthermore, a national strategy to promote Open Educational Resources (OER)**[502] was launched. Despite this progress towards digitalisation, however, data from 2022 shows that level of basic digital skills and basic digital content creation skills in Germany is slightly below the EU average[503].

While the Federal Ministry for Education and Research sets the overarching policy agenda**, it is the Landers that ultimately hold decisional power over education priorities and objectives**, curricula, and funding across levels of education, with municipalities being responsible for translating priorities into procurement and providing learning materials to schools. As such, the German education system is highly decentralised, resulting in different approaches to education, including digital education content.[504] Nevertheless**, public procurement is still focused on printed textbooks**, with traditional publishers jointly controlling more than 90% of the schoolbook market,[505] albeit investments in digital education and the policy focus on OERs are acting as a stimulus for education institutions and teachers to rely more on digital resources. Municipalities procure learning materials on the basis of a pre-approved list by the respective Lander,[506] and these are provided for free to students. **DEC can only be purchased if classified as learning material by schools**, and therefore its use may vary from institution to institution. However, digital version of printed textbooks are available, and provides digital add-ons, with **educators having high autonomy in deciding what learning materials to use**, including digital resources. Furthermore, public institutions such as media centres at Lander level also produce audiovisual and digital resources for educational purposes.

The figure below provides a snapshot of the current German DEC ecosystem.

[498] https://op.europa.eu/webpub/eac/education-and-training-monitor-2022/en/country-reports/germany.html
[499] https://www.digitalpaktschule.de/index.html
[500] Digital Economy and Society Index (DESI) 2022, Germany country report. Available at: https://digital-strategy.ec.europa.eu/en/policies/desi-germany
[501] https://commission.europa.eu/business-economy-euro/economic-recovery/recovery-and-resilience-facility/germanys-recovery-and-resilience-plan_en
[502] https://www.bmbf.de/SharedDocs/Publikationen/de/bmbf/3/691288_OER-Strategie.pdf?__blob=publicationFile&v=6
[503] Digital Economy and Society Index (DESI) 2022, Germany country report. Available at: https://digital-strategy.ec.europa.eu/en/policies/desi-germany
[504] https://www.bildungsserver.de/lehrplaene-400-de.html
[505] Dobusch, L., 2012: Digitale Lehrmittelfreiheit: Mehr als digitale Schulbücher; D64 White Paper. https://dobusch.net/pub/pol/White-Paper-DigitaleLehrmittelfreiheit-D64.pdf. See also: Wagner, M., & Hertling, A. (2023). Lizenzmodelle für digitale Schulbücher in wissenschaftlichen Bibliotheken: Ergebnisse und Perspektiven einer Markt und Bedarfsanalyse. *O-Bib. Das Offene Bibliotheksjournal / Herausgeber VDB*, *10*(1), 1–16. https://doi.org/10.5282/o-bib/5897
[506] For an overview of approved schoolbooks, see: https://www.bildungsserver.de/zugelassene-lernmittel-und-schulbuecher-522-de.html.

SNAPSHOT OF KEY PLAYERS IN THE DEC ECOSYSTEM



KEY CHALLENGES AND OPPORTUNITIES

STRENGTHS

- **Current policy and funding focus on the digital transformation in education has provided new impetus for digital learning**, including the use of digital resources. This has also resulted **increased awareness among teachers and learners, particularly of OERs**.
- **Good levels of infrastructure and connectivity,** including 5G and fibre, which are crucial to support the use of digital technologies in education.
- **Good level of diversity of DEC offer with both** commercial (mostly traditional publishers) and non-commercial providers offering a wide range of high-quality and legally secure digital educational resources based on the specific curricula needs of each Lander; as well as increased availability of OERs.
- **Availability of resources on public platforms,** with each Lander having its own online portal for digital educational resources.
- **Quality assurance processes are in place** to certify learning materials, albeit the focus is on technical standards rather than the quality of the content as such.
- **Possibility to further build on national initiatives (e.g. Digital Pact for Schools)** to ensure sustainable financing, establish more efficient procurement structures, promote knowledge sharing among teachers through communities of practice, and invest in teacher training.

DRAWBACKS

- **Regional disparities remain high with regards to access to equipment and connectivity.** This, paired with high dependence on individual teachers and/or schools for the take up of DEC can affect the use of digital learning resources.
- **The variety of the offers and providers** can be disorientating, including due to the current lack of guidance and **insufficient teacher training.**
- **Existing scepticism towards DEC.** While awareness of DEC is increasing, schools still heavily rely on printed textbooks as these match curricula directly, while DEC is perceived more as an add on.
- **Quality assurance processes are limited to compliance with technical standards** (accessibility, data protection, interoperability) but do not indicate whether digital learning resources are suitable to achieve education objectives.
- **Providers struggle with procurement processes,** which result in administrative burden and require qualified personnel, **and lack of funding for** DEC creators, which may put smaller players at a disadvantage in the market.
- **Lack of coordination among different online portals**, resulting in teachers relying more on search engines to find suitable digital resources.
- **Tight budgets for learning materials,** with textbooks (printed and/or digital) often taking up the vast majority of funding.
- **Widespread data privacy and copyright concerns** due to strict national level regulations that affect teachers' willingness to engage with DEC.

KEY MESSAGES

1. **Decentralisation in the German education system, and differing approaches across education levels mean that overarching solutions for a DEC ecosystem would not necessarily be effective.** While national standards and guidance on how DEC can contribute to the achievement of educational objectives would be helpful, concrete solutions for the uptake and development of DEC must be fostered at the regional and local level, and by level of education.
2. **Protecting school and teacher autonomy is crucial**. Education is considered a public good, which is reflected, for example, in the principle of freedom of learning materials (Lernmittelfreiheit, often enshrined in law) and the growing importance of OERs. **Greater investment in teacher training is therefore necessary,** with the possibility of including the use of digital media as a compulsory part of teacher training possibly being considered.
3. **Ensure greater interoperability** to connect different systems and portals, through the establishment of a national educational platform.
4. **Need for more and better cooperation** between the federal states, as well as exchanges and networking between schools, teachers, parents and students to encourage exchange of good practices on DEC usage.
5. **Guidance on how and which type of DEC can contribute to achieving individual learning objectives** could provide a helpful tool for educators and schools to increase their understanding of and trust in digital resources.

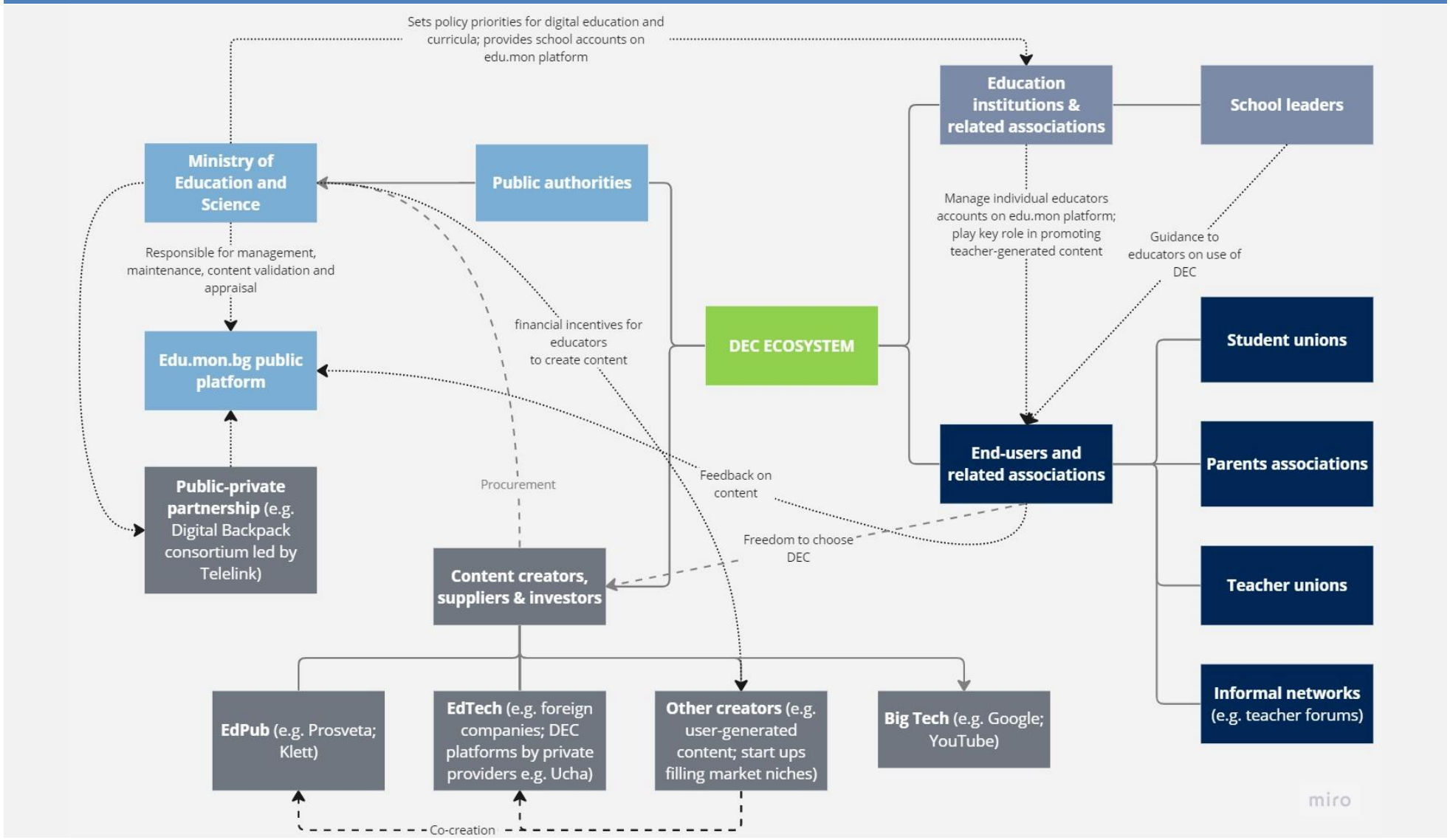
Source: Ecorys, 2023.

Table A. 5 – DEC ecosystem in Bulgaria

Case study - BULGARIA
OVERVIEW
Bulgaria is some way below EU averages when it comes to digital skills and digital literacy, with 29% of the population aged 16 to 74 falling into the lowest banding, against an EU average of 56%[507]. The COVID-19 pandemic, while further highlighting these shortcomings, provided **new impetus for digital education, which has become a policy and funding priority**. Ensuring adequate infrastructure, digital skills development, and generally promoting the digital transformation in education have been routinely included as key priorities within policy frameworks and strategies. For example, the Strategic Framework for development of education, training and learning 2021-2030 mentions the need to support learners and educators to develop skills for creating, editing, enriching and updating of digital content. Furthermore, EU structural funds have been invested to create the **new edu.mon.bg platform[508] to enable teachers to create and access DEC**, and with plans to train over 6.000 educators on to how to create interactive lessons and another 12.000 on how to work with the platform[509]. Prior to the COVID-19 pandemic, the DEC ecosystem was primarily dominated by private providers, often cooperating with educators as consultant. As such, the provision of DEC was mostly dependent on privately-run platforms (e.g. the "Education without backpacks" platform[510] by Khan Academy Bulgaria attracting more than 43.000 "learners" per month; the.Ucha.se portal providing more than 21.000 video lessons; or the Telerik School Academy[511] as an initiative providing free training in programming and digital science). However, since the launch of the new edu.mon.bg platform, the DEC marketplace has seen a shift, and is characterised by **an interplay of public authorities, education institutions, educators, as well as the private sector**, with each key stakeholder group playing a crucial role in a system where centralised policy and governance arrangements co-exist with streamlined approaches to user-created content and private companies filling market niches. In Bulgaria, DEC is primarily provided through the new, single, nation-wide, publicly funded online platform, edu.mon.bg. On the platform, DEC on all subjects relevant to national curricula across education levels and is available for free. While the **management and maintenance of the platform is centralised** at ministerial level, the **development of DEC resources is decentralised** and sees educators play an essential role. In the Bulgarian content, educators are not seen exclusively as end-users of digital education content, but they are encouraged to take an active role in creating their own digital resources, to be shared with the learner and teacher community on the platform. To this end, standardised procedures have been established to appraise and share digital materials and resources created by educators, through a process of validation and evaluation by a pool of experts and other educators. Furthermore, financial incentives are available for education institutions and educators who develop digital education content to be made available on the platform. The existence of a central platform for DEC, paired with support measures to promote the role of educators as content creators and a growing DEC market where private actors address specific needs, represents a **mixed approach to DEC governance that aims to ensure an increased take up and use of digital education materials**. As teacher-created DEC is produced and validated through formal processes and made available to the broader teaching community for free, it becomes a trusted and helpful resource that can support digitalisation of education as a key policy objective.

[507] https://op.europa.eu/webpub/eac/education-and-training-monitor-2022/en/country-reports/bulgaria.html
[508] https://edu.mon.bg/
[509] https://op.europa.eu/webpub/eac/education-and-training-monitor-2022/en/country-reports/bulgaria.html
[510] https://obr.education/
[511] https://www.telerikacademy.com/school

SNAPSHOT OF KEY PLAYERS IN THE DEC ECOSYSTEM



KEY CHALLENGES AND OPPORTUNITIES

STRENGTHS

- **EU funding programmes have played a crucial role** in supporting the digital transformation in education in Bulgaria.
- The **COVID-19 pandemic was a turning point for digital education**, as all teachers now use digital textbooks, which are made available by all main publishers (e.g. Prosveta and Klett).
- The new edu.mon.bg platform provides an opportunity to integrate existing DEC and platforms onto one single portal, with the possibility of:
  - **Facilitating access** for both educators and learners;
  - Providing an **incentive for providers** to develop DEC in compliance with national curricula, as this represents a key quality criterion for content to be uploaded;
  - **Enhancing competition** among providers to provide better quality material.
- The new edu.mon.bg platform has also the potential of encouraging and motivating educators to produce their own DEC and share it with the rest of the teaching community, thus **creating a generation of teachers as creators of DEC.**
- **Validation process for DEC** to be uploaded onto the platform being centrally managed ensures that users have access to content that has already been vetted and is compliant with national curricula. The **feedback system** on the edu.mon.bg platforms represents **an important opportunity for educators, learners, families and cares to contribute to quality of educational content**. However, as the platform has just been launched, the system is still in its testing stage.

DRAWBACKS

- While DEC available for the main general subjects taught at school, **digital education resources for upper secondary and vocational education are lacking**. In some specific subject areas, furthermore, while suitable DEC is available, access is limited due to paywalls or licensing.
- Purchase of DEC is still limited by **lack of adequate funding and/or specific budget lines** for the acquisition of digital content.
- As a consequence of the COVID-19 pandemic, **the DEC offer is often tailored to the afterschool market and/or remote teaching and learning**, making it difficult for educators to use these resources in the classroom.
- **The push towards teacher-generated content raises copyright concerns, as** educators might use parts of existing DEC by private providers to develop their own interactive lessons and materials, to be shared on the edu.mon.bg platform with other teachers, leading to potential copyright violations.
- **Foreign providers are active in the DEC market, however their content tends to be non-compliant with curricula**, and cannot be used in the classroom.
- **Broader issues (workload, low levels of digital skills, insufficient teacher training)** affect the development and take up of DEC in teaching, learning and assessment.

KEY MESSAGES

1. **Improving teacher training on key issues such as data protection, copyright and intellectual property** and ensuring these become integral part of teacher education is seen as a key step to promote digital education and the take up and use of DEC. In parallel, this could be accompanied by **increased efforts to improve media literacy among students and their families** and/or carers for the safe use of digital education resources.
2. Need to consider whether to **introduce specific copyright standards for digital education content** as existing legislative measures, while applicable, do not take into account the specificities of using digital resources in learning environments/for educational purposes.
3. Need to evaluate the **possibility of providing specific funding to schools for the creation and/or acquisition of DEC**, or ensure spending on digital content is included in ad hoc budget lines within school budgets.
4. Need to recognise that **DEC does not and cannot replace traditional teaching and learning**, which is heavily reliant on communication and interaction between teachers and students in the classroom. To this end, efforts should focus on how to make the best use of the possibilities provided by DEC (e.g. greater interactivity and personalisation), to complement, rather than replace, more traditional approaches to teaching and learning. To this end, a specific strategy on the use of DEC could be a potential next step.

Source: Ecorys, 2023.

Table A. 6 – DEC ecosystem in Greece

Case study - GREECE

OVERVIEW

In the last few years, **digital education has become a policy focus in Greece**. The strategic digitalisation of education is mainly implemented through the 2020-25 Digital Transformation Strategy and National Recovery and Resilience Plan 'Greece 2.0'[512]. Nonetheless, it is important to note that **the enabling landscape when it comes to digital education content in Greece is still developing**. For instance, while Greece has made considerable efforts to upgrade its digital infrastructure, it still relies significantly on European Structural and Investment Funds (ESIF) to support its acquisition of digital infrastructure and tools.[513]. Moreover, comparatively few students report above average digital skills[514]. While teachers are key enablers of digital education in Greece, prevalent teaching practices and culture are also considered by some to be restricting teachers' agency to meaningfully integrate ICT in education, while insufficient ICT support in schools may keep digitally trained teachers from applying their skills[515].

At present, digital educational content (DEC) is primarily developed through two axes:

a) **Content co-financed by European resources in the context of programs, projects and actions**. These programs are implemented either by the Computer Technology Institute and Press (CTI)[516] or by the Institute of Educational Policy[517] (IEP) or by the Ministry of Education and Religius Affairs (MoERA).

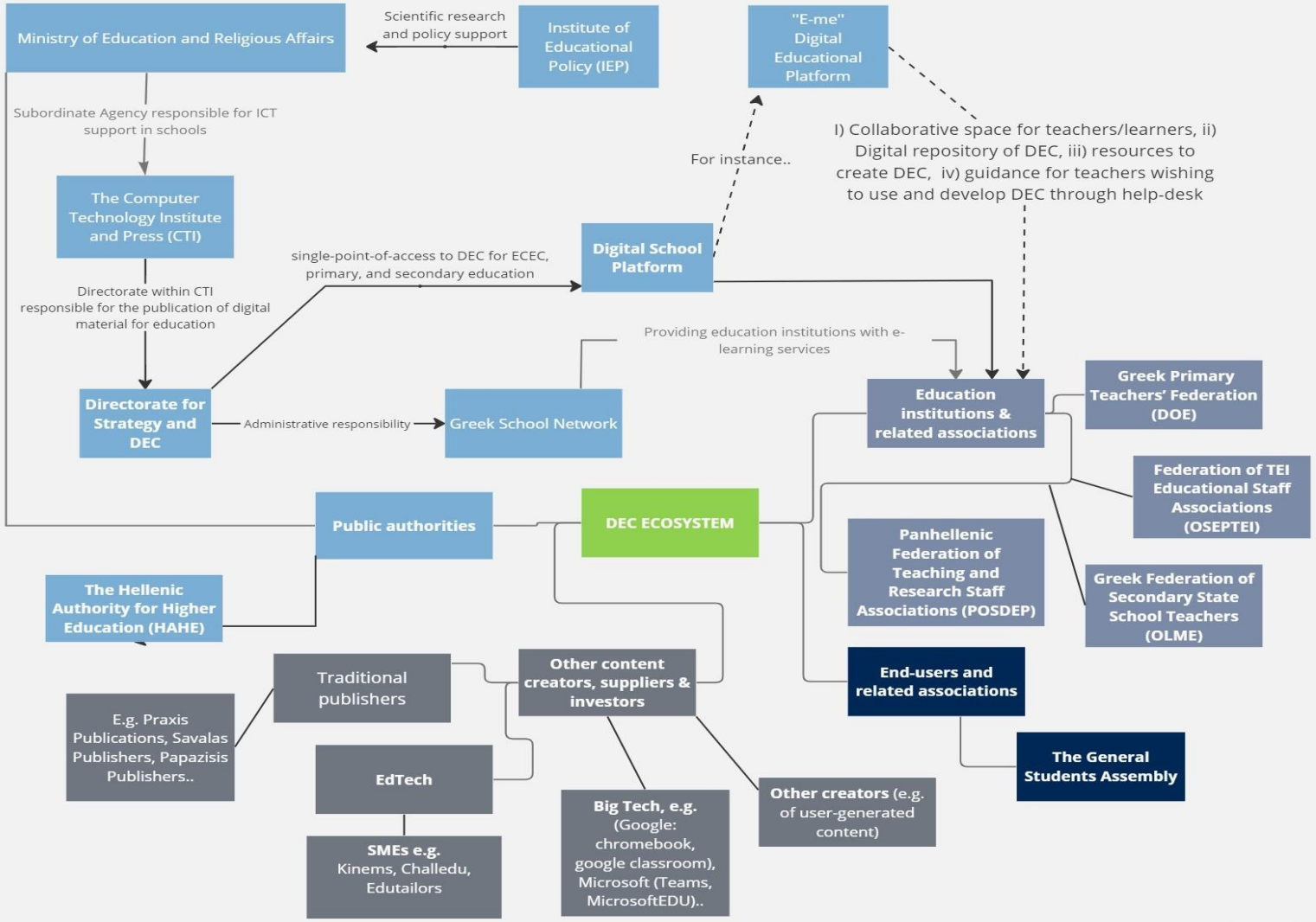
b) **Content created either by teachers (unpaid)** in the context of: ICT training programs in which they participate, or **postgraduate programs or doctoral theses, or the daily educational practice for the needs of their teaching**.

As seen in the Figure below, the Greek Ministry of Education has primarily been developing DEC and its related infrastructure in-house, through a specialised agency (CTI). This has enabled the MoERA to develop DEC using open educational resources that are free from the rights of publishers. However, this has also undercut the growth and market-size of the DEC market for private providers, including EdTech startups.

The Figure below provides an overview of the DEC ecosystem in Greece.

[512] https://digitalstrategy.gov.gr/website/static/website/assets/uploads/digital_strategy.pdf
[513] https://op.europa.eu/webpub/eac/education-and-training-monitor-2020/countries/greece.html
[514] Ibid
[515] Papadakis, Spyros et al. (2012), Integrating LMSs in the educational process: Greek Teachers' Initial Perceptions about LAMS. In: Turkish Online Journal of Distance Education (13) 2012, Article: https://www.semanticscholar.org/paper/Integrating-LMSs-in-the-Educational-Process%3A-Greek-Papadakis-Dovros/121807f3709aef2bf2f5de3914def1ed70960f5ehttps://www.semanticscholar.org/paper/Integrating-LMSs-in-the-Educational-Process%3A-Greek-Papadakis-Dovros/121807f3709aef2bf2f5de3914def1ed70960f5e
[516] The Computer Technology Institute and Press "Diophantus" is a research and technology organization focusing on research and development in Information and Communication Technologies (ICT). https://www.cti.gr/en/
[517] I.E.P. is a scientific agency that provides support to the Minister of Education, Research and Religious Affairs on issues regarding primary and secondary education, post-secondary education, transition from secondary to higher education, teacher training, student dropout and early school leaving. http://iep.edu.gr/en/

SNAPSHOT OF KEY PLAYERS IN THE DEC ECOSYSTEM



KEY CHALLENGES AND OPPORTUNITIES	
STRENGTHS	DRAWBACKS
• **Strong interest from the MoERA** and organisations implementing educational policy in the development of DEC and tools for use by teachers and students, as well as modernizing and enriching those already in existence. • **Personnel resources at national level** involved in the design and rollout of digital educational applications typically have well-placed knowledge and skills, particularly owing to the central role of the specialised MoERA agency (CTI) working directly with educational institutions. • The **market for digital educational applications is picking up**, evidenced by the emergence of local EdTech startups and the entrance into the Greek market of foreign EdTech companies (e.g. Lithuanian Memby[518]) • **A large volume of digital education content** has been produced with breadth in terms of topic areas and formats. Public authorities have a strong role in influencing what is produced, by way of targeted tender processes. • Widely used **national repository for digital content** through DSchool[519], featuring a specialized OER repository called "Fotodentro"[520], an online platform for collaboration and creation/dissemination of digital content (E-me[521]). • The ability to create **Open Educational Resources** (OERs) through central funding, without cost to users, mitigates economic inequalities and benefits the educational process. • **Skills labs[522]** for the educational community support skills development in searching for material and producing digital resources.	• **Lack of clear, overarching standards** for designing digital educational materials. • **Quality control** (through evaluation processes etc) for the material uploaded on websites is still insufficient. • **DEC platforms may still pose accessibility barriers for students with disabilities or limited internet access**. The content may not be available in alternative formats or may not be compatible with assistive technologies. Additionally, as seen during the pandemic, there were many learners and educators in remote or low-income areas who did not have reliable internet access, limiting their ability to engage with digital content. • **Lack of portable personal devices for students**, limiting access to digital course content. • The Greek market for accessible digital educational content is relatively small for investments in the development of specialized digital applications. • The **bureaucratic procedures** of tenders are extremely time-consuming and complex, especially for small innovative businesses. • **Lack of a central, overarching strategy/plan** to ensure continuity in digital educational material. • **Lack of communication** with the educational community regarding feasibility of available digital educational content.

[518] https://therecursive.com/greek-edtech-market-for-tutoring-to-grow-with-entry-of-lithuanian-startup-memby/
[519] https://dschool.edu.gr/
[520] http://photodentro.edu.gr/aggregator/
[521] https://auth.e-me.edu.gr/?eme=https://e-me.edu.gr/&cause=no-token&eat=72c2f352c018210880a41d496b35c428
[522] http://www.iep.edu.gr/el/psifiako-apothetirio/skill-labs

KEY MESSAGES
1. National authorities have taken on a strong role when it comes to the production and dissemination of DEC, which has helped to ensure that highly capable and specialised staff at the national level steers the process (in particular through CTI). However, this has somewhat **limited the growth of the domestic DEC market**.
2. Despite the strong national leadership when it comes to DEC, **DEC development and procurement is still characterised by a lack of overarching quality frameworks** and procedures, raising questions regarding the content's pedagogical value in learning environments. **Strict(er) quality control measures** attached to deliverables created within the context of public authorities' procurement calls and (co) funded projects. An overarching quality guidelines framework would be instructive in this regard.
3. **Linking DEC development to the specific needs of end users**, e.g. by exploring the needs of Greek teachers and learners when it comes to digital educational material (e.g. through public consultations, studies, cooperative frameworks between EdTech developers and schools);
4. **Providing funding incentives for educators** who create material adapted to their students' needs (e.g. through project funding, competitions, awards, grants).

Source: Ecorys, 2023.

Table A. 7 – DEC ecosystem in Italy

Case study - Italy
OVERVIEW
When viewed relative to the wider EU context, **the enabling environment for DEC in Italy** has a number of strengths and areas for improvement. For instance, schools are digitally equipped in line with other EU countries, but the level and speed of connectivity are identified areas for development[523]. Similarly, on the one hand students' overall trust in their digital competence is comparable to the EU average, as is the share of learners using a computer at school weekly. On the other hand, the percentage of teachers who feel well or very well prepared to use ICT for teaching is below the EU average[524]. From a **policy perspective**, the Ministry of Education and Merit has the main role in defining the quality and cost standards of Digital Education Content (DEC). It has defined the National Plan for Digital Education (Piano Nazionale Scuola Digitale - PNSD[525]) and oversees its implementation. In addition, the Ministry of Education and Merit issues the rules and procedures for the adoption of textbooks and other learning materials by schools[526]. While local and regional authorities plays a role in supporting schools by way of funding, as seen in the Figure below, schools have a large degree of autonomy in the procurement and use of DEC. Lastly, the COVID-19 crisis constituted an impetus for the government to step up investment in the digitalisation of schools, with the National Recovery and Resilience Plan significantly boosting the integration of DEC in teaching and learning[527]. From the **supply side perspective**, as a result of the textbook-dominated compulsory education market, the Italian publishing system has played a central role in supplying DEC for schools, as complimentary tools to physical textbooks[528]. Despite challenges to market entry for new players within the Italian ecosystem, recent data suggest that a large portion of startups have been formed in recent years. Italy currently constitutes one of the fastest growing EdTech markets on the continent[529]. The Figure below provides an overview of the DEC ecosystem in Italy.

[523] While virtually all schools have an internet connection (95,4%, MIUR), only 26.9% have a high speed connection, well below the EU average of 47%. For more, see: https://op.europa.eu/webpub/eac/education-and-training-monitor-2020/countries/italy.html

[524] https://op.europa.eu/webpub/eac/education-and-training-monitor-2020/countries/italy.html

[525] Ministero dell'Istruzione, dell'Università e della Ricerca, (2015), National Plan for Digital Education (*Piano Nazionale Scuola Digitale*), Roma, pp.140, available at https://www.istruzione.it/scuola_digitale/allegati/Materiali/pnsd-layout-30.10-WEB.pdf
National Plan for Digital Education (*Piano Nazionale Scuola Digitale*), available at https://scuoladigitale.istruzione.it/, a syntesis in English is available at https://www.istruzione.it/scuola_digitale/allegati/2016/pnsd_en.pdf

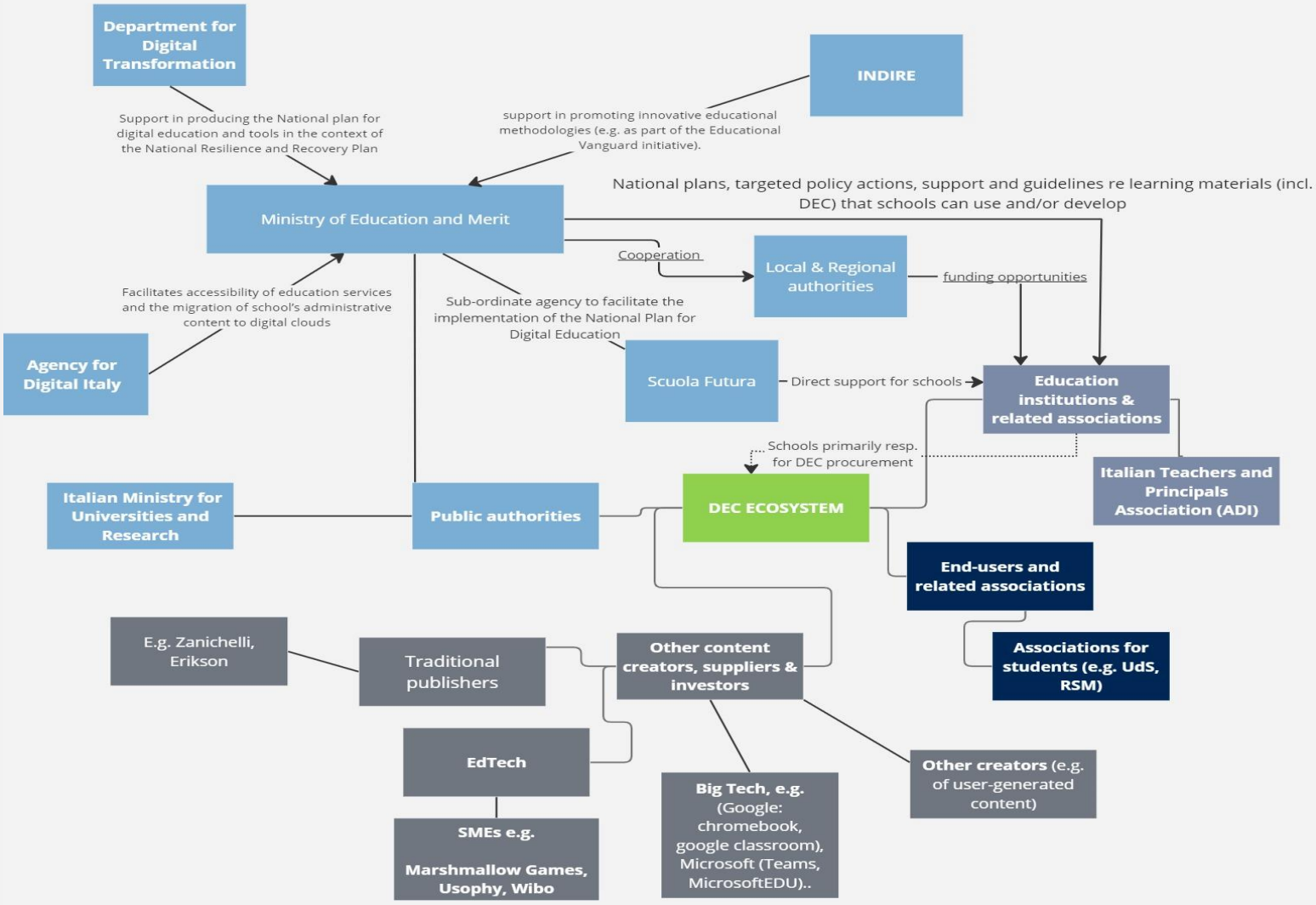
[526] https://www.istruzione.it/scuola_digitale/allegati/2016/pnsd_en.pdf

[527] National Plan for Digital Education (Piano Nazionale Scuola Digitale), at https://scuoladigitale.istruzione.it/

[528] https://dealroom.co/blog/european-edtechs-sleeping-giant-italy

[529] ibid

SNAPSHOT OF KEY PLAYERS IN THE DEC ECOSYSTEM



KEY CHALLENGES AND OPPORTUNITIES	
STRENGTHS	DRAWBACKS
• **Long tradition of e-book availability and a wide variety of supplementary materials**: all school textbooks have been available in digital format for over 10 years, and most textbooks are supplemented by digital resources available at no additional cost to students and teachers (partially due to the branching out of traditional publishers to also provide such supplementary digital materials). • The Italian **DEC ecosystem consists of a multitude of producers** competing in an open market. • **DEC market can be seen to have grown rapidly in recent years**- both in terms of demand but also in terms of supply/offers from a wide range of actors, from universities and business schools to startups. • **Continuous improvement of content and online learning environments** are observed by key stakeholders in the ecosystem. • The **increase in funding** for technological equipment and training is motivating school leaders and teachers to strengthen digital school culture and use. • Increase in **digital education content production activities by teachers**	• **Unsystematic/uneven use of DEC across regions and schools**; reliance on the motivation of individuals. • **Insufficient political and institutional attention to the digital divide.** • **Time and resource restraints, as well as lack of digital skills** among teachers and trainers. • Little available evidence of the **added value of DECs on student learning outcomes.** • Market led by private equity funds runs the **risk of creating oligopolies, hindering innovation.** • Lack of **coordination between technology and pedagogical experts** for content-creation. • The **lack of a centralised system and shared metadata standards** risks preventing teachers from using resources expressly designed for their teaching. • The **selection and procurement process of DEC often does not start from the identification of learning needs.** • High costs for having good quality and customised products.

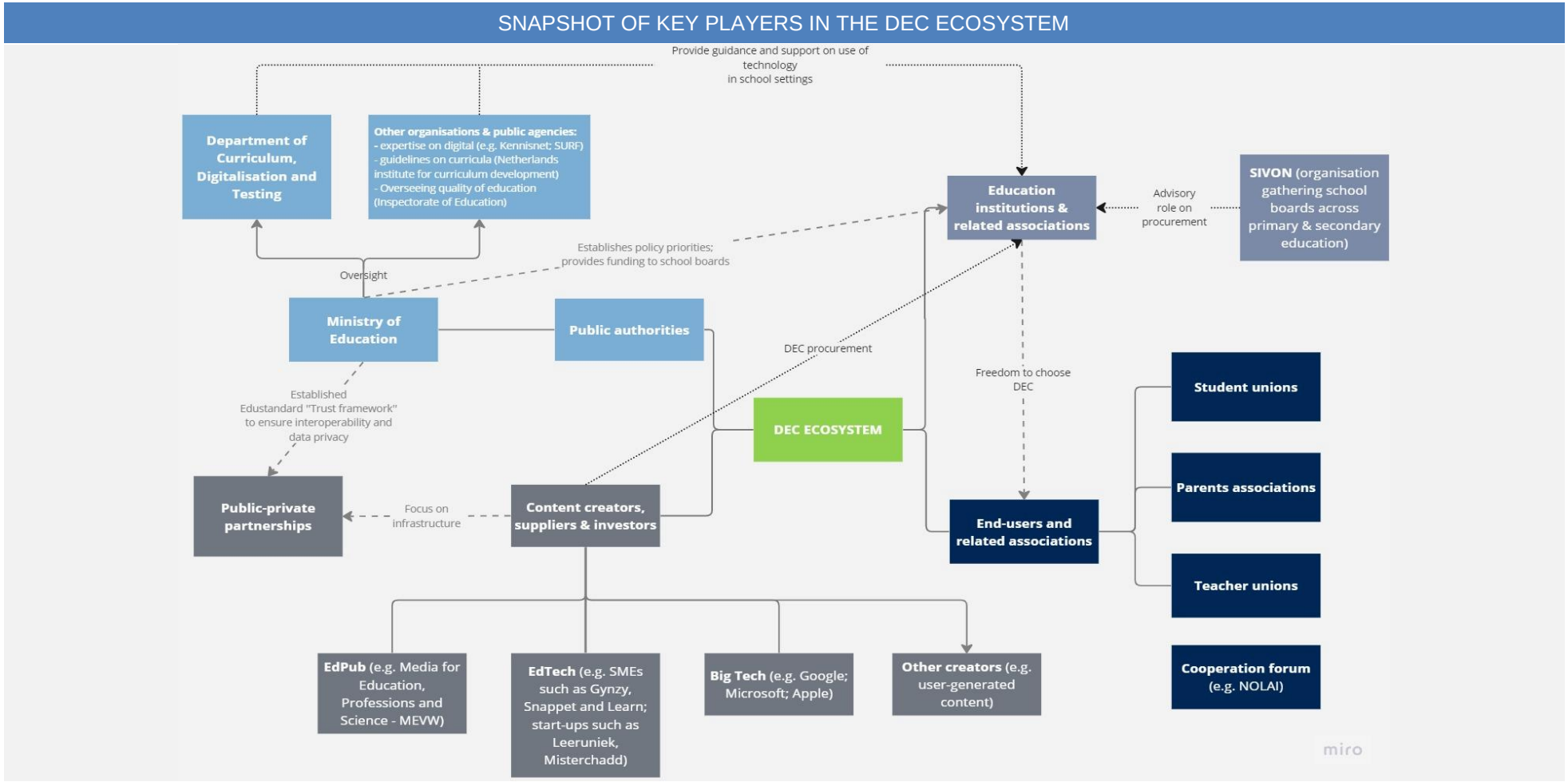
KEY MESSAGES
1. **Urgent policy action is needed in the Italian context when it comes to countering the impact of the digital divide,** which affects what digital materials learners can access (particularly with regard to varying levels of connectivity and infrastructure) 2. **Systematic and longitudinal research regarding the impact of DEC on learning** for different types of students and across education levels would also be needed in order to better gauge the educational effects of DEC and inform procurement decisions 3. **The functioning and interoperability of large-scale online education platforms is key to promoting access to - and use of - DEC**. Against this backdrop, it is also necessary to strengthen the vision and skills of platform managers. Access to and use of the DEC on these platforms depends not only on the quantity and quality of DEC made available on the platform, but also on the user-friendliness, support features, and continuous training services offered to users by the platform at large. 4. **School-level and policy-level action to facilitate the strengthening of teachers' role in the design and production of DEC** (on their own or in collaboration with publishers), is an important avenue for maximising the pedagogical value of DEC. This includes equipping teachers with the skills necessary for digital content development – but also ensuring that teachers have the time and resources to do so. Beyond design, it is important to note that teachers can prove valuable resources throughout the entire key DEC lifecycle, including when it comes to procurement and evaluation.

Source: Ecorys, 2023.

Table A. 8 – DEC ecosystem in the Netherlands

Case study - NETHERLANDS
OVERVIEW
Overall the Netherlands one of Europe's front runners when it comes to **digital skills and literacy**, with almost 80% of individuals having at least basic digital skills, and 83% possessing at least basic digital content creation skills – well above the EU average of 54 and 66% respectively[530]. In the Netherlands, digitalisation is seen as an important vehicle to drive educational goals and improve the quality of education. This is why **strategies and policies on digital education have been in place since the 1990s**, signalling that this has remained a policy priority over the years. For example, the 2019 Digitalisation agenda for Primary and Secondary Education[531] includes a **focus on digital learning resources**, to promote their take up in educational settings, as well as **foster public-private partnerships** between publishers, distributors, software and the education sector ''to build a vision'' for the use of these resources. However, despite this policy focus, the distinction between digital tools and content is indistinct within strategies and policies. The Recovery and Resilience Facility (RRF), moreover, provided **new impetus to investing in digital education**: the Dutch Recovery and Resilience Plan[532] foresees an investment of EUR 24 million to equip pupils with laptops or tablets in primary and secondary education. Moreover, in 2021 the government allocated EUR 80 million for setting up a **National Education Lab for Artificial Intelligence to** use AI technology for educational purposes in a safe and ethical manner[533]. In terms of the DEC ecosystem, the Dutch landscape is rather decentralised. At the national level, the Ministry of Education's main role is to set up relevant frameworks (e.g. national education plans and strategies) to **provide the conditions for the digitalisation of education and supporting schools to make responsible decisions regarding the use of technology.** To this end, the Department of Curriculum, Digitization and Testing is responsible for facilitating the digitalisation of education and providing guidance. Furthermore, a number of other **public agencies and organisations have been put in place to support schools**. These include Kennisnet[534] and SURF[535], which provide guidance and information on digital education, as well as SIVON,[536] an organisation bringing together school boards from across the primary and secondary school level, to support schools in procuring both digital and non-digital content. Dutch **education institutions retain a high degree of autonomy** for what concerns the pedagogical didactical approach, the organisation of education and the educational content (both digital and non-digital content) used for teaching and learning. Funding is provided to education institutions from the national budgets, and **schools are free to select and procure DEC themselves**. However, **education budgets do not include specific resources for digital content**, it is therefore up to each individual school to decide how to spend their resources. The procurement process is entirely up to the schoolboards and only supportive information is provided by SIVON, Kennisnet and Surf. Given this decentralised approach and the autonomy of schools in their spending decisions, the **DEC marketplace is quite diverse**. DEC providers (EdPub and EdTech) approach schools and teachers directly, or – in case of larger purchases – companies participate in public procurement. **Public-private partnerships are seen as a positive tool** to strengthen the market – an example is Edustandard, which brings together public authorities, education institutions and the private sector to establish a ''trust framework'' to ensure interoperability across systems and facilitate open connections and data flows across platforms[537]. The Figure below provides an overview of the DEC ecosystem in The Netherlands.

[530] https://digital-strategy.ec.europa.eu/en/policies/desi-netherlands
[531] https://www.nederlanddigitaal.nl/english/digitalisation-agenda-for-primary-and-secondary-education
[532] https://commission.europa.eu/business-economy-euro/economic-recovery/recovery-and-resilience-facility/country-pages/netherlands-recovery-and-resilience-plan_en



[533] https://www.ru.nl/en/nolai
[534] https://www.kennisnet.nl/
[535] https://www.surf.nl/en
[536] https://sivon.nl/
[537] https://www.edustandaard.nl/onze-werkwijze/

KEY CHALLENGES AND OPPORTUNITIES

STRENGTHS

- Overall **high level of digital skills and literacy**, as well as fairly well developed **digital infrastructure** (hardware, access to internet) across the country, which can be conducive to higher take up of digital resources in education.
- The **high level of school autonomy with regards to procuring and purchasing DEC** results in a dynamic market for DEC providers and distributors, with multiple providers supplying a diverse range of (adaptive) DEC.
- **Educators' freedom to choose** the type of DEC that best suits their needs and those of their learners.
- **Freedom of DEC providers to create and design content** according to market needs. Most traditional publishers provide digital content alongside printed materials, while digital publishers also offer paper content. This results in educators and learners having access to both types of content.
- The **key advisory role played by organisations such as Kennisnet, SURF and SIVON**, which provide invaluable support to facilitate the digital transformation in education.
- **Cooperation through public-private partnerships** can foster a level playing field in the market and create better conditions with regards to access to content and interoperability across platforms, which benefit both users and providers.

DRAWBACKS

- **Funding remains below levels where all schools can purchase DEC and hardware**, compared to increased attention to digitalisation, particularly after the COVID-19 pandemic. This may also increase the digital divide, as many schools rely on families to purchase devices due to lack of public funding.
- **Educators are not equipped to navigate the DEC offer** from different providers, including due to lack of research on educational value of DEC, with the risk of prioritising newer technologies rather than content that leads to the highest pedagogical impact.
- **Insufficient validation, certification and feedback efforts**, as no public organisation or agency has taken up this role yet, leaving DEC providers to self-assess their own products.
- As the **market is small**, there is a limited amount of DEC available in Dutch and investments in innovation are limited.
- Need for **more investment in teacher-training** for them to better understand how to integrate digital resource into their teaching.
- **Complex procurement processes** may discourage DEC providers. Moreover, smaller market players encounter more obstacles in approaching schools directly, remaining at a disadvantage compared to bigger companies as teachers tend to rely on the same suppliers.
- DEC is made available by providers on their platforms **with limited possibility to personalise content** and respond to classroom needs.

KEY MESSAGES

1. **Need for a bottom-up approach to DEC** by focusing on investing in research on the educational value of digital education content and how it can best be integrated in teaching. This would also support providers to ensure their products are more useful and impactful, shifting the focus from technological innovation to pedagogical impact.
2. **Increased efforts to involve end users in evaluation and feedback** to improve the quality of DEC, alongside providing opportunities for exchanges of good practices in the development and use of DEC (including across Europe).
3. **Greater investment in awareness raising and teacher training around the benefits and opportunities of DEC** to support quality education and teaching, including by exploring how DEC can tackle broader issues within the Dutch education system, such as teachers' high workload, low motivation of students or inequal opportunities.
4. **EU standards on the use of data and on interoperability**, for a more accessible EU DEC market.

Source: Ecorys, 2023.

Table A. 9 – DEC ecosystem in Estonia

Case study – ESTONIA

OVERVIEW

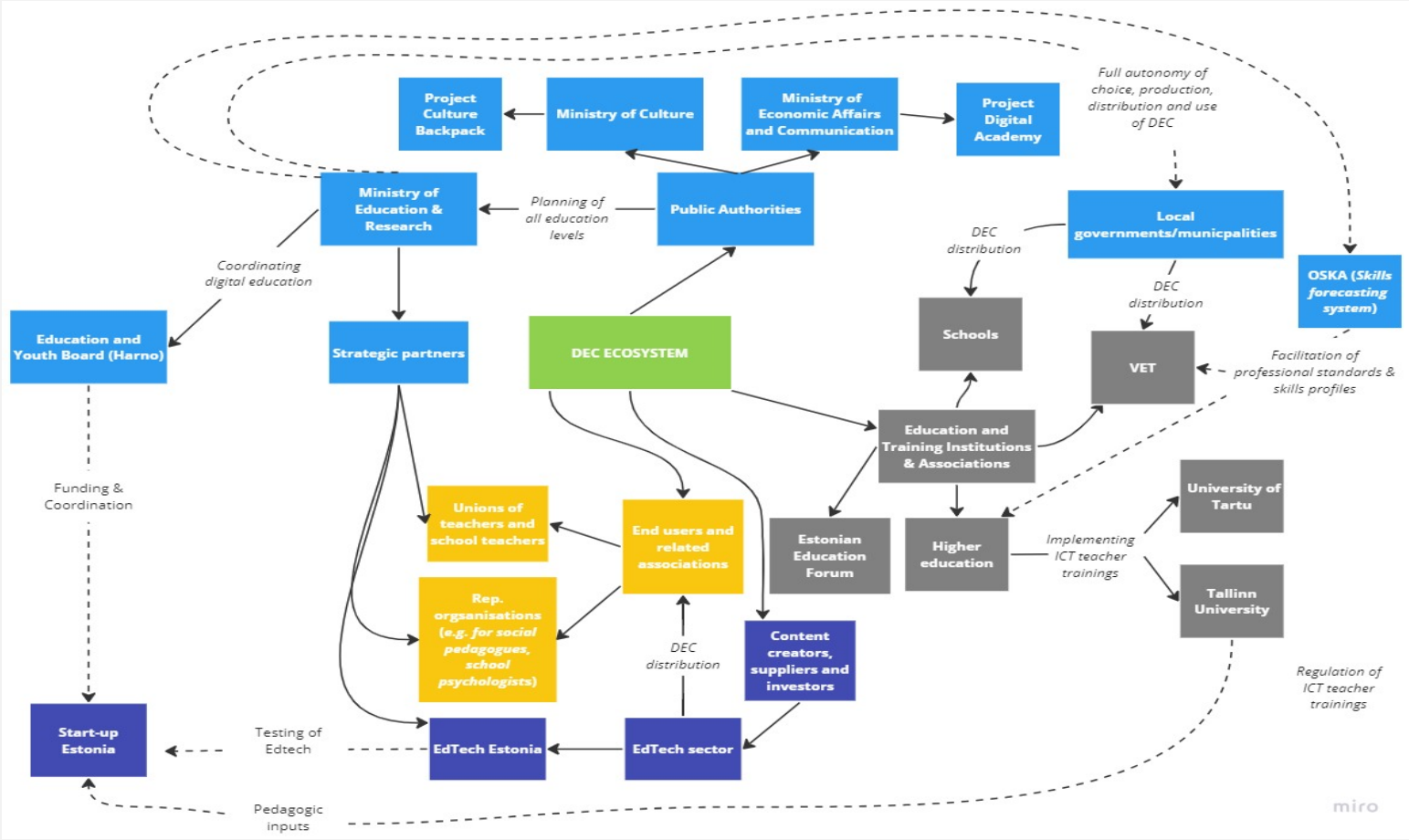
Estonia is a pioneering education system in the area of DEC, **characterised by deep integration of digital resources at all levels**. The stakeholder evidence from the study indicates that learning management systems such as ''Stuudium' or 'e-School' are used by virtually all schools – providing lesson plans, study materials, information regarding student process, homework assignments, grades and comments while enabling interactions between student, teachers and parents. Unlike many other education systems, the integration of DEC has also taken place at ECEC level where a strong majority of establishments (approx. 85% according to an interviewed expert) are using a similar platform, 'Elis', to exchange learning information and to facilitate communication with parents. Further leading **DEC integration into the VET sector**, Estonia's Recovery and Resilience Plan (RRP) aims to boost digital skills by focusing on the development of VET curricula and micro-credentials, as well as renewing professional standards and skills profiles. The planning underpinning the RRP is based on analyses by OSKA, an advanced jobs and skills forecasting system that produces projections of future labour market needs in all fields of the Estonian economy. [538]

While the Estonian education system has largely incorporated DEC, it still faces **challenges – in particular concerning an uneven uptake of DEC among schools with different socioeconomic profiles** and in how to make DEC work for learners. Research suggests that teachers and students have different experiences when it comes to using DEC. One study found that distance learning motivated teachers to use digital content, to improve their digital skills, and to collaborate more effectively. For learners, on the other hand, the remote use of DEC was challenging and gave poorer results compared to classroom learning, while making acquiring new skills more difficult (Loogma & Sirk, 2021). Consulted representatives from the publishing representatives confirmed this picture and added that **there is a varying appreciation of DEC, as 70% of teachers use digital content in their teaching, while only 30% of students use it for their learning**. One reason behind this variation is that teachers to a greater extent have access to login for the digital content platforms (e.g. the national digital curriculum learning content platform, OPIQ). Another reason is that educational establishments in socioeconomically disadvantaged areas often struggle with providing students with DEC which can be attributed to various factors, including limited resources, infrastructure constraints, and a lack of access to technology.

The DEC governance structure in Estonia is arranged in a manner where the Ministry of Education and Research in Estonia assumes the **central role in educational planning across all levels, encompassing adult, formal, non-formal, and informal education**. The Education and Youth Board (Harno), a government agency under the Ministry of Education and Research, oversees the implementation of educational policies and coordinates training and in-service education for educators concerning Digital Education Competence (DEC) and information and communication technology (ICT). Other ministries have introduced policy with DEC components, such as the 'Culture Backpack'[539] program by the Ministry of Culture and the 'Digital Academy'[540] by the Ministry of Economic Affairs and Communication. The Ministry of Education and Research has 33 strategic partners from 2022 to 2024, including professional unions, non-governmental organisations, and representatives of professional support staff. DEC-related inter-ministerial collaboration is limited, however, as education falls under the exclusive competence of the Ministry of Education and Research.

Estonia's **emerging EdTech community should also be noted**. During the period from **2017 to 2020, there was a consistent, stable growth** with an average annual increase of 22%, with the most substantial growth occurring from 2019 to 2020, when the total revenue saw a year-on-year increase of 44%. Consulted industry representatives point out that Estonian Edtech start-ups are often focused on providing solutions that improve the functionality of teacher management systems, online learning environment, or combine printed books with digital content for assignments. The Estonian Education Strategy 2021-2035, emphasising Digital Education Competence (DEC) and its enhancement of the learner-centred teaching approach, has further catalysed educational innovation and collaborative initiatives between the state and the private sector. For example, Startup Estonia – a governmental initiative – is running their EdTech-focused programme which provides startup incubation programmes for students, develops, and supports the EdTech community through meetups and a network of schools for piloting their services.[541]

SNAPSHOT OF KEY PLAYERS IN THE DEC ECOSYSTEM



[538] Education and Training Monitor 2022 (europa.eu)
[539] https://www.kul.ee/en/culture-backpacks
[540] https://digiriigiakadeemia.ee/
[541] Startup Estonia. Edtech Focus https://startupestonia.ee/focus-areas/edtech-focus

KEY CHALLENGES AND OPPORTUNITIES

STRENGTHS

- **Deep Integration of DEC:** Estonia's education system is characterised by the deep integration of digital resources at all levels, making it a European frontrunner.
- **Impressively wide distribution of DEC**. Comprehensive Learning Management Systems: Learning management systems like 'Stuudium', 'e-School' and Elis are widely used in virtually all schools, and even in most pre-schools (ECEC settings). These tools can enhance teaching and learning by offering lesson planning, study materials, progress tracking, and communication.
- **EU funding is promoting favourable conditions for DEC**. Such funding is being channelled into areas that Estonia needs to develop. These areas include boosting digital skills, developing VET curricula and micro-credentials, as well as renewing professional standards and skills profiles.
- **The way forward is marked by collaboration:** Looking towards the future, there is a growing emphasis on educational innovation and collaborative projects between the government and the private sector. This is catalysed by the Estonian Education Strategy 2021-2035 and initiatives such as Startup Estonia, supporting the EdTech community through meetups and a network of schools piloting services/products.

DRAWBACKS

- **Socioeconomic Disparities can hinder effective uptake of DEC:** Varied adaptation of DEC is observed among schools with greater proportions of students with low socioeconomic status (SES). This can lead to exacerbated educational disparities in how DEC is accessed and used.
- **Low uptake (usage) of DEC, especially among learners**: Despite a widespread distribution of DEC, a significant proportion of students use such content to a far lesser extent when compared with their teachers. This hinders the full leveraging the advantages of DEC to support teaching, learning and assessment.
- **Limited Inter-ministerial Collaboration:** Collaboration related to DEC is limited between various ministries, as education primarily falls under the exclusive competence of the Ministry of Education and Research.

KEY MESSAGES

1. **Estonia is a European leader in DEC, with such content being deeply embedded and used across educational levels**. The education system serves as an inspiring example of how DEC can be distributed widely to innovate teaching and learning methods.
2. **Estonia's EdTech community has shown inspiring growth** as it drives innovation in teacher management systems, online learning, and digital content integration in education, demonstrating the country's commitment to staying at the forefront of DEC.
3. **Socioeconomic Disparities are behind uneven use of DEC.** The unequal adoption of DEC in schools with diverse socioeconomic backgrounds underscores the importance of addressing disparities in access and usage.
4. **Limited Learner Engagement with DEC.** Despite widespread distribution of DEC, a notable proportion of students use these resources less frequently than teachers, potentially limiting the full realisation of the benefits of digital learning materials.
5. **Challenges in Inter-ministerial Collaboration.** Collaboration between ministries concerning DEC is constrained due to education primarily falling under the exclusive jurisdiction of the Ministry of Education and Research. Given the multifaceted nature of DEC, it may be necessary to adapt the institutional framework to promote more cross-disciplinary cooperation.

Table A. 10 – DEC ecosystem in Poland

Case study – POLAND

OVERVIEW

Over the last decade, Poland has made **substantial investments into ICT infrastructure, teachers' digital proficiency, and DEC**.[542] Despite this, there **is still scope for development when it comes to digital skills**[543], and there is evidence of digital exclusion affecting both learners and educators who often lack connectivity and access to equipment.[544] While there is a lack of data on the digital skills of students, national auditors have found low levels of digital skills among teachers and a shortage of continuous ICT-training.[545] Following the pandemic, consulted stakeholders stress that these challenges have been aggregated as digital tools have increasingly become part of everyday teaching.

Tackling these challenges, Poland **plans to continue its investments and develop a digital strategy for schools and digital competences, to improve inclusiveness**. In this direction, the Polish National Recovery and Resilience Plan (RRP) earmarks €1.4 billion of investments for upgrading digital infrastructure and equipment for schools, and to boost digital competences. All primary and secondary schools across Poland will receive multimedia equipment for teachers' and students' use, including 1.2 million laptops, a high-speed internet connection, and science, technology, engineering and maths (STEM) and artificial intelligence laboratories.[546]

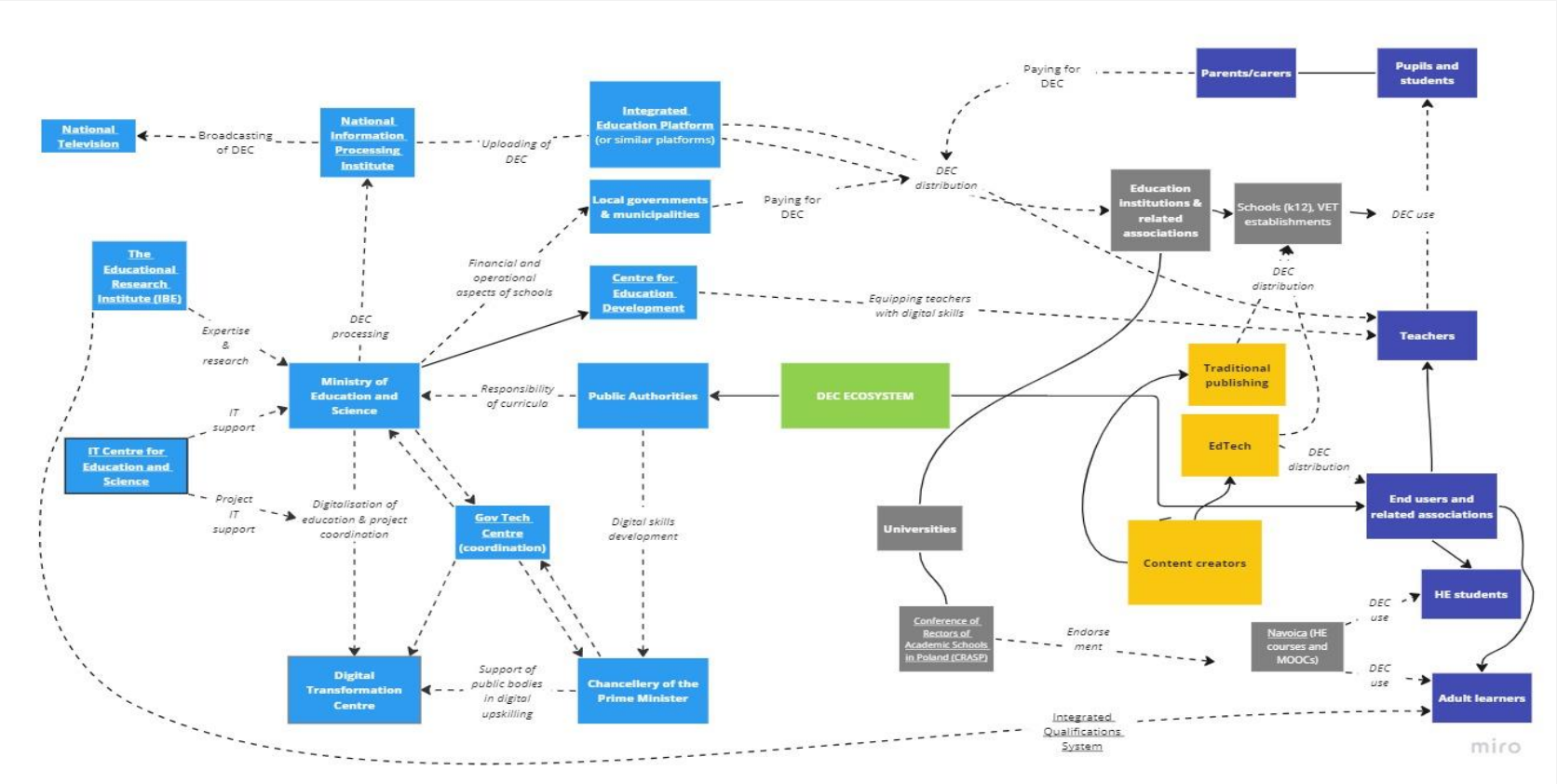
In parallel, Poland is working actively with **a set of national policies to make conditions more conducive and favourable for DEC**. The '*Integrated Skills Strategy' (Zintegrowana Strategia Umiejętności 2030*)[547] focuses on the significance of employing digital tools and raising 'misinformation awareness' among young people, highlighting ways that these tools bring to enhancing collaboration on digital content and group learning. DEC is also directly covered in the national '*2030 Digital Competences Development Programme*[548]' where teachers are guided in supporting their students in creating and using DEC and empowered to become content creators of their own e-resources. A third example of a timely national policy is the '*Policy for the Development of Artificial Intelligence in Poland from 2020*'[549] with the objective to continuously update the curriculum for all levels of education to keep pace with the development of AI and emerging technologies.

While the DEC governance is highly centralised in Poland, there are a **numerous public institutions and agencies that influence the selection, quality assurance and distribution of such content**. Two key players are the Ministry of Education and Science, responsible for overarching education strategy and curriculum development, and the Digital Transformation Centre overseeing digitalisation efforts in the formal education system and coordinating digital education projects. The Ministry has initiated various digital education programs, including the Integrated Education Platform, offering an online repository of accessible free educational materials in line with the Core Curriculum, with the Ministry delivering the content.

There are indications of an emerging environment for EdTech, with a growing presence of such companies in Poland. Gathered evidence suggests that the EdTech Sector in Poland has a total of 305 companies which include top companies like Brainly, SuperMemo and Glosbe.[550] Brainly – a EdTech unicorn and success story – was by far the most funded educational technology company in Poland between 2018 and 2020, with a total funding amount of over €140M[551]. Brainly, founded in 2009 in Poland (today with Headquarters in the U.S), is a platform where students, parents, and teachers help others with homework questions. By November 2020, the App reported having 350 million monthly users, making it the world's most popular education app. [552] This may suggest that Poland has the **conditions for EdTech companies to establish themselves and grow** beyond their home market.

[542] Education and Training Monitor 2022 (europa.eu)
[543] Poland: structural reforms and accelerating the digital and green transition would help to further raise living standards, OECD says - OECD
[544] Education and Training Monitor 2022 (europa.eu)
[545] Szkoły w czasach pandemii - Najwyższa Izba Kontroli (nik.gov.pl)

SNAPSHOT OF KEY PLAYERS IN THE DEC ECOSYSTEM



546 Education and Training Monitor 2022 (europa.eu)
547 https://www.gov.pl/web/edukacja-i-nauka/zintegrowana-strategia-umiejetnosci-2030-czesc-szczegolowa--dokument-przyjety-przez-rade-ministrow
548 https://www.gov.pl/web/cyfryzacja/zaproszenie-do-konsultacji-programu-rozwoju-kompetencji-cyfrowych
549 https://www.gov.pl/web/ai/polityka-dla-rozwoju-sztucznej-inteligencji-w-polsce-od-roku-2020
550 Top 300+ startups in EdTech in Poland - Tracxn
551 Poland: most funded EdTech companies 2022 | Statista
552 Education app becomes world's number one after surge in popularity caused by pandemic – The First News

KEY CHALLENGES AND OPPORTUNITIES

STRENGTHS

- **Poland has an institutional framework that ensures the quality of DEC and its alignment with formal curricula.** This dedication to maintaining high standards within the education sector underscores the country's commitment to equipping learners and educators with the most fit-for-purpose digital resources available.
- **Polish institutions have responded to the swiftness of DEC development by reshaping its governance framework**. Institutions such as the Digital Transformation Centre and the Gov Tech Centre ensure that public authorities harness technology-driven solutions to enhance government services.
- **New creative platforms** such as Integrated Education Platform (for K12) and Navoica (for HE) are rooted in both innovation and supported by established educational institutions, creating a synergy between DEC advancements and traditional educational structures.
- **EU funding is playing a crucial role** in reshaping the DEC landscape in Poland, driving investments into digital infrastructure, skills, and content. These initiatives have the potential to tackle long standing challenges in the education system and bring about positive transformations that benefit both learners and educators alike.
- **The presence of EdTech in Poland is becoming increasingly apparent, with an active role in public education.** A large number of Polish start-ups with innovative DEC, concepts, ideas and tools have emerged and evolved in recent years. These creative ventures have the potential to influence the education landscape positively, promoting continuous learning and adaptability.

DRAWBACKS

- **Centralised Governance with Multiple Influential Players:** While the governance of digital education content (DEC) is highly centralised, there are numerous public institutions and agencies involved in influencing the selection, quality assurance, and distribution of such content. This fragmentation could lead to inefficiencies, conflicting approaches to DEC across the country The emphasis on the public sector risks narrowing the available educational resources.
- **Digital exclusion is a significant challenge in Poland's education system**. Both learners and educators often lack connectivity and access to necessary equipment, which can hinder their effective use of DEC. This has a more significant impact on students and teachers from disadvantaged backgrounds. This is especially concerning since some municipalities require students to pay for educational resources, which further restricts their access to digital learning and collaboration opportunities.
- **Educators are not always sufficiently equipped or skilled to benefit from DEC**. The lack of accessible and ongoing training can hinder their ability to effectively integrate technology into their teaching, limiting the potential benefits of DEC. While consulted stakeholders emphasise that this is not an issue in all schools, there remains a clear need for a continued focus on equipping teachers with ICT skills and competences in large segments of the school system.
- **Currently, there is a notable absence of comprehensive and granular data regarding the digital education landscape in Poland, in particular with regards to DEC.** This makes it challenging to assess the state of play, to make informed decisions and to allocate resources where needed.

KEY MESSAGES

1. **Commitment to Quality and Alignment**: Poland's robust institutional network ensures the quality of Digital Education Content (DEC) and its alignment with formal curricula, highlighting the country's dedication to equipping learners and educators with the best digital resources.
2. **Polish institutional frameworks have adapted swiftly to the development of digital education technologies** by updating their governance framework, promoting innovation while maintaining support from established educational institutions.
3. **EU Funding for Positive Transformation:** EU funding programs are driving investments in digital infrastructure, skills, and content, offering the potential to address long-standing education system challenges and bring about positive transformations.
4. **Digital Exclusion and Resource Costs**: Digital exclusion is a significant issue, particularly affecting disadvantaged students and teachers who lack connectivity and equipment. The requirement for some students to pay for educational resources in certain municipalities is likely to further limit access to digital learning and collaboration.
5. **Filling Teacher Training Gaps:** Many educators lack the necessary training to effectively utilize DEC, hindering their ability to integrate technology into teaching. Addressing this training gap is crucial to maximize the potential benefits of DEC.

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