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Implementing Interactive Digital Mathematics Textbooks in Grades 5–6: A Practice-Based Approach to Competence Development

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ABSTRACT:
This study investigates the pedagogical design and educational potential of interactive digital mathematics textbooks for lower secondary education (Grades 5–6) within the context of Moldova's ongoing digital transformation. The research combines international benchmarking (France, Finland, and Romania), an analysis of alignment with the Moldovan National Curriculum for Mathematics, and the development of a typology of interactive learning activities derived from the design of the MDIR-Mate digital textbooks.
The findings indicate that effective implementation depends on the coherent integration of curriculum objectives, pedagogical design, technological infrastructure, and teacher preparedness, rather than on the simple digitisation of printed materials. The curriculum analysis confirms a strong correspondence between competence-based curriculum principles, and the instructional capabilities of interactive textbooks. The proposed four-category typology – comprising practice and consolidation, exploratory simulations, contextualised problem-solving, and assessment/self-assessment activities – offers a practical framework for designing digital resources that foster both conceptual understanding and procedural fluency.
The study concludes that interactive digital textbooks (IDTs) can effectively support competence-based mathematics education when implemented within coherent pedagogical and curricular frameworks. Further longitudinal research is recommended to examine learning outcomes, interaction patterns, and the role of teachers' digital competence in successful implementation.

Keywords: digital textbooks, mathematics education, lower secondary education, interactive learning activities, competence-based learning, ICT integration, digital pedagogy, educational innovation

1. Introduction

1.1 Educational Potential and Limitations of Digital Textbooks

In the current context of the digital transformation of education, interactive digital textbooks represent a modern teaching resource that extends beyond the limits of traditional printed materials. In particular, their integration into lower secondary mathematics education (grades 5–6) creates meaningful opportunities for developing students' competences through adaptive exercises, dynamic representations, immediate feedback, and interactive visualisations of abstract concepts.

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Nevertheless, despite these promising affordances, the educational impact of digital textbooks is not straightforward. Research points to both their strong pedagogical potential and a series of challenges that require careful consideration in educational practice.

On the one hand, digital textbooks offer significant educational advantages. Vaarala and Jalkanen (2010) emphasise the advantage of multimodality, showing that students benefit from reading digital texts and using online platforms, which enable active learning and increase the flexibility of the educational process. From a related point of view, Gu et al. (2015) underline that interactivity, accessibility, and personalisation embedded in digital textbooks can significantly enhance the learning experience by fostering student implication. Similarly, Baek and Monaghan (2013) highlight practical advantages such as reduced cost, portability, and extended accessibility, which contribute to a more inclusive distribution of educational resources.

On the other hand, several studies draw attention to critical limitations that are associated with the use of digital textbooks. Gillen (2014) argues that digital literacy should not be reduced to technical proficiency, but rather understood as a broader "disposition" involving critical thinking and metacognitive awareness. From this perspective, simply replacing printed textbooks with digital ones does not automatically improve learning outcomes unless students are explicitly guided to develop these competences. In line with this view, Thorne (2016) conceptualises digital learning environments as "unified ecologies", in which the capacity to act is shared between the learner, the digital tools, and the learning environment. Consequently, the effectiveness of learning depends not only on technological design, but also on learners' prior experiences and their patterns of technology use outside the classroom. In essence, technology alone is never enough.

1.2 International and National Policies Supporting Digital Education in Moldova

The increasing interest in the potential of digital textbooks has been accompanied by a series of policy initiatives at both international and national levels. These frameworks are designed to support the effective integration of digital resources into education systems by establishing the necessary conditions for their implementation.

At the international level, UNESCO plays an essential role in supporting Member States to harness the potential of information and communication technologies (ICT) in education, including the development and use of digital textbooks, in order to ensure equitable and inclusive lifelong learning opportunities for all. Its policy frameworks provide guidance for aligning digital education strategies with national priorities (UNESCO, 2024). This direction builds on earlier work: in this context, as UNESCO (2011) emphasised that defining clear policy goals and translating them into appropriate implementation strategies and action plans is the key factor in achieving systematic transformation of education through ICT.

At the European level, digital education has become a strategic priority through the "Digital Education Action Plan 2021-2027" (European Commission, 2020), which sets out a common vision of high-quality, inclusive, and accessible digital education across Europe. The plan focuses on two strategic priorities: fostering the development of a high-performing digital education ecosystem, and enhancing digital skills and competences for the digital transformation.

Beyond this Plan, the European Union has developed several complementary policy initiatives that directly support the integration of digital textbooks into educational systems across member states. A significant milestone in this direction is the Council Recommendation on improving the provision of digital skills and competences in education and training (Council of The European Union, 23.11.2023). This recommendation emphasises the need for high-quality digital education content across all levels of education, supporting the development of digital competences as a core component of lifelong learning. The recommendation is grounded in the DigComp framework, which defines key elements of digital competence across five interrelated areas.

More recently, building on these foundational policies, the European Commission (2025) introduced the Digital Education Content Guidelines, providing a landmark to introduce the EU's first-ever official definition of digital education content and establishing quality criteria for its development and evaluation. Together, these policy initiatives demonstrate that the effective integration of digital textbooks requires not only technological infrastructure, but also coherent strategies, quality standards, and pedagogical guidance.

At the national level, the Republic of Moldova has undertaken significant steps toward the digital transformation of education. The current government program declares digital transformation an imperative and strategic priority to ensure an innovative and inclusive digital society on the base of the Digital Transformation Strategy of the Republic of Moldova for 2023-2030 (Guvernul Republicii Moldova, 2023). Within this framework, education is expected to evolve into a proactive system that supports digital transformation. Consequently, the implementation of the Action Plan in the Field of Digital Education 2024–2027 (Ministerul Educaţiei şi Cercetării al Republicii Moldova, 2024) serves as the operational framework for translating this vision into concrete actions within the educational system – namely, developing digital competences among teachers and students, modernizing educational infrastructure, and promoting the use of digital learning resources, including digital textbooks. These priorities are further reinforced by the Education Development Strategy "Education 2030", which emphasises the integration of ICT in teaching and learning processes and supports the use of digital textbooks and open educational resources (Ministerul Educaţiei şi Cercetării al Republicii Moldova, n.d.).

To support the implementation of these strategies, the Government approved in May 2025 the Implementation Program for 2025–2027 of the Digital Transformation Strategy (Agenţia de Guvernare electronica, 2025). The program outlines a set of targeted measures aimed at advancing the digitalisation of education, modernising infrastructure, and strengthening digital competences. It also defines specific actions to achieve these objectives, including expanding access to high-speed internet, promoting the use of electronic signatures, and enhancing digital skills development. These initiatives are essential for ensuring the effective integration of digital textbooks into the Moldovan education system.

In parallel with these policy frameworks, significant progress has been made in developing digital infrastructure. The Government has approved the concept of the Information System "National Platform for Open Educational Resources" (Guvernul Republicii Moldova, 2026), a strategic initiative designed to function as a centralised

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repository for open digital resources, including digital textbooks, freely accessible and aligned with the national curriculum.

1.3 Research Context and Rationale

In this evolving context, the present study builds on substantial research experience in the field of digital textbooks. The research team has previously contributed to national and international projects focused on the development and implementation of interactive digital textbooks in pre-university education. These include the national project "Development and Implementation of Interactive Digital Textbooks in Pre-University Education" (project code: 20.80009.0807.25 P1P2-0150) (Agenţia Naţională pentru Cercetare şi Dezvoltare, Raport, 2023), carried out within the State Program 2020–2023 under the strategic priority "Societal Challenges". Building on these research results, the team is currently involved in the international project "Ensuring Quality Teaching and Learning in a Digital Age: Development and Implementation of E-Textbooks" (EuDigBook), ERASMUS-JMO-2023-HEI-TCH-RSCH, reference number 101126852 (2023–2026), which extends this line of research within a broader European framework (https://upsc.md/international/proiecte-cooperari/).

This trajectory is further consolidated through the recent project "Innovation in the Design and Implementation of Interactive Digital Math Textbooks for Lower Secondary Education" (project code: 25.80012.0807.42SE), aligned with the strategic priority "Societal Challenges" under the strategic direction "Innovative Educational Technologies and Products". The research presented in this article forms part of this initiative and focuses on the development and classroom use of interactive digital mathematics textbooks in the Republic of Moldova.

Given the convergence of policy support, technological development, and accumulated research expertise, this study addresses both the educational potential of interactive digital textbooks and the practical challenges related to their implementation, including teacher training, curriculum alignment, and equitable access to digital technologies.

Importantly, the study is grounded in the assumption that the educational impact of digital textbooks depends not only on their technological features but also on the pedagogical approaches that guide their use and on the ways learners engage with digital environments. This perspective is particularly relevant in lower secondary mathematics education, where students transition from concrete reasoning to more abstract forms of thinking. In this context, interactive digital textbooks (IDTs) can support the development of key competences such as logical reasoning, mathematical modelling, numerical and spatial understanding, and early algorithmic thinking. However, these outcomes depend on the integration of technology into meaningful learning activities that stimulate exploration, problem-solving, and the application of knowledge in real-world contexts.

2. Methodology

2.1 Theoretical Framework

The transition from concrete to abstract reasoning represents a critical stage of cognitive development in early adolescence (Grades 5–6), which introduces specific

pedagogical challenges in mathematics education. Research in mathematical cognition shows that, during this period, students develop distinct patterns of arithmetic fluency and cognitive processing that differ both from those of younger children and older adolescents. Within this developmental context, IDTs should not be viewed simply as digitised content repositories, but rather as cognitive tools that actively mediate the learning process.

From a pedagogical perspective, a practice-based approach that focuses on active learning through exploration, problem-solving, and applying knowledge in real-life contexts is particularly important. In this framework, interactive digital textbooks can help students develop key mathematical competences. Thus, the pedagogical approach plays a key role in how ICTs are integrated into teaching and learning practices, helping to enhance and extend existing pedagogical activities (Mall et al., 2022).

However, the effective design of IDTs should take into account the ongoing pedagogical challenges that continue to limit students' learning in mathematics. As Srilatha and Sen (2024) state in their systematic analysis, mathematics education confronts multiple obstacles: cognitive challenges (difficulties in abstract thinking, working memory limitations, and problem-solving organisation), affective barriers (mathematical anxiety and fear of failure), and structural gaps between conceptual understanding and procedural fluency. Additionally, Canto et al. (2025) observe persistent difficulties in students' mathematics learning, explained by the complexity of underlying cognitive processes (working memory, fluid intelligence, and processing speed), poor performance in international standardised tests, and a lack of clear understanding of learning mechanisms and effective teaching methods for overcoming these difficulties.

Taken as a whole, these challenges suggest that improving mathematics learning is not merely a matter of introducing digital tools, but of rethinking how these tools are pedagogically designed and integrated. A theoretically based approach to IDT design should therefore address both how students think and how they feel about learning, while also helping them connect conceptual understanding with procedural skills.

In response to these needs, the present study builds on three interconnected theoretical frameworks that provide a coherent basis for both the development and pedagogical use of IDTs.

First, contemporary digital pedagogy moves beyond the simple replacement of analogue resources with digital ones (the "digitisation" paradigm), focusing instead on how technology can meaningfully transform learning processes. In the context of mathematics education, this transformation is particularly significant because technology can address engagement gaps by making abstract concepts perceptible through dynamic visualisations and simulations (Srilatha & Sen, 2024). Furthermore, research emphasises that digital tools can actively support students' cognitive and metacognitive learning processes, including the use of visual representations, the decomposition of complex problems, and the development of self-regulated and reflective learning strategies (Tañola & Lomibao, 2024). Systematic studies show that tools such as dynamic geometry software (e.g., GeoGebra, Desmos Geometry), adaptive learning platforms (e.g., Khan Academy, DreamBox Learning), and interactive simulations (e.g., PhET Interactive Simulations, Desmos Activity Builder) can enhance students' conceptual understanding and thinking skills when used within an appropriate pedagogical framework. In this sense, the pedagogical value of

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technology lies not only in transforming instructional delivery, but also in supporting how students think, learn, and construct mathematical understanding.

Second, constructivist learning theory shows that students learn math best when they are active, not passive. Interactive digital textbooks (IDTs) align with these principles through three key features: *dynamic visualisations* (enabling object manipulation), *exploratory tasks* (discovery over memorisation), and *immediate feedback*. Evidence comes from Nshimiyimana and Andala (2024), who surveyed 275 lower secondary students. According to their findings, 81.7% of students believed that discussing math with classmates improved their learning, and 89.9% felt their teachers were well prepared to deliver student-centred instruction. In the Moldovan context, Chiriac (2016) similarly argues that IDTs derive their pedagogical value from learning activities rooted in practice, discovery, and reflection, actively engaging students in collaborative contexts that transform the textbook into a living model for learning. However, despite this theoretical alignment, current digital textbooks have serious design problems. Mao et al. (2025) studied 231 teachers and 102 students, finding that 71.3% reported poor navigation, 68.9% noted weak interactive features, and 76.5% could not follow their own learning path. Moreover, 82% of digital resources consisted of static text and images, with paper textbooks simply transferred to a screen rather than transformed into truly interactive learning tools For Moldova's digital textbooks to support active, student-centred learning, their design must prioritise navigation clarity, interactive features, and flexible learning pathways.

Third, competence-based education (CBE) in mathematics focuses less on covering content and more on students' ability to demonstrate what they can do, prioritising the acquisition of specific skills and practical expertise. According to the OECD report *"An Evolution of Mathematics Curriculum"* (OECD, 2024), mathematical competence in the 21st century extends beyond traditional content areas (such as quantity, geometry, and measurement) to include mathematical reasoning, problem-solving, critical thinking, and data literacy – skills that are essential for navigating a data-driven and technologically rich society. However, the report also warns against "curriculum overload" – a situation "when the quantity of content required to be taught exceeds the available instructional time or capacity" (OECD, 2024, p. 88). To address this, the OECD proposes three design principles for a competence-based curriculum: *focus* (prioritising key mathematical concepts – fewer topics, deeper learning), *rigour* (ensuring depth and challenge – maintaining cognitive challenge), and *coherence* (connecting topics and competences – logical progression across grades) (OECD, 2024, pp. 91 to 96).

Recent research findings further reinforce the relevance of competence-based approaches in digital learning environments. First, Salinas-Hernández et al. (2025) demonstrate that the use of diverse digital resources, adapted to specific learning challenges, enhances students' self-regulated learning and fosters interdisciplinary collaboration. Second, Drijvers and Sinclair (2024) note that research on digital technologies in mathematics education has progressed beyond the question of whether technology is effective, toward an emphasis on its pedagogical purposes, including improving learning processes, understanding how learning occurs, designing innovative instructional activities, ensuring equitable access, and transforming curricula and assessment practices. Third, Cho and Kim (2025), in their analysis of three AI-based platforms (Khan Academy, KnowRe Math, and ALEKS), confirm that adaptive

personalisation across four dimensions: source, target, time, and method of adaptation, supports competence development by prioritising problem-solving and conceptual understanding over procedural repetition.

Altogether, these three strands of research – contemporary digital pedagogy, constructivist learning theory, and competence-based education – converge toward a central design principle: interactive digital textbooks should function as integral components of everyday classroom practice. Rather than serving as supplementary materials or technological add-ons, they should actively support knowledge construction, learner engagement, and the systematic development of mathematical competences (Laurillard, 2012, pp. 2 to 5).

2.2 Research Design and Questions

This study proposes a practice-based research design to investigate the development and preliminary implementation of interactive digital mathematics textbooks in authentic educational settings in the Republic of Moldova. The study integrates theoretical analysis, curriculum alignment, instructional design, and classroom implementation to explore how interactive digital textbooks may support competence-based mathematics education in Grades 5–6.

The research design is organised as a sequence of three interconnected stages: (1) analysis of international practices in digital textbook development; (2) curriculum alignment analysis; and (3) design and categorisation of interactive learning activities integrated into digital mathematics textbooks.

Within this research design, the study is guided by the following research questions:

- What can be learnt from international practices (France, Finland, Romania) regarding the development and implementation of interactive digital textbooks?
- How does the national mathematics curriculum for Grades 5–6 align with the pedagogical design of digital textbooks, and which competences are emphasised?
- What types of interactive activities can be integrated into digital mathematics textbooks, and what pedagogical functions do they serve in the learning process?

2.3 International Benchmarking Analysis: France, Finland, and Romania

A comparative review of digital textbook implementation in France, Finland, and Romania was conducted to identify pedagogical, technological, and organisational practices relevant to the development of interactive mathematics textbooks in the Republic of Moldova. Using purposive sampling, these countries were selected based on four criteria: (a) recognised experience in digital textbook development; (b) the availability of well-documented national policies; (c) diversity in curriculum implementation, teacher involvement, and digital ecosystems; and (d) the transferability of their methods to the Moldovan context. Specifically, Finland offers a mature, competence-oriented digital education ecosystem with high teacher autonomy. France provides extensive experience in collaborative digital textbook development. Romania shares a comparable curricular and institutional framework that facilitates the transfer of these educational practices to the Moldovan system.

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2.3.1 The French Case

This analysis draws on three main sources: the article by Loffreda et al. (2017) on the current transformations of the digital educational resource landscape in France, the comparative study by Gueudet et al. (2016) of two French digital mathematics textbooks (Hélice & Sésamath); and materials from leading international organisations (UNESCO, OECD, World Bank) (Alemán de la Garza et al., 2019), providing a broader framework for understanding the digital transformations observed in the French context.

In France, digital textbooks have evolved through three generations: from simple PDF versions of printed textbooks (2008), to versions enriched with audio, video and animations (2009), and to versions that allow teachers to mix their own resources with those of the textbook and personalise the content (2011).

Gueudet et al. (2016) compare two opposing models of French digital textbooks for mathematics. *Hélice* platform offers a complex spiral structure and high didactic quality, but is static – once published, it does not change. *Sésamath*, the product of a collective of around 57 teachers, is dynamic – it continuously improves based on user feedback, offers open-source resources and is integrated into a rich platform (*LaboMEP*).

Lofreda et al. (2017) describe the rise of *Lelivrescolaire.fr* (2010), a company that offers digital textbooks for free while selling printed versions, and analyse the BRNE platforms, created by the state in 2015, which provide thousands of free digital resources. However, they identify two main problems: insufficient testing (often conducted in the absence of students) and ambiguity regarding the end user – teacher or student.

The UNESCO report *Rethinking Pedagogy: Exploring the Potential of Digital Technology in Achieving Quality Education* (Alemán de la Garza et al., 2019) argues that digital technologies can either promote or undermine quality education, depending on how they are designed and used pedagogically. French experience with digital textbooks validates several key findings. First, France's national experiment (2009 – 2011) showed that simple digitised versions of textbooks (Generations 1 and 2) failed because they did not transform pedagogical practices. Second, successful initiatives such as the *Sésamath* collective demonstrated that open, flexible, and teacher-driven resources are more effective than top-down, static products. Third, the emergence of *Lelivrescolaire.fr* disrupted the traditional publishing market by offering free digital access, revealing that alternative economic models are possible. Fourth, state-led initiatives such as the BRNEs portals faced criticism due to insufficient classroom testing (conducted without students) and ambiguity about whether the end user is the teacher or the student.

The UNESCO report's (Alemán de la Garza et al., 2019) emphasis on teacher professional development, system coherence, and the primacy of pedagogy resonates strongly with the French case. The key lesson is that successful digital textbook implementation requires not only technological infrastructure but also a coherent alignment between curriculum, teacher training, resource design, and sustainable economic models. Without this alignment, digital tools risk becoming add-ons rather than integral components of quality education.

A recent trend is exemplified by the digital platform developed by Belin Éducation that provides textbooks across multiple levels of education. It offers access to digital versions of officially published textbooks, integrating the full content of printed books

with enriched multimedia and interactive features. For example, the digital mathematics textbooks for Grade 5 ("manuels numériques") include interactive exercises, videos, animations, and formative assessment tools designed to support both teaching and learning processes. Overall, the platform reflects a hybrid model in which traditional textbook structures are enhanced through digital interactivity, supporting a gradual transition from static printed resources to more dynamic, technology-enhanced learning environments.

2.3.2 The Finnish Case

Finland is internationally recognised as one of the pioneers of educational innovation and digital transformation in schooling. The Finnish education system consistently ranks among the world's highest-performing systems and is often considered a benchmark for the integration of technology into teaching and learning (Leviäkangas et al., 2016). Consequently, the Finnish experience with digital textbooks and digital learning materials offers valuable insights for countries seeking to modernise educational resources and promote digital competence among learners.

Drawing on the Finnish experience, this section analyses the evolution of digital textbooks in Finland, with particular emphasis on the development of the Dream School concept. According to Leviäkangas et al. (2016), the Dream School project demonstrated that the education system must be regarded as "an ecosystem where the different interacting organisations and individuals co-create applications and services" (p. 509). Furthermore, the Finnish case shows that innovative procurement models – specifically the procurement of "ICT as a service rather than ICT hardware and software" – together with public-private partnerships and bottom-up approaches can successfully transform ICT services in education from hardware-oriented investments into scalable, service-based ecosystems (Leviäkangas et al., 2016, p. 509).

Finland represents a valuable reference model for the study of digital textbooks due to its coherent digital education ecosystem, which combines curriculum reform, digital competence development, teacher autonomy, advanced technological infrastructure, and the systematic evaluation of educational technologies. Within this framework, leading educational publishers, including *Sanoma Pro* and *Otava Oppimisen Palvelu*, have developed interactive digital textbooks featuring multimedia resources, automated feedback, and interactive learning activities aligned with the national curriculum (OECD, 2023, p. 144). The widespread adoption of these resources is reflected in the findings of the OECD Digital Education Outlook 2023, which reports that "a significant portion of textbooks are digital, with substantially higher use reported in Helsinki" and that "nearly 80% of textbooks are digital in upper secondary education" (OECD, 2023, pp. 143 to 144).

One notable example of Finnish innovation in digital mathematics education is the Eduten platform, implemented by the Turku Research Institute for Learning Analytics (TRILA), University of Turku. The platform features over 200,000 mathematics tasks, comprehensive assessment tools, and learning analytics that enable teachers to monitor student progress and provide differentiated instruction (UNICEF, 2022).

In addition to the major educational publishers Sanoma Pro and Otava Oppimisen Palvelut, the Finnish digital learning ecosystem includes specialised platforms such as Eduten, e-Oppi, and Claned. These platforms provide interactive learning

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materials, automated assessment tools, multimedia resources, and learning analytics, contributing to the widespread integration of digital resources into teaching and learning practices across Finnish schools.

Today, digital learning materials are widely used across Finnish schools, particularly in lower secondary and upper secondary education. Most publishers provide both printed and digital versions of textbooks, allowing schools and teachers to choose the format that best suits pedagogical objectives.

However, in recent years, Finland has also adopted a more balanced perspective regarding educational digitalisation. While digital textbooks remain an important component of teaching and learning, educational authorities and researchers increasingly emphasise the need to combine digital and printed resources according to learning objectives and student needs. This balanced approach is reflected both in classroom practice and in municipal policy decisions. A study by Mäkipää et al. (2024) surveying 550 Finnish language teachers confirmed that printed textbooks remain widely used across basic education, serving as the primary instructional resource. At the municipal level, several local authorities have reassessed extensive screen-based learning and reintroduced printed textbooks in certain subjects. As Luoma and Kauranen (2024) report for Reuters, from autumn 2024 onwards, several Finnish municipalities, including Riihimäki – a town of approximately 30,000 inhabitants and a pioneer in digitalisation – decided to return to printed textbooks for younger students.

The Finnish experience demonstrates that the successful implementation of digital textbooks depends not only on technological infrastructure but also on curriculum alignment, teacher competence, pedagogical design, and continuous evaluation. On the whole, the transition from traditional textbooks to digital learning environments, as well as the recent critical reassessment of extensive screen-based learning, highlights the importance of integrating technology within an inclusive educational ecosystem focused on competence development, learner autonomy, and evidence-based decision-making.

2.3.3 The Romanian Case

Romania has undergone a complex process of educational digitalisation, marked by significant progress but also by persistent challenges in implementation. According to Moroianu et al. (2024), the digital transformation of the Romanian pre-university education system after a decade of regulatory changes, the global pandemic crisis, and the refugee crisis generated by the Russian invasion of Ukraine has revealed both promising foundations and deep structural gaps.

Despite substantial investments in digital infrastructure, policy development, and the creation of digital learning resources, the everyday integration of interactive digital textbooks into classroom practice remains uneven across schools. As the European Council report (2025) highlights, Romania continues to face significant challenges in digital skills: only 27.7% of the population possessed basic digital skills in 2023, well below the EU average of 55.56%. The situation is even more pronounced in rural areas, where the figure drops to just 20.99%.

Nevertheless, Romania's experience offers valuable lessons for the Republic of Moldova. The two countries share similar educational traditions, linguistic proximity, and

comparable challenges in educational resource provision, making these insights particularly relevant.

Moreover, Romania operates a centrally coordinated system for textbook procurement and distribution. Under this system, the state purchases both printed and digital textbooks from private publishers and provides them free of charge to all students. This model is especially pertinent for Moldova, which faces very similar institutional and financial constraints in developing, acquiring, and distributing educational materials. A clear example of this coordinated approach is the Romanian Ministry of Education's "4E-Education" project, supported by the National Recovery and Resilience Plan. The project aims to develop a secure online assessment platform, create 200,000 test items, and expand the digital textbook platform (*manuale.edu.ro*) by supplementing it with 67,000 open educational resources (OER) for pre-university education (Ministerul Educaţiei şi Cercetării al României, 2024).

Currently, Romania has made significant progress in the development and implementation of digital learning resources. The Ministry of Education and Research establishes the curricular framework and approves educational materials, while their development and publication are carried out by private publishing houses like Art Digital, Corint Educational, Intuitext, CD Press.

Although substantial progress has been achieved, important differences remain in the quality and functionality of the available digital resources. The level of interactivity, integration of multimedia elements, diversity of learning activities, and overall user experience vary considerably among providers. Consequently, ensuring greater coherence and consistency across digital educational offerings remains an important challenge. The development of a national platform capable of integrating high-quality interactive content could contribute to a more unified and equitable digital learning environment. Equally important is the continuous professional development of teachers, whose digital competences play a decisive role in the effective pedagogical use of these technologies in classroom practice.

To synthesise the international benchmarking, a comparative framework examined digital textbook implementation in France, Finland, and Romania. The comparison covers six essential dimensions for successful integration: governance, funding, teacher autonomy, digital infrastructure, curriculum alignment, and evaluation practices, providing insights for developing interactive mathematics textbooks in Moldova (Table 1).

Table 1: Comparative framework of digital textbook implementation in France, Finland, and Romania

Dimension	France	Finland	Romania
Governance	Mixed ecosystem combining state initiatives (e.g., BRNE), publishers, and teacher-driven models such as Sésamath (Loffreda et al., 2017; Gueudet et al., 2016).	Coherent ecosystem based on collaboration between schools, authorities, researchers, and technology providers, illustrated by the Dream School model (Leviäkangas et al., 2016).	Centrally coordinated system led by the Ministry of Education and supported by EU programmes (Moroianu et al., 2024; Ministerul Educaţiei şi Cercetării al României, 2024).

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Funding and sustainability	Combination of public initiatives and alternative market-based models, including free digital access combined with printed textbook sales (Loffreda et al., 2017).	Supported by public investment, innovative procurement models, and public–private partnerships (Leviäkangas et al., 2016).	Mainly based on public funding and European investment programmes (Ministerul Educației și Cercetării al României, 2024).
Teacher autonomy and competences	Teacher participation is important in successful models such as Sésamath (Gueudet et al., 2016).	High teacher autonomy and strong emphasis on digital competence development (Leviäkangas et al., 2016).	Teacher digital competences remain a key factor for effective implementation (Moroianu et al., 2024).
Infrastructure and digital ecosystem	Developed platforms and digital resources, however, technological availability alone did not guarantee pedagogical transformation (Loffreda et al., 2017).	Advanced digital ecosystem including interactive textbooks, integrated platforms, multimedia resources, and learning analytics solutions such as Eduten (OECD, 2023; UNICEF, 2022).	Significant progress, but differences in access and resource quality persist (Moroianu et al., 2024; European Council, 2025).
Curriculum alignment and pedagogy	Transition from e-textbooks to more interactive and adaptable resources (Loffreda et al., 2017; Gueudet et al., 2016).	Strong alignment with competence-based curriculum and personalised learning approaches (OECD, 2023).	Digital textbooks meet national curriculum standards, but their interactivity and quality vary by provider (Ministerul Educației și Cercetării al României, 2024).
Evaluation and quality assurance	Limited classroom testing remains a challenge (Loffreda et al., 2017).	Continuous evaluation and evidence-based data drive educational improvement, though recent studies emphasise balancing digital and print resources (UNICEF, 2022; Mäkipää et al., 2024).	Evaluation mechanisms are still developing, with differences in functionality and user experience among digital resources (Moroianu et al., 2024).

For the Republic of Moldova, the analysed cases provide valuable reference points for the development of a national vision for digital textbooks. Rather than adopting a single international model, future initiatives should integrate the most relevant features of different educational systems while respecting the national curriculum, available infrastructure, institutional capacity, and local educational needs. Overall, the international evidence suggests that digital textbooks can contribute meaningfully to educational improvement only when they are embedded within a coherent educational ecosystem that places learning, pedagogy, and equity at the centre of digital transformation.

2.4 Curriculum Alignment and Competence Mapping (Grades 5–6)

The pedagogical architecture of interactive digital textbooks (IDTs) requires a rigorous, systematic alignment with the official national curriculum to ensure coherence,

legitimacy, and effectiveness. In the Moldovan context, the primary reference is the *Curriculum Naţional la disciplina Matematică pentru clasele a V-a – IX-a* (Ministerul Educaţiei şi Cercetării al Republicii Moldova, 2020). This document establishes mathematics education as both informational and formative, explicitly requiring textbooks and resources to support "learning through study, research and independent discovery, stimulation, self-instruction, self-assessment and, ultimately, competence formation" (Ministerul Educaţiei şi Cercetării al Republicii Moldova, 2020, p. 8). Consequently, this requirement is directly relevant to digital textbooks, especially since interactive environments are particularly well-suited to fostering discovery-based learning and, at the same time, offering immediate feedback for self-assessment.

The National Curriculum for Mathematics (grades 5–9) is built upon several principles that have direct implications for digital textbook design (Ministerul Educaţiei şi Cercetării al Republicii Moldova, 2020, pp. 6 to 7):

- *The constructivist principle* (spiral/structural learning) – mathematical learning is organised "concentrically in a spiral", meaning that key concepts are revisited and deepened across grades. IDTs must support this spiral structure through dynamic concept maps, recapitulation modules, and adaptive pathways that link prior knowledge with new content.
- *The formative principle* – the educational process directly targets the development of the learner's personality, including values such as curiosity, creativity, perseverance, independent thinking, and cooperation. IDTs can scaffold these values through collaborative problem-solving tasks, and open-ended investigations.
- *Student-centred learning* – instruction is designed in relation to the learner's life environment. IDTs must therefore offer personalised learning trajectories, context-rich problems drawn from everyday situations, and flexible navigation that accommodates different learning paces.
- *Interdisciplinary and transdisciplinary correlation* – mathematical content is optimally aligned with other disciplines. IDTs can realise this principle through integrated case studies (e.g., fractions, geometry) and STEM projects.

The Moldovan mathematics curriculum adopts a competence-based approach, outlining seven specific competences that guide learning throughout the lower secondary education cycle (Ministerul Educaţiei şi Cercetării al Republicii Moldova, 2020, p. 9). Among these, one explicitly targets the integration of digital tools, highlighting the curriculum's support for the design of interactive learning activities that support logical thinking, mathematical communication, and reasoning. The operationalisation of these competences into grade-specific content is structured systematically. For Grade 5, the curriculum is organised into three main content units (ibid., pp. 10 to 16).

A particularly encouraging aspect is that the curriculum explicitly recommends that students "represent the studied geometric figures using drawing instruments, ICT tools" (Ministerul Educaţiei şi Cercetării al Republicii Moldova, 2020, p. 14). In other words, this provision legitimates the inclusion of dynamic geometry environments within IDTs – something that would otherwise be difficult to implement in a traditional paper textbook.

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In Table 2, the alignment between the Grade 5 content units, targeted competence units, and the potential applications of IDTs is illustrated.

Table 2: Content units, key competence units, and digital textbook implications for Grade 5

Content Unit	Key Competence Units	Digital Textbook Implications
I. Set of natural numbers	Writing, reading, representing on the axis, comparing, rounding, performing operations, translating real situations into mathematical language	Interactive number line; automated exercise generation for operations; step-by-step equation solvers
II. Ordinary fractions. Decimal numbers	Representing on the axis, comparing, performing operations, developing an idea plan, justifying results	Dynamic fraction models (circles, rectangles); drag-and-drop ordering activities; gamified equivalent fraction activities
III. Elements of geometry and measurement units	Identifying geometric figures, using geometric tools (including ICT), constructing figures, determining perimeters/areas/volumes	Virtual geometry toolkit (ruler, compass, protractor, set square); ICT-based construction exercises; STEM projects

For grade 6, the curriculum extends and deepens the competences introduced in grade 5, introducing additional number domains and more complex geometric concepts (Ministerul Educaţiei şi Cercetării al Republicii Moldova, 2020, pp. 18 to 27), as presented in Table 3.

Table 3: Content units, key competence units, and digital textbook implications for Grade 6

Content Unit	Key Competence Units	Digital Textbook Implications
I. Natural numbers	Prime/composite numbers, prime factor decomposition, simple equations	Interactive factorisation trees; step-by-step equation solvers with error analysis
II. Operations with integers	Set of integers (Z), number line representation, opposites and absolute value, ordering and comparison, addition and subtraction of integers, order of operations, multiplication of integers and its properties	Simulations with thermometers, bank accounts, elevators; absolute value as distance on an interactive axis; ordering games with negative numbers
III. Rational numbers	Rational Numbers (Q): representation, comparison, fractions and decimals, absolute value, reciprocals, arithmetic operations, properties of operations, powers, order of operations, and applications of fractions	Dynamic conversion between fraction and decimal representations; Venn diagram interactives for set operations; adaptive practice with rational number arithmetic
IV. Ratios and proportions	Ratios, proportions, direct/inverse proportionality, percentages, simple rule of three, probability elements, arithmetic mean, graphs	Data table and chart generators (bar charts, pie charts); shopping simulations with percentages; etc.
V. Plane and solid geometric figures	Angles (measurement, classification, bisector), circle (length, area), solids (pyramid, cylinder, cone, sphere), nets, volumes	Virtual compass; 3D solid manipulation and unfolding; π estimation through virtual measurements; STEM projects

At the end of grade 6, students are expected to, among other outcomes, "investigate problems and problem situations that require the application of arithmetic operations, learnt solution methods, organising data in tables and/or statistical diagrams

for collection, recording, processing and presentation" (Ministerul Educaţiei şi Cercetării al Republicii Moldova, 2020, p. 28). This statement directly supports the inclusion of data-handling and visualisation tools within IDTs.

In conclusion, the National Curriculum for Mathematics in grades 5–6 provides a robust and detailed framework that is highly compatible with interactive digital textbooks. Its emphasis on spiral learning, formative development, student agency, digital tool use, and interdisciplinary connections creates a favourable environment for IDT adoption. At the same time, the curriculum places clear demands on digital design: IDTs must not merely digitise static content but must actively support exploration, reasoning, self-assessment and interdisciplinary application – precisely the affordances that distinguish interactive digital textbooks from their printed predecessors (Borba et al., 2017).

2.5 Typology of Interactive Activities for Grades 5–6

The pedagogical effectiveness of digital mathematics textbooks depends largely on the diversity and educational relevance of the integrated interactive learning activities. Contemporary research emphasises that digital technologies can support conceptual understanding, mathematical reasoning, and formative assessment when integrated through well-designed learning activities, rather than being used merely as presentation tools (Sofroniou et al., 2025).

Several classifications of digital tasks have been proposed in the literature. For example, Weigand et al. (2024) distinguish between practice, exploratory, simulation, and evaluation activities, emphasising the role of immediate feedback and adaptability. Yerushalmy (2015) highlights the potential of "guided inquiry" tasks in digital environments, while Glasnović Gracin and Kristo (2022) compare the task requirements of digital and printed textbooks, focusing on dimensions such as interactivity, dynamic manipulation, and authentic context.

This case study proposes a typology of interactive learning activities developed for the digital mathematics textbooks MDIR-Mate 5a (Chiriac et al., 2026) (Figure 1) and MDIR-Mate 6a (Chiriac et al., 2026) (Figure 2), developed in accordance with the national mathematics curriculum for Grades 5 and 6. Rather than adopting an existing classification framework, the proposed typology was derived inductively from the instructional design process and from a qualitative analysis of all interactive activities integrated into the two digital textbooks. The aim was to develop a pedagogically meaningful classification that reflects not only the characteristics of digital resources but also their contribution to competence-based mathematics learning. Unlike technology-oriented classifications that primarily differentiate digital resources by format or technical features, this typology focuses on the pedagogical function of activities and their role in supporting mathematical competence development.

The two digital textbooks were developed based on the national curriculum and the officially approved printed textbooks (Achiri et al., 2020; Achiri et al., 2024). They incorporate a wide range of interactive resources, including adapted mathematical exercises and problems, fill-in-the-blank activities, true/false questions, matching and sequencing tasks, interactive formative assessments, virtual laboratories, mathematical visualisations, and digital calculation tools. This diversity provided a rich empirical basis for identifying recurring patterns and developing the proposed typology.

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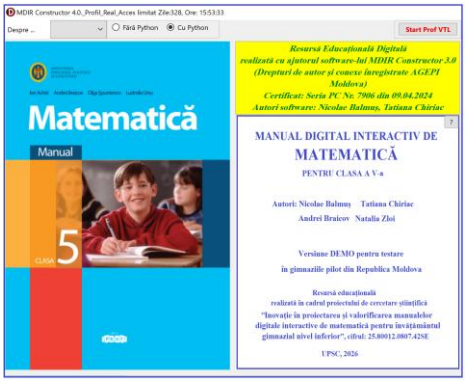

Figure 1. Digital mathematics textbook for 5th grade, „Mate 5a"

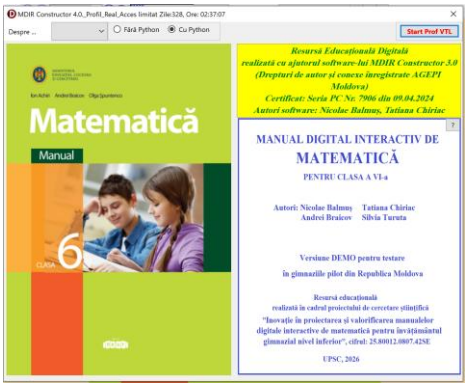

Figure 2. Digital mathematics textbook for 6th grade, „Mate 6a"

The interactive activities were analysed and grouped into four categories according to their primary pedagogical purpose, the nature of learner interaction, and the mathematical competences they were intended to support. Activities exhibiting characteristics of more than one category were classified according to their dominant pedagogical function. Table 4 summarises the proposed typology, while the following subsections describe each category in detail and illustrate it with representative examples extracted from the digital textbooks.

Table 4: Typology of interactive activities in digital mathematics textbooks

Category	Main characteristics	Learner interaction	Supported mathematical competences
Practice and consolidation activities	Activities focused on applying mathematical procedures, practising skills, and consolidating knowledge through immediate feedback.	Individual interaction with tasks, answers, and feedback mechanisms.	Support procedural fluency, accuracy, and consolidation of mathematical knowledge.
Exploratory and dynamic simulation activities	Activities that enable students to explore mathematical concepts through dynamic representations, simulations, and visual models.	Manipulation of digital objects and observation of mathematical relationships.	Support conceptual understanding, mathematical reasoning, and the interpretation of abstract concepts.
Contextualised problem-solving activities	Activities requiring students to apply mathematical knowledge in contextualised situations and develop solution strategies.	Active engagement in analysing problems, selecting methods, and constructing solutions.	Develop problem-solving skills, reasoning, and the ability to apply mathematics in real contexts.
Assessment and self-assessment activities	Interactive tasks designed to evaluate learning, provide feedback, and encourage self-monitoring.	Response submission, feedback interpretation, and correction of errors.	Support self-assessment, reflection, and monitoring of mathematical progress.

2.5.1 Practice and Consolidation Activities

These activities are designed to consolidate procedural fluency and reinforce mathematical knowledge. They help students automate routine operations and confidently

apply standard procedures. Typical examples include multiple-choice questions, drag-and-drop exercises, matching tasks, fill-in-the-gap activities, and numeric entry exercises with automatic feedback. In the analysed digital mathematics textbooks, these activities were implemented after introducing new concepts and provided opportunities for guided practice. Immediate feedback enables students to identify mistakes, correct misconceptions, and monitor their learning progress.

Automated formative assessment is widely recognised as a major pedagogical advantage of digital learning resources. Feedback may range from simple verification ('correct/incorrect') to elaborated feedback with hints, suggestions, and explanations, each supporting different learning objectives (Glasnović Gracin & Kristo, 2022).

Examples from the analysed IDTs illustrate the variety of interactive formats used to support practice and consolidation. Fill-in-the-gap activities were among the most frequently implemented formats, appearing in both Grade 5 (Exercise 1, p. 24; Figure 3, and Exercise 11 – complete-the-table task, p. 20; Figure 4) and Grade 6 (Exercises 4 and 14, pp. 30–31; Figure 5). Other examples include crossword puzzles (Grade 5, p. 167; Figure 6), identifying the intruder tasks (Grade 5, Exercise 18, p. 59; Figure 7), sorting information into columns (Grade 5, Exercise 10, p. 85; Figure 8), and word association activities (Grade 5, p. 31; Figure 9).

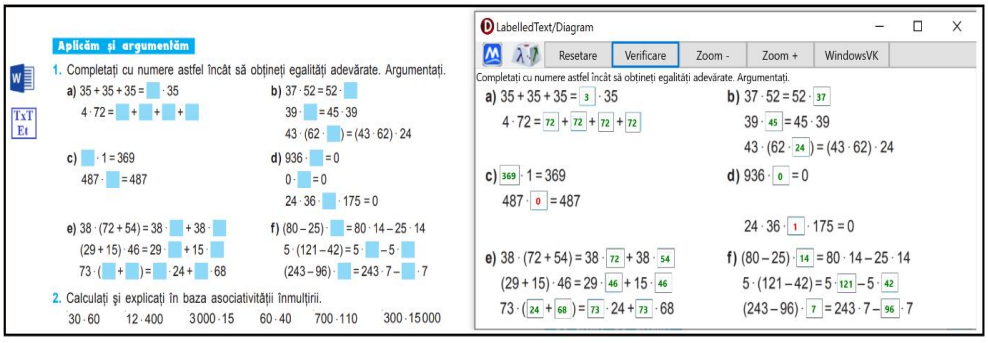

Figure 3. Example of "Fill in the gaps" exercise, ex.1, page 24, "Mate 5a"

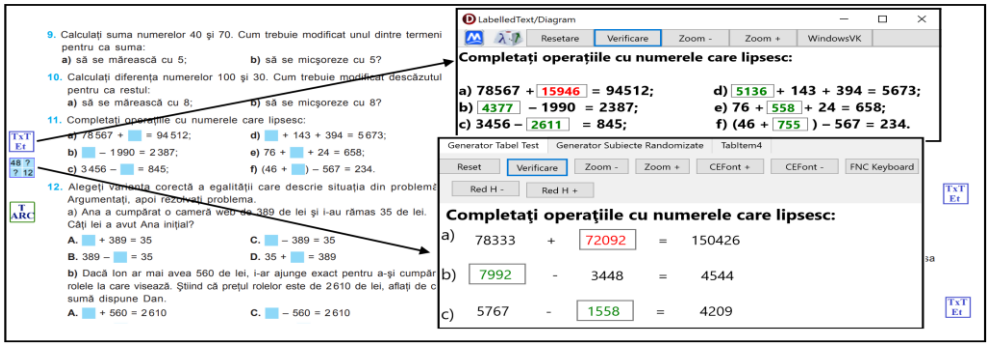

Figure 4. Example of "Fill-in-the-gap, complete the table" exercise, ex.11, page 20, "Mate 5a"

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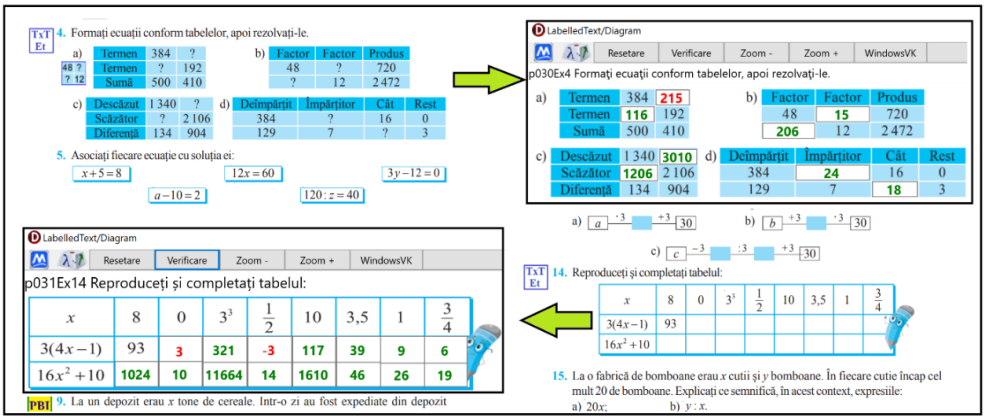

Figure 5. Example of "Fill-in-the-gap, complete the table" exercise, ex.4; ex. 14, pp. 30 to 31, "Mate 6a"

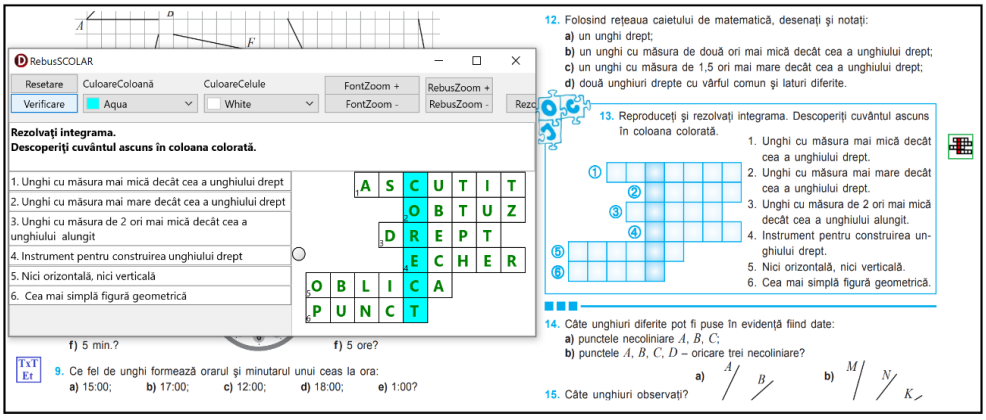

Figure 6. Example of crossword puzzle, ex. 13, p. 167, "Mate 5a"

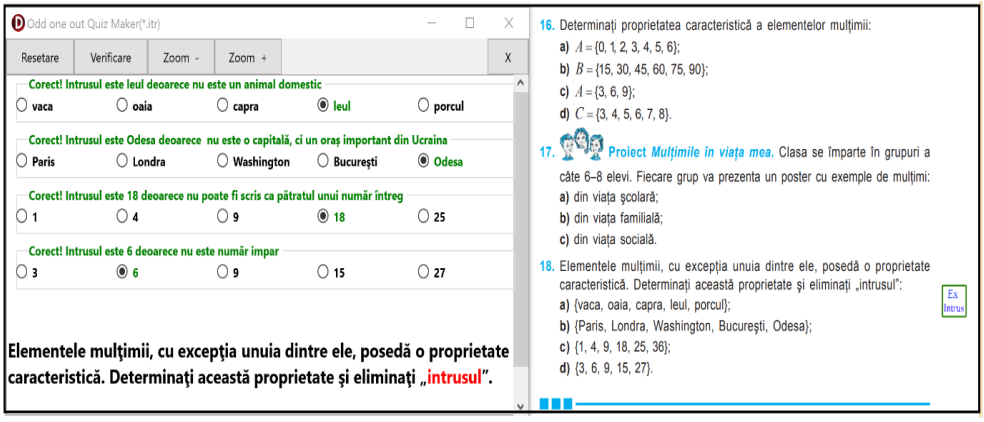

Figure 7. Example of "find the intruder" exercise, ex. 18, p. 59, "Mate 5a"

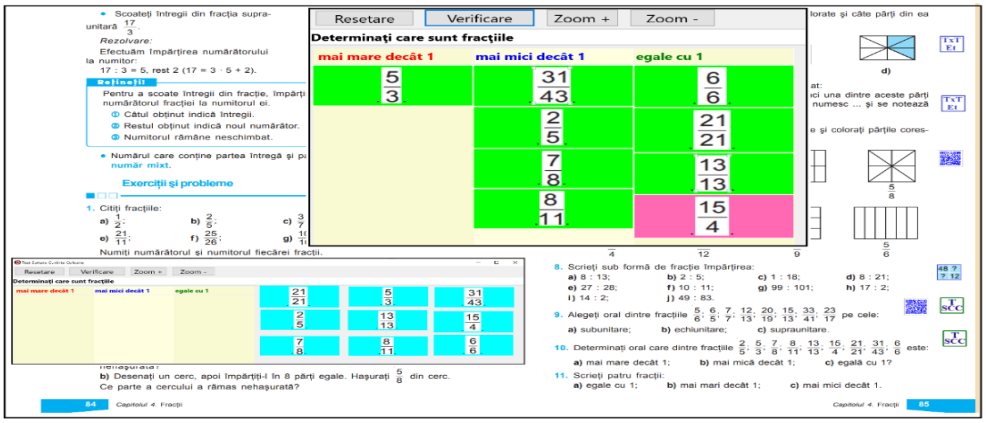

Figure 8. Example of sorting information into columns, ex. 10, p. 85, "Mate 5a"

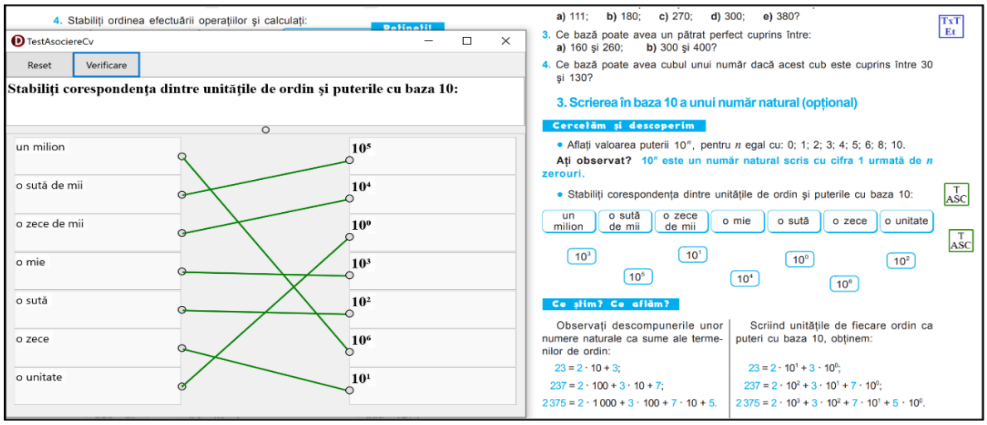

Figure 9. Example of word association exercise, p. 31, "Mate 5a"

2.5.2 Exploratory and Dynamic Simulation Activities

These activities allow students to investigate mathematical concepts through direct manipulation, observation, and experimentation. They are particularly valuable for introducing new notions and supporting conceptual understanding. Interactive visualisations, animations, dynamic mathematical models, and simulations enable students to identify patterns, formulate conjectures, and test hypotheses.

For example, in the geometry unit for grade 6, students can manipulate the dimensions of geometric figures and observe real-time changes in perimeter and area. Such exploratory interactions help transform abstract mathematical relationships into observable phenomena, supporting conceptual development and mathematical reasoning. Other examples include interactive number lines, fraction models, coordinate systems, and geometric constructions. These tools support inquiry-based learning and help students develop deeper conceptual understanding by connecting symbolic, graphical, and numerical representations.

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Further examples from the analysed digital textbooks highlight the integration of interactive resources that support exploratory learning, visualisation, and contextualised mathematical understanding. In Grade 5, these include interactive activities and randomised worksheets on the topic "Perimeter and Area of Polygonal Figures" (p. 197; Figure 10), as well as a virtual laboratory on "Units of Time Measurement" incorporating randomised assessment sheets (p. 207; Figure 11). For Grade 6, dynamic geometry environments were developed to support the exploration of angle measurement, circle properties, and the construction of solid figure nets.

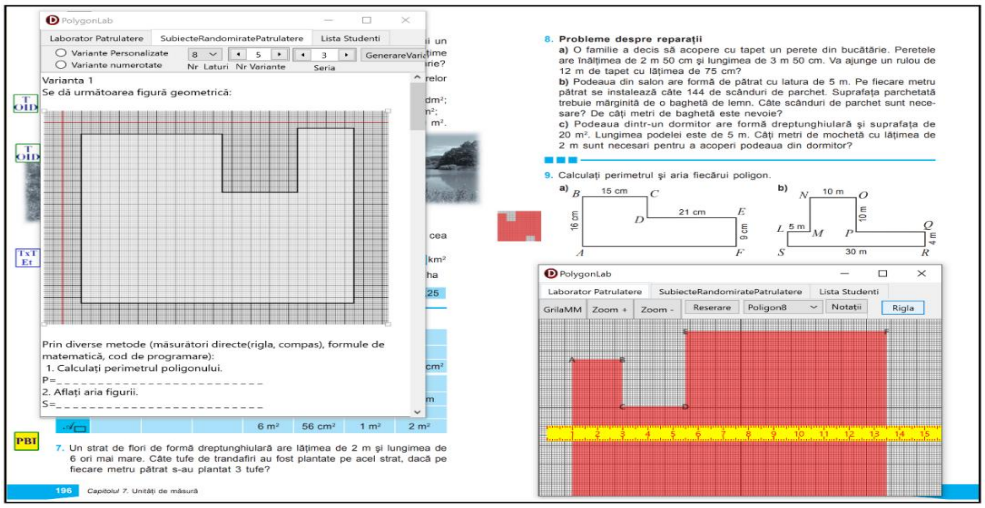

Figure 10. Example of interactive activities and randomised evaluation sheets on the topic "Perimeter and area of polygonal figures", page 197, "Mate 5a"

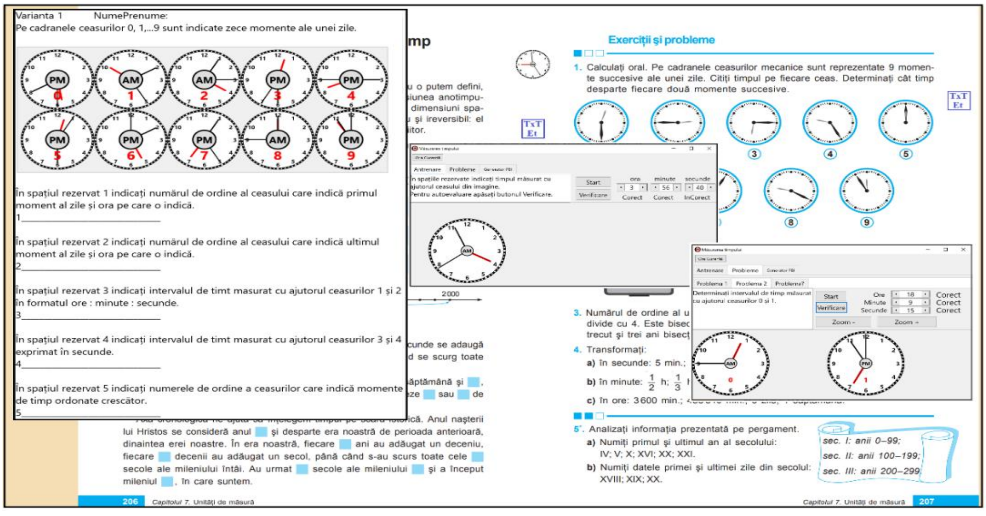

Figure 11. Example of a virtual laboratory on the topic "Units of time measurement" and randomised worksheets for assessing knowledge, page 207, "Mate 5a"

According to Yerushalmy (2015), dynamic geometry environments and interactive diagrams provide effective ways for students to explore mathematical relationships and support the transition from concrete manipulations to abstract reasoning. Furthermore, Simsek et al. (2026) argue that technology-enhanced tasks should position students as active explorers of mathematical ideas, not as passive recipients of information.

2.5.3 Contextualised Problem-Solving Activities

Competence-based mathematics education requires students to apply mathematical knowledge in real-life situations. Accordingly, the digital textbooks analysed include contextualised problems that simulate everyday situations involving measurements, percentages, data interpretation, and practical decision-making.

These activities promote the transfer of mathematical knowledge to practical contexts and contribute to the development of higher-order thinking skills. This approach aligns with current trends in mathematics education that emphasise authentic mathematical modelling and meaningful learning experiences. When students encounter mathematical concepts embedded in familiar situations, they are more likely to recognise the relevance of what they are learning and to transfer their knowledge to new contexts.

Additional examples from the analysed digital textbooks illustrate the use of interactive problem-solving activities that support the application of mathematical knowledge in varied contexts. In Grade 5, these include cloned problem tasks with randomised parameters (Exercise 18, p. 175; Figure 12) and interactive "complete-the-table" exercises supported by a randomised worksheet generator (p. 73; Figure 13).

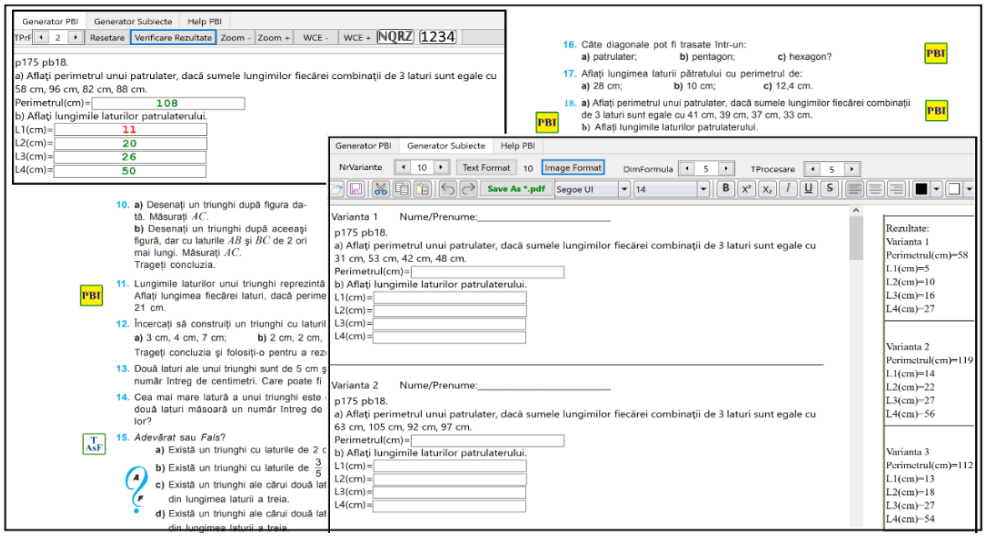

Figure 12. Example of cloned problem with randomised subjects, problem 18, page 175, "Mate 5a"

These features allow students to practise the same mathematical structure across different contexts, reinforcing their ability to transfer knowledge. For instance, a problem involving percentage calculations can be randomly generated with different products, prices, or discount rates, requiring students to apply the same reasoning to new situations.

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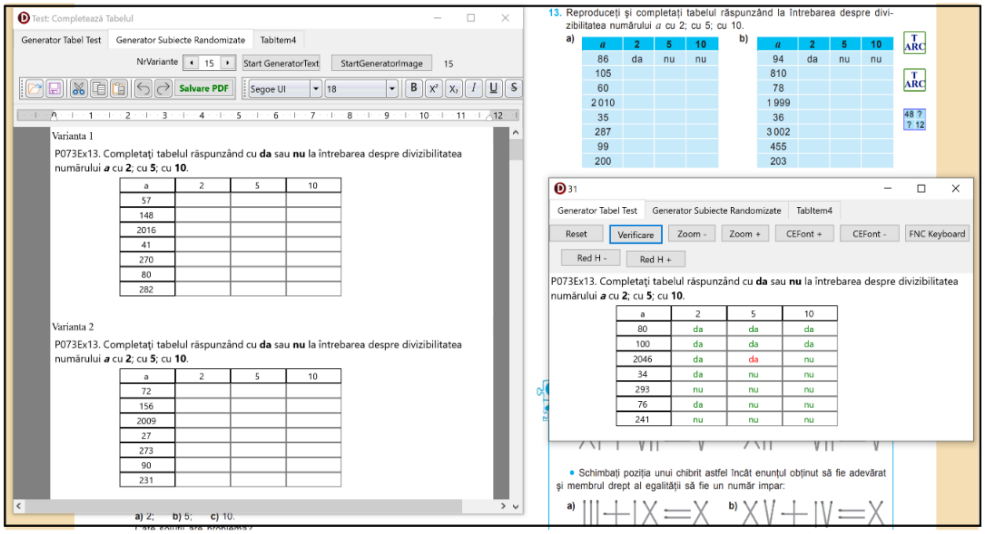

Figure 13. "Complete the table" exercise and randomised worksheet generator, page 73, "Mate 5a"

2.5.4 Interactive Assessment and Self-Assessment Activities

Digital textbooks offer continuous assessment opportunities through quizzes, self-checking tasks, and automatically evaluated exercises. Unlike traditional paper-based tasks, these activities provide immediate feedback and allow students to regulate their own learning process independently.

In the digital textbooks analysed, assessment activities were integrated throughout the learning units, not only at the end of a chapter. This design supports formative assessment practices and enables students to identify their strengths and weaknesses during the learning process, rather than only after instruction has finished.

Research on digital mathematics education highlights the growing importance of technology-supported assessment as an integral component of digital learning environments. In particular, adaptive systems can provide individualised support for learners by adjusting the difficulty or type of task based on student performance in accordance with Weigand et al. (2024).

An example from the analysed digital textbooks is provided by the Grade 5 activities on "Column Calculation Techniques" (Figure 14), which integrate learning, assessment, and self-assessment components. These activities enable students to practise column addition, subtraction, multiplication, and division while receiving immediate feedback. Students can verify their answers independently, review step-by-step solutions, and generate new randomised exercises for additional practice, thereby supporting both procedural accuracy and self-regulated learning.

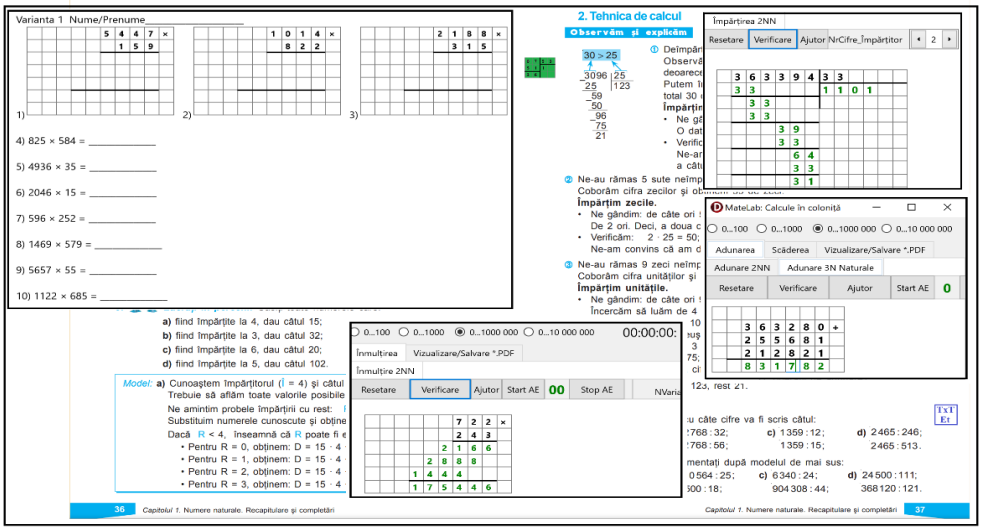

Figure 14. Example of learning / assessment / self-assessment activities on the topic "Column Calculation Techniques", page 73, "Mate 5a"

3. Discussion and Conclusions

This study explored the pedagogical design of interactive digital mathematics textbooks for Grades 5–6 through a competence-oriented perspective. By combining international benchmarking, curriculum alignment analysis, and the development of a pedagogically grounded typology of interactive learning activities, the research provides both theoretical and practical insights into the creation of interactive digital textbooks (IDTs) for the Moldovan educational context. Overall, the findings suggest that the successful integration of IDTs depends not only on technological factors but also on pedagogical design, curriculum alignment, and teacher preparedness.

The international benchmarking analysis conducted across France, Finland, and Romania highlights that effective implementation of digital textbooks requires considerably more than the availability of technological infrastructure. While the French experience demonstrates that merely converting printed textbooks into digital formats has a limited impact on teaching practices, teacher-driven and collaborative resources, such as those developed through the Sésamath initiative, appear to generate more meaningful educational benefits.

Furthermore, the curriculum alignment analysis indicates that the National Curriculum for Mathematics in grades 5–6 offers a solid foundation for the integration of IDTs. In particular, its emphasis on spiral learning progression, formative assessment, student-centred learning, and the meaningful use of digital technologies creates favourable conditions for the implementation of interactive learning resources.

Another important finding concerns the four-category typology of interactive activities proposed in this study. The analysis demonstrates that carefully designed digital textbooks can support a wide range of educational objectives, extending from the development of procedural fluency to exploratory learning, problem-solving, and

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competence demonstration. Consequently, IDTs should be viewed not simply as digital versions of printed materials, but as pedagogical environments capable of supporting diverse learning processes.

Taken together, these findings underline two major contributions of the study. First, the research brings together principles of digital pedagogy, constructivist learning theory, and competence-based education into a coherent framework for the design of interactive digital mathematics textbooks. This shifts the focus from viewing digital textbooks as mere content repositories to understanding them as cognitive tools that actively mediate learning. Second, focusing on Moldova, the study provides practical insights for other educational systems facing similar infrastructure, teacher competence, and curriculum reform challenges.

In conclusion, interactive digital textbooks represent a promising instrument for competence-based mathematics education in grades 5–6 when they are carefully aligned with curricular objectives and sound pedagogical principles.

Although technology alone cannot transform education, well-designed IDTs create favourable conditions for active learning, exploration, and competence-oriented mathematics instruction. In Moldova, where digital transformation is a strategic priority, these resources can significantly modernise teaching and learning. However, fully realising this potential requires sustained collaboration among policymakers, curriculum developers, educators, school leaders, and researchers.

Future research should empirically validate the proposed typology and digital textbook framework through large-scale, longitudinal studies. Further investigations should directly assess students' mathematical competences, use learning analytics to examine interaction patterns, and compare schools with differing technological infrastructures. Finally, future studies should explore how teacher digital competence and pedagogical practices influence IDT integration, providing stronger evidence regarding their usability, equity, and educational effectiveness.

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References

Achiri, I., Braicov, A., Şpuntenco, O. & Ursu, L. (2020). *Matematică: Manual pentru clasa a 5-a.* Ministerul Educaţiei, Culturii şi Cercetării al Republicii Moldova.

Achiri, I., Braicov, A., & Şpuntenco, O. (2024). *Matematică: Manual pentru clasa a 6-a.* Ministerul Educaţiei, Culturii şi Cercetării al Republicii Moldova.

Agenţia de Guvernare electronica. (2025). *Noi direcţii strategice pentru accelerarea digitalizării şi apropierea de UE*. https://www.cio.gov.md/ro/node/40874?month=2025-06

Agenţia Naţională pentru Cercetare şi Dezvoltare (2023). Raport final. Retrieved from https://ancd.gov.md/sites/default/files/document/attachments/Raport_final_2020-2023_Chiriac%20Tatiana.pdf

Alemán de la Garza, L., Anichini, A., Antal, P., Beaune, A., Bruillard, E., Burke, D., & Hosman, L. (2019). *Rethinking pedagogy: Exploring the potential of digital technology in achieving quality education*. Mahatma Gandhi Institute of Education for Peace and Sustainable Development (MGIEP), UNESCO. https://digitalcommons.odu.edu/teachinglearning_fac_pubs/114

Baek, E.-O., & Monaghan, J. (2013). Journey to textbook affordability: An investigation of students' use of eTextbooks at multiple campuses. *International Review of Research in Open and Distributed Learning, 14*(3), 1–26. https://doi.org/10.19173/irrodl.v14i3.1233

Borba, M. C., Askar, P., Engelbrecht, J., Gadanidis, G., Llinares, S., & Aguilar, M. S. (2017). Digital technology in mathematics education: Research over the last decade. In G. Kaiser (Ed.), *Proceedings of the 13th International Congress on Mathematical Education: ICME-13 Monographs* (pp. 221–233). Springer. https://doi.org/10.1007/978-3-319-62597-3_14

Canto, M. C., Manchado, M., Aragón, E., Mera, C., Piñero, J. C., Menacho, I., & Navarro, J. I. (2025). Domain-general cognitive precursors and their relationship with mathematical competence in students aged 10 to 12 years. *Current Psychology, 44*, 13561–13573. https://doi.org/10.1007/s12144-025-08124-z

Cho, M. K., & Kim, S. (2025). Analyzing AI-based educational platforms for supporting personalized mathematics learning. *International Electronic Journal of Mathematics Education, 20*(4), Article e0847. https://doi.org/10.29333/iejme/16664

Council of the European Union. (2023). *Council Recommendation of 23 November 2023 on improving the provision of digital skills and competences in education and training* (C/2024/1030). EUR-Lex. https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=OJ:C_202401030

Chiriac, T. (2016). Cadrul psihopedagogic şi metodologic al manualului digital. *Acta et Commentationes. Ştiinţe ale Educaţiei, 1*(8), 105–114. https://ibn.idsi.md/vizualizare_articol/48206

Chiriac, T., Balmuş, N., & Braicov, A. (2026). *MDIR-MATE-5a: Manual digital interactiv de matematică pentru clasa a 5-a* [Interactive digital mathematics textbook for Grade 5]. Certificat AGEPI de înregistrare a programului pentru calculator Seria PC Nr. 8407 din 23.02.2026. https://db.agepi.md/opere/Details.aspx?id=738112276745868773724606255584 1&nr=738112286745864773724606255847

Chiriac, T., Balmuş, N., Braicov, A., & Turuta, S. (2026). *MDIR-MATE-6a: Manual digital interactiv de matematică pentru clasa a 6-a* [Interactive digital mathematics textbook for Grade 6]. Certificat AGEPI de înregistrare a programului pentru calculator Seria PC Nr. 8419 din 23.02.2026. https://db.agepi.md/opere/Details.aspx?id=738112276745868773724616255843&nr=738112286745864773724616255849

Drijvers, P., & Sinclair, N. (2024). The role of digital technologies in mathematics education: Purposes and perspectives. *ZDM–Mathematics Education, 56*(2), 239–248. https://doi.org/10.1007/s11858-023-01535-x

European Commission. (n.d.). *Digital Education Action Plan: Actions*. European Education Area. https://education.ec.europa.eu/focus-topics/digital-education/actions

European Commission. (2020). *Digital Education Action Plan 2021–2027: Resetting education and training for the digital age* (COM(2020) 624 final). https://education.ec.europa.eu/focus-topics/digital-education/actions

European Commission, Directorate-General for Education, Youth, Sport and Culture. (2025). *Making informed choices on digital education content: EU guidelines for teachers and educators*. Publications Office of the European Union. https://doi.org/10.2766/6984929

European Commission. (2025). *Digital Decade 2025: Country reports – Country Report: Romania*. https://digital-strategy.ec.europa.eu/en/library/digital-decade-2025-country-reports

Gillen, J. (2014). *Digital literacies*. Routledge. https://www.loc.gov/resource/gdcebookspublic.2021758955/?pdfPage=11

Glasnović Gracin, D., & Kristo, N. (2022). Differences in the requirements of digital and printed mathematics textbooks. *CEPS Journal, 12*(2), 101–122. https://journals.uni-lj.si/CEPSJ/article/view/26771/20901

Guvernul Republicii Moldova. (2026, April 14). *Increased access to digital educational resources: They will be stored on modern national platform*. Gov.md. https://gov.md/index.php/ro/comunicate-de-presa/acces-sporit-la-resurse-educationale-digitale-vor-fi-stocate-pe-o-platforma

Guvernul Republicii Moldova. (2023). *The digital transformation strategy of the Republic of Moldova for 2023–2030*. https://mded.gov.md/transparency/digital-transformation-strategy-2023-2030/

Gu, X., Wu, B., & Xu, X. (2015). Design, development, and learning in e-textbooks: What we learned and where we are going. *Journal of Computers in Education, 2*(1), 25–41. https://doi.org/10.1007/s40692-014-0023-9

Laurillard, D. (2012). *Teaching as a design science: Building pedagogical patterns for learning and technology*. Routledge.

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Leviäkangas, P., Schneitz, A., & Aapaoja, A. (2016). The evolution of Finnish "Dream School" – Via public entrepreneurship from innovative concepts to national scale-up. *International Journal of Information and Education Technology, 6*(7), 508–514. https://www.ijiet.org/vol6/742-A00007.pdf

Loffreda, M., Levoin, X., & Bruillard, E. (2017). Textbooks and digital resources: Current transformations in France. *Revista Latinoamericana de Tecnología Educativa, 16*(2). https://hal.science/hal-02164636

Luoma, E., & Kauranen, A. (2024, September 10). *Books in, screens out: Some Finnish pupils go back to paper after tech push*. Reuters. https://www.reuters.com/world/europe/books-screens-out-some-finnish-pupils-go-back-paper-after-tech-push-2024-09-10/

Mall, I., Dlamini, R., Ndlovu, N. S., Drennan, G., Nkambule, F., Phakathi, N., et al. (2022). A developing realist model of the pedagogical affordances of ICTs. *South African Computer Journal, 34*(2), 50–75. https://doi.org/10.18489/sacj.v34i2.1076

Mao, X., Dai, Y., Liu, Y., Jiang, Y., & Zhang, Y. (2025). Optimizing cognitive load in digital mathematics textbooks: A mixed-methods study on content organization and application models. *Journal of Educational Technology and Innovation, 7*(3), 44–59. https://doi.org/10.61414/pxn87q66

Mäkipää, T., Hahl, K., Luodonpää-Manni, M. K., & Lahti, L. (2024). Teaching strategies and materials in foreign language teaching in Finland: Focus on basic and upper secondary education. *The Nordic Journal of Language Teaching and Learning, 12*(1), 106–134. https://doi.org/10.46364/njltl.v12i1.1235

Ministerul Educaţiei şi Cercetării al Republicii Moldova. (n.d.). *Education Development Strategy "Education 2030"*. Press releases. https://mecc.gov.md/en/node/12083; https://ipp.md/wp-content/uploads/2022/06/Buletin-informativ-aprilie-Educatia-2030.pdf

Ministerul Educaţiei şi Cercetării al Republicii Moldova. (2024). *The action plan in the field of digital education 2024–2027*. https://mec.gov.md/sites/default/files/roadmap_on_digitalisation_in_education_and_action_plan_for_the_period_2024_-_2027.pdf

Ministerul Educaţiei şi Cercetării al Republicii Moldova. (2020). *Curriculum naţional: Matematică, clasele 5–9: Curriculum disciplinar: Ghid de implementare*. Liceu. https://mecc.gov.md/sites/default/files/matematica_gimnaziu_ro.pdf

Ministerul Educaţiei şi Cercetării al României. (2024). *Proiectul „e-Evaluare, e-Examinare în Educaţie (4E-Education)"*. https://www.edu.ro/proiect_4E_Education

Moroianu, N., Constantin, A., Istudor, M., & Gândea (Roşoiu), I. M. (2024). Digital transformation of the Romanian pre-university education system. *Theoretical and Applied Economics, XXX*(Special Issue, Summer), 49–67. https://ideas.repec.org/a/agr/journl/vxxxy2023ispecialp49-67.html

Nshimiyimana, V., & Andala, H. O. (2024). Effect of implementing a competence-based curriculum on students' academic performance in mathematics: A case of selected lower secondary public day schools in Rwamagana District, Rwanda. *African Journal of Empirical Research, 5*(4), 512–519. https://doi.org/10.51867/ajernet.5.4.41

OECD. (2023). *OECD digital education outlook 2023: Towards an effective digital education ecosystem*. OECD Publishing. https://doi.org/10.1787/c74f03de-en

OECD. (2024). *An evolution of mathematics curriculum: Where it was, where it stands and where it is going*. OECD Publishing. https://doi.org/10.1787/0ffd89d0-en

Salinas-Hernández, U., Kock, Z. J., Pepin, B., Gabbana, A., Toschi, F., & Lazendic-Galloway, J. (2025). Digital resources in support of students with mathematical modelling in a challenge-based environment. *Education Sciences, 15*, Article 1123. https://doi.org/10.3390/educsci15091123

Simsek, A., Clark-Wilson, A., Bretscher, N., & Hoyles, C. (2026). Exploring mathematics teachers' integration of technology into classroom teaching practice: A focus on geometric similarity. *International Journal of Mathematical Education in Science and Technology, 57*(4), 697–727. https://doi.org/10.1080/0020739X.2025.2469865

Sofroniou, A., Patel, M. H., Premnath, B., & Wall, J. (2025). Advancing conceptual understanding: A meta-analysis on the impact of digital technologies in higher education mathematics. *Education Sciences, 15*(11), Article 1544. https://doi.org/10.3390/educsci15111544

Srilatha, N., & Sen, A. K. (2024). Exploring pedagogical barriers and challenges in mathematics education. *Journal of Nonlinear Analysis and Optimization, 15*(2). https://jnao-nu.com/Vol.%2015,%20Issue.%202,%20July-December%20:%202024/151_online.pdf

Tañola, M., & Lomibao, L. (2024). Understanding how students learn mathematics: A systematic literature review of contemporary learning strategies in mathematics education post-2020. *Journal on Innovations in Teaching and Learning, 4*, 66–75. https://doi.org/10.12691/jitl-4-1-11

Thorne, S. L. (2016). Cultures-of-use and morphologies of communicative action. *Language Learning & Technology, 20*(2), 185–191. https://doi.org/10.64152/10125/44473

UNESCO. (2024). *Six pillars for the digital transformation of education: A common framework*. UNESCO. https://unesdoc.unesco.org/ark:/48223/pf0000391299

UNESCO. (2011). *Transforming education: The power of ICT policies* (R. B. Kozma & S. Isaacs, Eds.). UNESCO. https://unesdoc.unesco.org/ark:/48223/pf0000211842

UNICEF Office of Global Innovation and Technology. (2022). *Meet Eduten, the edtech startup with the potential to become a "Blue Unicorn"*. UNICEF. https://wcmsprod.unicef.org/innovation/press-releases/unicef-edtech-award-eduten

Vaarala, H., & Jalkanen, J. (2018). Changing spaces, expanding mindsets: Towards L2 literacies on a multimodal reading comprehension course. *Language Value, 2*(1). https://www.e-revistes.uji.es/index.php/languagevalue/article/view/4739

Weigand, H.-G., Trgalova, J., & Tabach, M. (2024). Mathematics teaching, learning, and assessment in the digital age. *ZDM–Mathematics Education, 56*(4), 525–541. https://doi.org/10.1007/s11858-024-01612-9

Yerushalmy, M. (2015). E-textbooks for mathematical guided inquiry: Design of tasks and task sequences. In *New ICMI Study Series* (pp. 229–247). Springer. https://doi.org/10.1007/978-3-319-09629-2_7

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