

DUAL EDUCATION DIGITALIZATION: UNPACKING FINANCIAL STRATEGIES ACROSS EUROPE

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Abstract: *This paper presents a literature review on the financing of digitalisation in dual education across Europe. It examines the funding models utilised, the efficiency of these models, the impact of the COVID-19 pandemic, and offers country-specific analyses of Germany, Romania, and the Republic of Moldova. The review highlights the significance of public-private partnerships, the disparity in the availability of funds and digital readiness across countries, and the intensifying need for digitalisation due to the pandemic. Policy recommendations emphasise fostering cooperation between sectors, leveraging international funding, and investing in digital competencies. The paper concludes by identifying potential areas for further research.*

Key words: *dual education, digitalisation, financing models*

JEL: I25, O33, H52

1. Introduction

The ongoing digital revolution has ushered in a transformational shift in various sectors of society, including education. One educational model that has particularly been influenced by this digitalisation process is dual education—a system that combines classroom-based learning with practical, on-the-job training (Bilynska, Ridei, & Anhelina, 2020).

Dual education has a rich historical origin, dating back to medieval craft guilds (Langthaler, 2015). In the modern context, it is considered a robust model that bridges the gap between theoretical knowledge and practical skills, contributing to the effective preparation of a skilled workforce. The success of dual education, especially in countries such as Germany and Switzerland, is well-documented (Bilynska et al., 2020). Yet, the advent and rapid expansion of digital technologies present both an exciting opportunity and a challenging dilemma for dual education.

Digitalisation refers to the process of converting and integrating digital technologies into everyday practices, operations, and systems (Legner et al.,

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2017). The increased use of digital technologies like AI, big data, and e-learning platforms are fundamentally altering the nature of education. Digitalisation not only promises a greater reach and accessibility but also fosters innovative teaching-learning practices that can enhance the quality of education (Øvrelid, Bygstad, Ludvigsen, & Dæhlen, 2023). In the dual education context, digitalisation can enrich both theoretical and practical aspects of learning, enabling students to acquire digital competencies that are increasingly sought in the modern job market.

However, the digitalisation of dual education is not without its challenges. Access to digital resources, maintaining the quality of online learning, and the need for digital literacy are just a few of the hurdles that need to be addressed (Leitner, Kreimer, Heck, & Vakavlieva, 2023).

This paper seeks to delve into this realm by examining the financing models and efficiency of digitalisation in dual education across Europe. Despite the diverse socio-economic conditions among European nations, the region as a whole has shown significant commitment to the advancement of dual education (Hippach-Schneider & Rieder, 2022). This analysis will provide valuable insights into how different financing models influence the effectiveness of digitalisation efforts in dual education.

The *research objectives* of this paper are as follows:

- To provide an overview of the current state of dual education's digitalisation across Europe.
- To critically analyse the various financing models adopted for digitalisation in dual education in selected European countries.
- To assess the efficiency and effectiveness of these financing models.
- To understand the impact of the COVID-19 pandemic on the financing of digitalisation in dual education.
- To identify the challenges and opportunities in financing the digitalisation of dual education.

The underlying *research questions* include:

- What are the prevailing financing models for the digitalisation of dual education across Europe?
- How efficient are these models in facilitating digitalisation?
- What impact has the COVID-19 pandemic had on the financing of dual education's digitalisation?
- What are the major challenges and opportunities in financing digitalisation in dual education, and how can they be addressed?

By exploring these objectives and questions, the study aims to offer critical insights into advancing dual education through digitalisation in a diverse European context.

2. Methodology

This study follows a systematic approach for the literature review to address the research objectives. A literature review serves as a solid foundation for the examination and interpretation of developments in a specific field of study (Machi & McEvoy, 2021). In this context, it offers the ability to understand, analyze, and compare various financing models for the digitalisation of dual education across Europe.

The literature review was conducted using a two-stage method. The first stage involved the identification and extraction of relevant literature pertaining to the financing of dual education's digitalisation. This process was guided by the principles of systematic reviews, ensuring a rigorous and transparent approach to identifying and assessing literature (Aveyard, 2023).

The second stage involved the analysis and synthesis of the selected literature. This provided insights into the different financing models across Europe, their efficiency, the impact of the COVID-19 pandemic, and the identified challenges and opportunities.

The narrative synthesis approach guided this stage, allowing a descriptive and thematic interpretation of the findings across a broad range of literature (Popay et al., 2006).

The selection of sources followed explicit criteria to ensure the relevance and quality of the literature.

Firstly, the study focused on peer-reviewed journal articles and official reports as they maintain a high standard of academic integrity (Adams, Smart, & Huff, 2017). This includes documents from institutions such as the OECD, the European Commission, and reputable universities.

Secondly, the literature must be relevant to the topic—specifically, it should pertain to dual education, digitalisation, and financing models in the context of Europe. This ensures that the analysis is based on evidence that directly addresses the research objectives.

Thirdly, the recency of the literature was considered, with a preference for works published in the last decade to ensure that the insights reflect recent trends and developments. However, seminal and relevant works beyond this timeframe were also included for a comprehensive understanding.

Finally, the geographic coverage was taken into account, with the study focusing on literature that covers various regions in Europe, reflecting the diverse socio-economic contexts of the countries.

This meticulous source selection process helped ensure that the literature review was comprehensive, relevant, and academically rigorous.

3. Education and Digitalisation: A Theoretical Perspective

Dual education and digitalisation are two critical concepts driving the evolution of today's education sector. An understanding of these concepts and their intertwining role is essential to investigate the financing models and their efficiency in advancing digitalisation of dual education in Europe.

Dual education, sometimes referred to as dual training or cooperative education, is an instructional approach that combines classroom-based education with practical, on-the-job training (Gonon, 2012). This model of education exists in various forms across the world, but it is particularly prominent in Germany, Switzerland, and Austria. It hinges on the principle that theoretical knowledge and practical skills are two sides of the same coin in vocational training (Wolter & Ryan, 2011).

On the other hand, digitalisation represents the integration and use of digital technologies in everyday practices and systems (Hess, Benlian, Matt, & Wiesböck, 2016). In education, digitalisation can take several forms, including the use of e-learning platforms, digital textbooks, virtual classrooms, and data analytics for monitoring and improving student performance (Picciano, 2021).

The role of digitalisation in dual education is multifaceted and profound. It has significant implications for the effectiveness, reach, and accessibility of dual education, thereby contributing to the overall quality of vocational training.

Firstly, digitalisation can enhance the learning process in dual education. Digital learning resources, such as e-learning modules, virtual labs, and interactive simulators, can supplement traditional classroom-based teaching and workplace training. They can provide learners with a dynamic and interactive learning experience that promotes better understanding and retention of knowledge (Searson, 2023).

Secondly, digitalisation can expand the reach and accessibility of dual education. Online learning platforms can provide remote access to course materials and training sessions, enabling individuals from geographically dispersed regions to participate in dual education programs. This can be particularly beneficial in countries with sparse population density or inadequate transport infrastructure (Bilynska et al., 2020).

Lastly, digitalisation can facilitate better tracking and assessment of learner progress in dual education. Digital tools can automate the process of recording and analysing learner data, providing instructors with valuable insights into each learner's performance and progress. This can enable more personalised instruction and support, leading to better learning outcomes (Daniel, 2016).

Despite the immense potential of digitalisation, its integration into dual education is still a work in progress. The level of digitalisation varies greatly across countries, regions, and institutions, reflecting differences in financial resources, infrastructure, policy, and digital literacy among teachers and learners.

In developed countries like Germany, digitalisation in dual education is relatively advanced. The German Federal Ministry of Education and Research has implemented numerous initiatives to promote digitalisation in vocational education and training, such as the "Digital Media in Vocational Education and Training" programme. However, issues such as unequal access to digital technologies and inadequate digital literacy among some groups of learners remain a concern (Euler, 2013).

In many developing and transition countries, the digitalisation of dual education is still in its infancy. These countries often face significant barriers to digitalisation, including limited financial resources, inadequate digital infrastructure, and low levels of digital literacy. Yet, the potential benefits of digitalisation for dual education are recognised, and efforts are being made to overcome these barriers. For instance, the European Training Foundation is supporting several projects aimed at promoting digitalisation in vocational education and training in transition countries (Brolpito, 2018).

The ongoing COVID-19 pandemic has underscored the urgency and importance of digitalisation in dual education. As traditional classroom-based education and workplace training have been disrupted, digital technologies have become a crucial lifeline for continuing vocational education and training. However, the sudden and large-scale shift to online learning has also highlighted the challenges and gaps in the current state of digitalisation, such as unequal access to digital technologies and the need for digital pedagogical skills among teachers (Crawford et al., 2020).

4. Financing Dual Education's Digitalisation: An Overview of Models Across Europe

The financing of dual education's digitalisation represents a complex and diverse landscape across Europe, with different nations adopting different approaches based on their socio-economic context, policy preferences, and educational infrastructure.

A review of the literature reveals at least three prominent models for financing dual education's digitalisation: government-led funding, private sector investment, and public-private partnerships.

Government-Led Funding is the most common model across Europe, particularly in countries with strong state involvement in education and training. The government typically finances the digitalisation of dual education through direct funding, grants, or subsidies. For instance, Germany's "Digital Pact for Schools" has provided billions of Euros to improve digital infrastructure in schools, including vocational schools and training centres (Berger & Wolling, 2019). Similarly, Norway's Directorate for ICT and Joint Services in Higher Education and Research provides funding for digital initiatives in higher

education and training (Norwegian Ministry of Education and Research, Digitalisation strategy for the higher education sector 2017-2021).

While this model can ensure broad and equitable access to digital technologies in dual education, it may not always be the most efficient. Governments can face budget constraints that limit the amount of funding available. Moreover, bureaucratic processes can sometimes lead to delays in funding allocation or inefficiencies in its use (Witte & López-Torres, 2017).

Private Sector Investment: Some countries rely heavily on private sector investment to finance the digitalisation of dual education. This can include direct investment by companies in their training facilities or broader industry investment in education and training infrastructure. In Switzerland, for instance, many companies invest heavily in advanced digital technologies for their apprenticeship programmes (Deissinger & Gonon, 2021).

This model can be efficient in terms of leveraging the resources and expertise of the private sector. Companies can often invest in digital technologies more quickly and effectively than governments. However, private sector investment can also lead to inequalities, as not all companies or sectors have the same resources to invest in digitalisation (Windisch, 2015).

Public-Private Partnerships (PPPs) represent a hybrid model that combines public funding and private investment. They are particularly common in countries with strong partnerships between the state and the private sector in education and training. For example, the UK's Apprenticeship Levy, a tax on large employers that is used to fund apprenticeships, represents a form of PPP. The levy funds can be used to invest in digital technologies for apprenticeship training (Department for Education, 2018).

Public-Private Partnerships can offer an efficient way to leverage both public and private resources for the digitalisation of dual education. They can combine the strengths of both sectors, such as the scale and equity of public funding and the agility and expertise of private investment. However, the efficiency of PPPs can depend on the quality of the partnerships, including the alignment of objectives, the sharing of risks and rewards, and the mechanisms for cooperation and accountability (Cheung, Chan, & Kajewski, 2012).

Efficiency refers to the extent to which a financing model achieves its objectives at the least cost. The efficiency of the financing models varies considerably across countries, reflecting differences in their design, implementation, and context.

In sum, the financing of dual education's digitalisation in Europe involves a diversity of models, each with its strengths and limitations. More research is needed to understand and compare their efficiency in different contexts, and to identify best practices for financing the digitalisation of dual education.

5. Impact of COVID-19 on Dual Education's Digitalization

The COVID-19 pandemic has been a global disruptor, affecting all sectors of society, including education. Its impact on dual education's digitalisation has been substantial, with immediate and long-term implications for the financing models discussed earlier.

The immediate impact of the pandemic on dual education's digitalisation has been profound. Traditional classroom-based instruction and on-the-job training were disrupted as schools, workplaces, and public spaces were shut down to control the virus's spread (Reich et al., 2020). This disruption necessitated a sudden and large-scale shift to online learning, which greatly intensified the demand for digital technologies in dual education (Burgess & Sievertsen, 2020).

However, the resources to finance this digital transformation were strained by the pandemic. Governments faced unprecedented fiscal pressures as they had to finance large-scale health responses, social protection measures, and economic stimulus packages (OECD, 2020). This put a squeeze on education budgets and potentially threatened the sustainability of government-led funding for dual education's digitalisation.

Private sector investment also faced challenges. Many companies suffered losses due to the economic downturn caused by the pandemic, which may have limited their capacity to invest in the digitalisation of dual education. Sectors that were hit hard by the pandemic, such as tourism and hospitality, were particularly affected (Nicola et al., 2020).

Public-private partnerships faced their unique challenges. The alignment of objectives, risk sharing, and cooperation between the public and private sectors, key to the success of PPPs, were tested by the pandemic's upheaval. The strains on both public and private resources may have compromised the effectiveness of these partnerships in financing dual education's digitalisation.

The pandemic's long-term impact on dual education's digitalisation is complex and uncertain, with both challenges and opportunities. The crisis highlighted the critical importance of digital technologies in ensuring the continuity and resilience of dual education. This could potentially lead to a higher prioritisation of digitalisation in education policies and budgets, boosting the resources available for it (Hodges, Moore, Lockee, Trust, & Bond, 2020).

However, the financial implications of this higher prioritisation are uncertain. The public debt incurred by governments to finance their pandemic responses could constrain education budgets in the long term. The recovery of private sector investment will depend on the speed and robustness of economic recovery. PPPs may also need to adapt to the new post-pandemic context, potentially requiring new models of partnership and financing (World Bank, 2020).

On the other hand, the pandemic could accelerate the trend towards more efficient and effective uses of digital technologies in dual education. The forced experiment with online learning during the pandemic has yielded valuable lessons and innovations that could be built upon. These include, for instance, the use of blended learning models that combine face-to-face and online instruction, the integration of digital technologies into workplace training, and the use of data analytics to monitor and support learner progress in dual education (Bao, 2020). The financing of dual education's digitalisation will need to support these innovations and the ongoing experimentation and learning that they entail.

The COVID-19 pandemic has had a substantial impact on dual education's digitalisation, with significant implications for its financing. Understanding and addressing these implications will be critical for the future development and resilience of dual education in Europe.

6. Country-Specific Case Studies

In this chapter, we will explore the financing of dual education's digitalisation in three different European contexts, represented by Germany, Romania, and Ukraine. These case studies provide insights into the dynamics and challenges of financing digitalisation in countries with different levels of economic development, educational systems, and socio-political conditions.

a. Germany

Germany, with its well-established dual education system, is a frontrunner in the digitalisation of dual education. The country's government-led funding model has been instrumental in supporting this digitalisation. The "Digital Pact for Schools", launched in 2019, provided over five billion Euros for digital infrastructure, including dual education establishments (The Federal Government, 2021).

However, the COVID-19 pandemic strained Germany's education budget and tested the government's commitment to digitalisation. Nonetheless, the federal government maintained its financial commitment to the "Digital Pact", recognising the importance of digitalisation for educational continuity and resilience (The Federal Government, 2021).

Private sector investment in dual education's digitalisation is also robust in Germany. Many companies have invested in advanced digital technologies for their apprenticeship programmes, recognising the importance of digital skills for their future workforce (Deissinger & Gonon, 2021). However, the pandemic's economic impact has challenged this investment, particularly in sectors hit hard by the crisis.

In conclusion, Germany's financing model for dual education's digitalisation has shown resilience in the face of the pandemic, but also faces challenges, particularly in terms of sustaining private sector investment.

b. Romania

Romania presents a contrasting case of a country undergoing transition. The digitalisation of dual education is relatively new and not yet fully integrated into the education system (Pleșca, Vass, Nan, Orboi, & Mateoc Sîrb, 2021). The financing model for digitalisation is largely government-led, with support from the European Union funds.

The COVID-19 pandemic has created both challenges and opportunities for Romania's digitalisation efforts. The sudden shift to online learning during the pandemic exposed the weaknesses in Romania's digital infrastructure and the digital skills of teachers and students (Țițan, Manea, Mihai, & Cărămidaru, 2020). However, it also catalysed efforts to address these weaknesses and increased the priority given to digitalisation in education policy and funding (Velicu, 2021).

Private sector investment in digitalisation is less prominent in Romania than in Germany, reflecting the country's lower level of economic development and the private sector's limited resources. However, some multinational companies have invested in digital technologies for their apprenticeship programmes in Romania, seeing this as an investment in their future workforce (Pîrlog, Nuțu, Purcărea, & Vlase, 2017).

Overall, the financing of dual education's digitalisation in Romania faces significant challenges, but also potential opportunities as the country learns from its pandemic experience and seeks to modernize its education system.

c. Republic of Moldova

As a country in Eastern Europe with socio-political and economic challenges, the Republic of Moldova provides a unique context for examining the financing of dual education's digitalisation.

Government funding for digitalisation in Moldova is restricted by the country's financial constraints and the competing demands of various sectors. This is despite the recognition by the Moldovan Ministry of Education, Culture, and Research of the importance of integrating digital technologies into all forms of education, including dual education (Ministerul Educației și Cercetării al Republicii Moldova, 2023).

Private sector investment in dual education's digitalisation in Moldova is relatively limited. However, some multinational companies operating in the country have integrated digital technologies into their vocational training programs, recognising the importance of cultivating a digitally skilled workforce (Sobetzko, 2016).

Like Romania, Moldova has also been a recipient of funding from international entities such as the EU and the World Bank for educational initiatives. In particular, the EU-funded project "Vocational Education and Training Network" (VETnet) has sought to strengthen the digital competence of

vocational education and training teachers and trainers in the country, enhancing the digitalisation of dual education (European Commission, 2015).

The COVID-19 pandemic has underscored the importance of digitalisation in Moldova, as in other countries. It has highlighted the gaps in digital infrastructure and digital skills in the education sector and has intensified the need for funding to support the transition to online learning (Castraveț, 2023; Guțu, 2021; Mancaș, 2022).

In conclusion, while Moldova faces significant challenges in financing the digitalisation of dual education due to economic and socio-political factors, it also has opportunities through international support and the impetus provided by the pandemic.

7. Challenges and Opportunities in Financing Digitalization

The digitalisation of dual education in Europe presents a range of challenges and opportunities. The ability to navigate these intricacies largely depends on a comprehensive understanding of the varying circumstances across nations and the commitment to foster collective growth and innovation.

One major challenge is the *disparity in the availability of funds for digitalisation* across Europe. Wealthier nations, like Germany, can afford to allocate substantial resources towards the digitalisation of dual education, while countries undergoing economic transitions, like Romania and Moldova, grapple with more limited budgets (Mancaș, 2022; Pîrlog et al., 2017; The Federal Government, 2021). This discrepancy not only impacts the pace of digitalisation but also accentuates the digital divide within Europe.

Another critical challenge is *maintaining a consistent flow of private sector investment*. Private entities, especially multinational companies, have been pivotal in the digitalisation of dual education, contributing both financially and technically. However, their contributions vary significantly depending on their financial health and business outlook, which can be affected by economic downturns, such as the one caused by the COVID-19 pandemic (Deissinger & Gonon, 2021).

The third challenge is the *uneven distribution of digital infrastructure and digital skills*. The success of digitalisation efforts hinges not only on sufficient funding but also on the underlying digital infrastructure and the digital competencies of educators and learners (Țițan et al., 2020). In many cases, investments in digitalisation are impeded by weak digital infrastructures and low levels of digital skills, especially in less economically developed regions.

Despite these challenges, several opportunities for financing the digitalisation of dual education present themselves. One significant opportunity is *leveraging international funding*. Countries like Romania and Moldova have benefited from financial support from international entities like the European

Union and the World Bank. Such international partnerships can play a crucial role in bridging the digital divide within Europe and facilitating the digitalisation of dual education in less economically developed regions (European Commission, 2015, 2021).

Another opportunity is to *promote public-private partnerships (PPPs)*. These partnerships can bring together the resources and expertise of the public and private sectors to advance the digitalisation of dual education. PPPs can be particularly useful in mobilising private sector investment in digitalisation, even in economically challenging times (European Cluster Collaboration Platform, 2023).

Finally, a major opportunity lies in *building digital competencies*. Investing in the development of digital skills among educators and learners can enhance the effectiveness of digitalisation efforts and generate better educational outcomes. This can be achieved through targeted training programmes and continuous professional development initiatives (Ministerul Educației și Cercetării al Republicii Moldova, 2023; Stroe, 2022).

In conclusion, while significant challenges exist in financing the digitalisation of dual education in Europe, there are also ample opportunities to overcome these challenges and advance digitalisation. This requires collective efforts, innovative partnerships, and a shared commitment to enhancing the quality and relevance of dual education in the digital age.

8. Conclusion

This paper has provided an extensive review of the literature on the financing of digitalisation in dual education in Europe, shedding light on the models used, their efficiency, the impacts of COVID-19, and the specific situations in Germany, Romania, and the Republic of Moldova.

The review found that the *financing of digitalisation in dual education varies significantly across Europe*, largely due to economic disparities and differences in digital readiness. Wealthy nations such as Germany are better equipped to fund digitalisation, while countries such as Romania and Moldova face economic constraints but are finding ways to navigate them.

The study also revealed that *public-private partnerships play a pivotal role* in financing digitalisation, combining the resources and expertise of both sectors. The private sector's involvement, however, is susceptible to fluctuations due to economic conditions, as highlighted by the impact of COVID-19.

The *COVID-19 pandemic has intensified the need for digitalisation* across Europe, necessitating further investments in digital infrastructure and competencies and prompting international support.

Based on these findings, several policy recommendations emerge. First, it is recommended to *encourage and facilitate public-private partnerships*,

particularly in nations struggling with economic constraints, to foster cooperation and resource pooling for digitalisation efforts.

Second, countries should *seek to leverage international funding opportunities* from entities like the European Commission and the World Bank. Additionally, these international entities should continue and expand their support for digitalisation efforts in less economically developed regions.

Third, it is crucial to *invest in developing digital skills* among teachers and learners to enhance the effectiveness of digitalisation efforts.

While this review provides an essential understanding of the financing of digitalisation in dual education, it also reveals several avenues for further research. For example, more in-depth, country-specific dynamic studies could shed light on the unique challenges and opportunities in different socio-economic contexts. Furthermore, research could also explore the role of non-traditional financing methods, such as crowdfunding or impact investing, in supporting digitalisation efforts.

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