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Methodological aspects of improving the information and digital competence of technology teachers in general secondary education institutions

Abstract. The purpose of the study was to provide a comprehensive analysis of the level of information-digital competence formation among technology teachers in general secondary education institutions and to substantiate methodological approaches to its improvement. The study employed content analysis of scientific sources, regulatory and legal documents, as well as a synthesis of findings from Ukrainian and international monitoring studies. The study identified key barriers hindering the development of information-digital competence among technology teachers in general secondary education institutions. These included outdated technical infrastructure, limited access to modern digital equipment and resources, fragmented and unsystematic professional development, as well as the lack of adapted methods for assessing digital skills. These factors complicated the integration of digital technologies into the educational process, reduce the effectiveness of teaching practices, and impede teachers' professional growth. To address the identified challenges, a multi-level model for enhancing digital competence was proposed. At the institutional level, it involved developing a digital strategy for the educational institution, strengthening internal support for digital initiatives, fostering digital culture, and ensuring access to digital resources. The individual level included personalised professional development trajectories, consideration of motivational factors, initial competence levels, access to resources, as well as the implementation of mentoring programs and digital coaching. The methodological level encompassed the systematic integration of tools into the educational process, adaptation of learning materials to online formats, development of professional communities of practice, formation of digital pedagogy, and support for innovative educational solutions. The practical significance of the research lies in formulating specific recommendations for the administration of general secondary education institutions, methodological services, and teachers themselves regarding the creation of a supportive learning environment that promotes sustainable development of digital skills. The proposed approaches can be integrated into professional development programs, internal evaluation systems, and strategic planning for the digital transformation of educational institutions

Keywords: DigCompEdu; methodological approaches; professional development; digital transformation

INTRODUCTION

The development of the information-digital society and the rapid integration of innovative technologies into all spheres of human activity, particularly in education, are fundamentally changing the perception of the role and functions of the modern teacher. These transformations impose new, more complex requirements on the professional competencies of educators, who must not only possess basic knowledge but also be capable of adapting to a dynamic digital environment, thinking critically, creatively using digital tools, and ensuring high-quality teaching in

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conditions of constant change. During the so-called Fourth Industrial Revolution, characterised by the convergence of physical, digital, and biological technologies, the digitalisation of education is no longer merely a trend – it has become an urgent necessity that determines the competitiveness of the educational system as a whole (Diia.Osvita, n.d.). The effectiveness of this process directly depends on the level of teachers' digital literacy, their ability to integrate digital resources into curricula, use online platforms, virtual environments, artificial intelligence, and other technologies to enhance student motivation and the quality of the educational process.

In Ukraine, information and digital competence (IDC) is officially recognised as one of the ten key competencies defined by the New Ukrainian School Concept (Resolution of the Cabinet of Ministers of Ukraine No. 988-2016, 2016). This highlights its fundamental importance for modern pedagogical practice, as IDC encompasses not only technical skills but also the ability to use digital technologies safely, ethically, and responsibly. Developing this competence is critically important for ensuring equal access to quality education, fostering an inclusive learning environment, and preparing students for life in a digital world. A review of research and scientific publications on this issue demonstrates the scientific community's deep awareness of the critical importance of developing teachers' digital competence in the context of educational transformation. In the works of I. Ivaniuk & O. Ovcharuk (2022), as well as N.V. Morze & A.B. Kocharian (2023), digital competence is considered not merely as a set of technical skills but as a complex structure that includes five key components: information literacy, effective digital communication, creation and editing of digital content, cybersecurity, and problem-solving in the digital environment. Such an approach allows for a deeper understanding of digital competence as both a tool for teachers' professional development and a means of improving the quality of education.

The analysis of monitoring results conducted in the 2024-2025 academic year in Kyiv (State Service for Education Quality of Ukraine, 2025) confirms that despite the generally high level of media literacy among Ukrainian educators, there remain systemic challenges that hinder the full digital transformation of the educational process. In particular, significant infrastructural limitations have been identified-lack of modern equipment, unstable internet connectivity, as well as methodological difficulties related to the absence of clear algorithms for integrating digital tools into curricula. The studies of A. Ponomarenko (2024) emphasise barriers of both technical and pedagogical nature. These include the use of outdated equipment that does not support modern educational platforms, as well as insufficient teacher training in the didactic use of digital technologies. This encompasses not only knowledge of tools but also an understanding of their potential for developing critical thinking, personalising learning, and creating an inclusive educational environment.

In conditions of digital transformation of education, which is an integral part of global socio-technological changes, the formation and development of teachers' IDC is becoming especially relevant (Shpak & Bardadym, 2022). Scientific research by O.P. Tretiak (2023) not only highlights the issues of insufficient digital preparedness of educators but also provides theoretical and practical foundations for developing effective strategies for its improvement. Teachers' digital competence is regarded as a key factor in the successful implementation of educational reforms aimed at modernising the content, forms, and methods of teaching in response to the challenges of the information society (Samoylenko *et al.*, 2022).

The relevance of this study is determined by the need to develop a holistic, scientifically grounded methodological approach capable not only of overcoming the identified infrastructural, organisational, and competence-related barriers but also of transforming teachers' theoretical knowledge into effective educational practices. As noted by O. Spirin *et al*. (2024), existing models of digital competence development still demonstrate fragmentation, particularly in aligning institutional requirements with teachers' actual digital practices; therefore, a unified conceptual framework remains essential. Research by D. Kolomiiets *et al*. (2018) demonstrates that technology- and design-oriented learning activities significantly intensify students' engagement only when teachers themselves possess a sufficiently high level of technological and methodological preparedness. Furthermore, N. Soroko & L. Mykhailenko (2019) emphasise that the integration of STEAM and Information and communications technology (ICT) components into the educational process requires the development of IDC as an integral element of pedagogical mastery, highlighting that digital competence functions not as an isolated skill but as a systemic characteristic influencing instructional design, assessment strategies, and communication with learners. The aim of this study was to systematise and develop the scientific and methodological aspects of improving technology teachers' IDC. Within the framework of the research, the following tasks were set: clarifying the conceptual framework of IDC, analysing its key components – information literacy, digital communication, content creation, security, and problem-solving.

MATERIALS AND METHODS

The research methodology was based on a combination of theoretical analysis and secondary processing of empirical data. A systematic analysis of scientific publications, regulatory documents, and international digital competence frameworks was conducted, including DigCompEdu (European Commission, n.d.), UNESCO (2021; 2023), the Conceptual and Reference Framework of Digital Competence for Pedagogical Staff in Ukraine (Diia.Osvita, 2021), and the Professional Standard for Teachers (Order of the Ministry of Education and Science of Ukraine No. 1225, 2024). Scientific publications were selected according to criteria of relevance, scientific novelty, and alignment with the

research subject. The analysis included publications from 2017-2025 indexed in Scopus and Web of Science, as well as official analytical reports of educational institutions. The search was performed using key terms ("digital competence", "teacher digital skills", "ICT in education", "DigCompEdu", "digital pedagogy"), ensuring comprehensiveness and systematicity in the selection of source materials.

The empirical basis of the study consisted of secondary data from the official monitoring conducted by the State Service for Education Quality of Ukraine (2025). The monitoring covered more than 332 technology teachers from different regions of Ukraine and included information on teachers' digital skills, the state of digital infrastructure, and practices of using digital tools in the educational process. Since the authors did not collect primary data, all sampling parameters, instruments, and data collection procedures were determined by the State Service for Education Quality. The secondary analysis of aggregated statistical indicators involved the use of descriptive statistics, analytical grouping, and comparative analysis. This made it possible to identify key barriers to the development of teachers' IDC, including the fragmented integration of digital tools, lack of methodological support, and significant disparities in material and technical resources across educational institutions.

Within the framework of the international comparative analysis, approaches to developing teachers' digital competence in Finland and Germany were examined. The analysis of documents issued by the Finnish National Agency for Education (2025) made it possible to identify key emphases on supporting creativity, integrating STEAM-oriented practices, and fostering professional teacher communities. In the German context, the central concept was "digital sovereignty", which encompassed the critical, responsible and informed use of digital technologies. The methodological review of German policy and regulatory documents enabled the identification of the prioritisation of ethical, legal and security aspects of digital interaction, as well as the autonomy of schools and teachers in selecting digital solutions (University of Tübingen, n.d.; Meinel *et al*., 2023). The comparison of the Finnish and German models with the Ukrainian educational context made it possible to determine adaptive elements relevant to developing the digital competence of technology teachers.

RESULTS AND DISCUSSION

IDC in the modern educational space is viewed as a complex, integrative construct that extends far beyond purely technical skills in using digital devices and software. As noted in the study conducted by the Naurok (2025) platform, this concept encompasses not only proficiency with application software but also a deep understanding of the essence of processing, analysing, and transmitting information. IDC develops at the intersection of several key components, each with its own specifics and significance for the professional activity of a teacher. O. Storonska & M. Vorobel (2023) defined digital competence as an integrative personal quality that includes the ability to recognise and identify information needs, effectively process educational information using digital technologies, and utilise appropriate resources, software, and technical tools for professional activities. The researchers outlined four key components of this competence and identified the conditions conducive to its development: motivation to use digital technologies, the creation of a digital educational environment, and the focus of professional training content on the development of digital skills.

International publications indexed in Scopus and Web of Science confirm the relevance of the issue. The European DigCompEdu framework (Redecker, 2017) defines five key components of teachers' digital competence: information literacy, communication, digital content creation, security, and problem-solving. Studies, conducted by J. Cabero-Almenara *et al*. (2021) and S. Tkachov *et al*. (2023) indicated that the greatest challenges arise in transitioning from theoretical training to the practical application of digital technologies. In Finland, emphasis is placed on strengthening teachers' confidence in integrating ICT into teaching as well and on developing professional communities and mentoring systems, as evidenced by the Scandinavian experience analysed by I. Ivaniuk (2019). In the United States, similar approaches are observed, where methodological foundations for ICT integration and forms of professional support are systematically developed, particularly in STEM and engineering education (Kiianovska *et al*., 2018). A significant problem highlighted by researchers is teachers' low self-assessment of their digital competence. Even when they possess the necessary knowledge, educators do not always confidently apply it in practice, as noted by O.V. Sakhno (2020). It was suggested to address this problem through a combination of self-assessment and external monitoring tools, as well as through the creation of practice-oriented methodological materials that demonstrate successful cases of ICT implementation.

Special attention in the literature is devoted to digital security. S. Tolochko (2021) suggested that technology teachers who actively use online resources and digital platforms often face risks associated with cybersecurity and the ethics of using information technologies. It is considered that the inclusion of digital security modules in professional development programs, the use of simulation tasks, and the development of digital behaviour codes in educational institutions as essential solutions. Among new challenges is teachers' readiness to use artificial intelligence technologies. Y. Kulyk *et al*. (2022) show that technology teachers and teachers of other subjects are not yet prepared to integrate AI tools into the learning process due to a lack of relevant methodological materials and training programs. Researchers propose introducing specialised digital literacy courses on artificial intelligence and fostering cooperation with IT companies to create resources adapted to the school environment.

Summarising the analysis, it can be concluded that the main problematic aspects of developing IDC among

technology teachers are: the gap between theoretical and practical training, low self-assessment of skills, lack of methodological support, challenges in digital security, and the integration of advanced technologies, particularly artificial intelligence. Solutions lie in systematic methodological support, practical training, the development of professional communities, expanding the material and technical base of educational institutions, and creating conditions for teachers' continuous professional development. Thus, the analysis of scholarly sources indicates that IDC is a multidimensional phenomenon that encompasses technical, cognitive, communicative, and ethical aspects. Its development is a necessary condition for the successful professional activity of teachers in the context of a digital society and rapid technological change.

For technology teachers, this issue is especially relevant, as they are responsible for integrating applied innovations into school practice, including STEM education, robotics, 3D modelling, and other digital tools. These findings align with national requirements for teachers' digital competence, as established in the Order of the Ministry of Education and Science of Ukraine No. 1225 (2024). The development of digital competence is considered as one of the key factors for effective professional activity of educators. Based on monitoring data collected in Kyiv (State Service for Education Quality of Ukraine, 2025), it was found that despite the high level of media literacy among Ukrainian educators there are significant infrastructural and systemic barriers. In particular, schools face worsening access to computer equipment and multimedia tools, which complicates the implementation of digital innovations in the educational process. This is also confirmed by Arbook (n.d.) pointing to the widespread problem of outdated equipment and unequal access to high-speed internet.

At the same time, the lack of a coherent strategy for education digitalisation leads to the fragmentation of individual initiatives, a pattern also described by UNESCO (2023), which do not ensure a systematic approach to IDC development. Technology teachers, as carriers of practical knowledge and skills, should be not only users of digital tools but also active participants in their integration into curricula. This implies the use of cloud services, distance learning platforms, digital laboratories, as well as augmented and virtual reality technologies. An effective means of enhancing IDC is microlearning – short online courses, webinars, and training sessions covering topics of digital security, STEM approaches, and robotics.

International experience, particularly the Finnish model, highlights the importance of teacher trust and autonomy (Finnish National Agency for Education, 2025). Teachers are encouraged to experiment and continuously develop, while instruction is based on STEAM approaches and project-based learning (Experience Workshop, 2025). Educators are given freedom in choosing teaching methods, digital tools, and the pace of professional growth. Such an approach fosters an environment where experimentation, innovation, and continuous improvement are the norm. Learning in Finland actively integrates STEAM, combining science, technology, engineering, arts, and mathematics. Educational programs emphasise project activities, interdisciplinary collaboration, and the development of creative thinking. Within initiatives such as Experience Workshop, teachers participate in training sessions that help them create learning environments stimulating creativity, critical thinking, and teamwork. Importantly, digital technologies in Finnish schools are not used solely as tools but also as a means of personalising learning, supporting diverse learning styles, and ensuring inclusivity. These characteristics align with broader research-based analyses of the Finnish system, which emphasise that trust-based governance and teacher autonomy are foundational elements enabling educators to take responsibility for technology-rich pedagogical decisions (Chung, 2023).

In Germany, the focus is placed on "digital sovereignty", which combines practical skills with a reflective attitude toward technology (University of Tübingen, n.d.; Meinel *et al.*, 2023). This concept covers not only technical proficiency but also the ability to use digital technologies consciously, responsibly, and critically. Significant attention is paid to developing reflective attitudes toward the digital environment through courses in digital ethics, media literacy, and digital democracy. Educational institutions, including universities, actively implement programs that train teachers to understand the risks of digitalisation-such as issues of privacy, cybersecurity, and algorithmic bias. At the same time, schools and universities enjoy autonomy in choosing digital strategies, allowing them to adapt educational processes to local needs. Cooperation with industry partners, the creation of digital laboratories, and involving students in real-life cases all contribute to the practical acquisition of digital skills in real-world contexts.

Thus, the Finnish model emphasises trust, freedom of action, and a creative approach to digital learning, whereas the German model prioritises critical thinking, ethical use of technology, and conscious digital participation. Both models demonstrate that the development of teachers' IDC should not be limited to technical aspects but must also be deeply humanistic, taking into account social, ethical, and cultural contexts. The Ukrainian educational system can adapt these approaches, considering national realities, with the goal of forming a sustainable, innovative, and responsible digital culture in schools. Table 1 demonstrates that international and Ukrainian framework documents share a common vision of the multifaceted nature of digital competence (DC).

However, existing empirical data indicated a gap between theoretical understanding and practical application. An important condition for sustainable IDC development is the creation of professional communities of practice that facilitate experience sharing, mentoring support, and the adaptation of newcomers to the digital environment. Equally important is the introduction of IDC assessment tools, including self-assessment instruments and external

monitoring, which help identify needs for professional development and adjust educational strategies accordingly. According to the monitoring results of the State Service for Education Quality of Ukraine (2025), only 39% of teachers create digital learning content, while 47% engage in communication within the digital environment (Table 2).

Table 1. Comparative analysis of digital competence components at the European and Ukrainian national levels

Component	DigCompEdu (EU)	Professional teacher standard (Ukraine)	General IDC components (Ukraine)
Information and media literacy	Information and digital literacy, communication, collaboration	Ability to navigate the information space, search for and critically evaluate information	Skills in identifying sources, selecting, evaluating, and analysing information (Ponomarenko, 2024)
Content creation	Creation of digital content	Ability to effectively use and, when necessary, create new electronic (digital) educational resources	Ability to integrate technologies into teaching, create content (Morze & Kocharian, 2023)
Safety	Safety (including data protection and cybersecurity)	Ability to protect personal data, avoid risks, and respect copyright	Compliance with online safety rules, understanding copyright and information ethics (Diia.Osvita, 2021)
Problem solving and professional development	Problem-solving, lifelong learning	Use of digital services and technologies for professional development	Ability to continuously learn and adapt to new technologies (Naurok, 2025)
Pedagogical approaches	Professional engagement, teaching and assessment, learner empowerment	Use of digital technologies in the educational process, organisation of learning activities	Ability to integrate digital technologies into teaching, design online and blended learning environments (Morze & Kocharian, 2023)

Source: developed by the author

Table 2. Results of monitoring the conditions and use of IT in secondary schools of Kyiv (2024/2025 academic year)

Indicator	Data for 2024/2025 academic year	Changes compared to 2023/2024 academic year
Access to computers for each teacher	88%	Decrease from 98%
Access to multimedia equipment	71%	Decrease from 74%
Free access to the Internet	61%	Increase from 57%
Availability of computers only in the computer science classroom	25%	Increase from 14%
Teachers creating digital content	39%	Not specified
Teachers using technologies for collaboration	59%	Not specified
Teachers communicating in the digital environment	47%	Not specified

Source: developed by author based on State Service for Education Quality of Ukraine (2025)

This creates a contradiction between the high level of readiness and recognition of the importance of innovations and the limited capacity for their practical implementation. To overcome the existing barriers and ensure the sustainable development of digital competence among technology teachers, it is advisable to implement a set of measures. One of them is the establishment of digital hubs in schools – modern, well-equipped spaces for learning, experimentation, and collaboration. In addition, it is necessary to strengthen institutional support, in particular by enhancing the role of the Institute for Digitalisation of Education of the National Academy of Educational Sciences of Ukraine in developing methodological guidelines, educational materials, and organising scientific-practical activities. It is also important to expand international cooperation through participation in joint educational projects, internships, and experience exchanges with European Union countries. Finally, a decisive factor is ensuring adequate funding for the technical modernisation of school infrastructure, which may be provided both from the state budget and through the involvement of private investment. Considering this, the proposed multi-level model for enhancing digital competence is based on the principles of continuity and individualisation, taking into account the current competence level of each teacher (UNESCO, 2023). The model includes three levels:

Level 1: Basic User. Focused on overcoming initial barriers and acquiring fundamental skills such as working with cloud services (Arbook, n.d.). This level represents the starting point in the development of teachers' digital competence, particularly for those who previously lacked systematic experience with digital technologies. The main goal is to overcome initial barriers, which may be both technical and psychological, and to form the basic skills necessary for confident functioning in a digital educational environment. At this stage, teachers become familiar with the basics of working with computers, mobile devices, operating systems, and basic interfaces of educational platforms. Particular attention is paid to mastering cloud services such as Google Workspace, Microsoft 365, Zoom, and Padlet, which enable the creation,

storage, editing, and sharing of learning materials online. According to Arbook (n.d.), access to cloud technologies is a key factor in overcoming digital isolation and expanding opportunities for teachers at the initial stage. In addition to technical skills, teachers acquire the basics of digital safety: creating secure passwords, protecting personal data, and safe online behaviour. This forms a basic level of digital literacy, which serves as a prerequisite for further professional growth. Support at this stage is provided through access to instructional materials, video tutorials, step-by-step guides, as well as mentoring assistance from more experienced colleagues. Such an approach helps reduce anxiety, build confidence, and increase motivation for further learning. In practical terms, teachers begin integrating digital tools into their daily activities: creating electronic lesson plans, conducting online polls, maintaining electronic gradebooks, and communicating with students via educational platforms or messengers. These actions lay the foundation for transitioning to the next level – the functional stage, where digital technologies become an integral part of the teaching methodology.

Level 2: Digital Use. Involves regular and productive use of technologies in teaching, including content creation and organisation of collaboration (Naurok, 2025). At this stage, teachers move from basic mastery of digital tools to their systematic and purposeful use in the educational process. The functional user level implies that digital technologies are no longer an external addition but are integrated into the structure of teaching, methodological activities, and professional communication. Teachers at this stage confidently work with educational platforms such as Google Classroom, Moodle, and Microsoft Teams, and use interactive tools like Kahoot, Mentimeter, Canva, and Genially to create visual content, tests, presentations, and digital teaching materials. They are able to organise distance or blended learning, conduct online lessons, create digital courses, and effectively communicate with students and parents via digital channels.

Particular attention is given to the pedagogical design of digital content – that is, the ability to adapt learning materials to students' age characteristics, lesson objectives, forms of assessment, and technical capabilities. Teachers do not merely use ready-made resources but adapt them, create their own interactive assignments, video tutorials, and electronic portfolios. Moreover, this level implies a conscious approach to digital safety, data privacy, copyright, and the ability to teach students the basics of digital ethics and media literacy. Teachers understand the risks associated with the digital environment and know how to minimise them in the learning process. Professionally, teachers actively participate in digital educational communities, share experiences, complete online courses and certifications, and attend webinars and conferences. This broadens their professional horizons and prepares them for the next stage-the innovative level, where teachers become developers of digital educational products and leaders of digital transformation in schools.

Level 3: Digital Transformation. The highest level, characterised by creative and innovative use of technologies (Naurok, 2025). The innovative level of digital competence development assumes that teachers not only use digital tools in their activities but also create new educational practices, actively implement technological innovations, and act as change agents in the digital transformation of educational institutions. At this stage, teachers or school leaders demonstrate high digital literacy, methodological flexibility, creativity, and the ability for interdisciplinary integration. Teachers at this level design original digital products-interactive courses, educational platforms, mobile applications, digital simulators, and virtual laboratories. They actively apply STEAM approaches, combining science, technology, engineering, arts, and mathematics into a unified educational system. The learning process incorporates AR/VR technologies such as Google Expeditions, Unity, and Metaverse Studio, enabling immersive learning environments and simulation of complex processes in virtual reality.

Beyond technical mastery, teachers at this level possess reflective thinking-the ability to critically assess the impact of digital technologies on the educational environment, the ethics of their use, as well as issues of privacy and digital security. They participate in research activities, develop methodological guidelines, conduct training sessions and workshops for colleagues, speak at conferences, and publish their own findings. Innovative users also actively contribute to building digital culture within educational institutions-initiating the creation of digital hubs, implementing open educational resource policies, forming professional communities of practice, and supporting novice teachers in the process of digital adaptation. Thus, the innovative level is not only an indicator of advanced digital competence but also a marker of leadership, strategic thinking, and readiness to transform the educational environment in line with the challenges of the 21st century.

In the context of educational digital transformation, the strategy on technological innovation in education, proposed by the UNESCO (2021), is particularly relevant. It is based on the principles of continuity and individualisation, which allow for consideration of the initial competence level, professional needs, and motivation of each teacher. For technology teachers and school leaders, this model creates opportunities not only for personal growth but also for strategic management of digital processes within their institutions. For technology teachers, the model envisions a gradual transition from basic digital tool use to the level where the teacher becomes a creator of original digital products, integrates STEAM approaches, employs augmented reality, 3D modelling, cloud services, and elements of artificial intelligence. Importantly, each stage is accompanied by reflection, self-assessment of progress, and the ability to adjust one's educational trajectory. Figure 1 visualises this cyclical progression, illustrating how teachers move through successive stages of digital competence development while continuously reflecting on and adapting their professional practices.

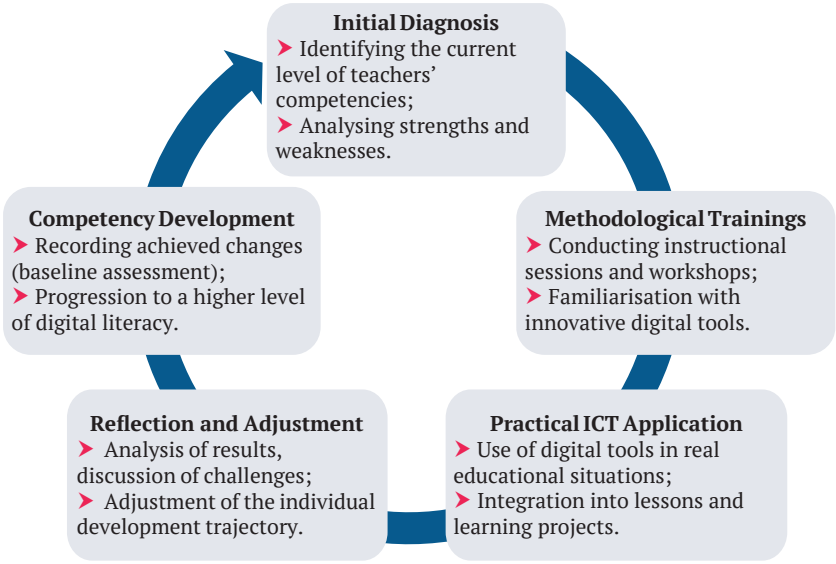

Figure 1. Cyclical model for methodical improvement of teachers' IDC
Source: developed by the author based on UNESCO (2023), O.V. Ovcharuk (2024)

For heads of general secondary education institutions, the multi-level model IDC serves a dual purpose. First, it enables the leader to develop their own digital competence, which is essential for effective management of a modern educational institution. Second, it functions as a tool for strategic planning of the professional development of the teaching staff. The head can initiate the creation of individualised educational trajectories for teachers, organise mentoring programs, implement modular professional development courses, and monitor IDC levels within the internal quality assurance system. Special attention should be paid to the formation of a digital culture within the educational institution. This includes not only technical equipment but also creating an environment where digital tools are used to enhance learning, management, communication, and professional collaboration. Successful implementation of the multi-level model is possible with a combination of institutional support, teacher motivation, and flexible educational formats – such as online platforms, microlearning, certification programs, digital hubs, and professional communities of practice. The multi-level IDC model is not only a tool for individual development but also a foundation for the systematic improvement of digital competence across the entire institution. Its implementation contributes to the creation of a sustainable digital ecosystem capable of adapting to modern challenges and ensuring quality education in the digital era. The improvement of technology teachers' IDC is a multidimensional process that requires a comprehensive approach, combining methodological innovations, institutional support, and a strategic vision for the digital transformation of education.

The conducted study made it possible to identify key trends, challenges, and prospects for the development of IDC among technology teachers in Ukrainian general secondary education institutions. One of the core elements of digital and information competence (DIC) is information and media literacy. It implies the ability to formulate information queries, effectively locate necessary data, and critically evaluate its reliability and relevance. This aligns with the position of A. Ponomarenko (2024), who emphasised that in conditions of information oversaturation it is especially important to teach educators to recognise manipulative technologies, fake information, and adhere to the principles of academic integrity. This idea was also supported by the Ukrainian Institute of Education Development study (UID, 2021), which highlighted the need to develop critical thinking skills as a foundation of information security. T. Berezhna & N. Bessarab (2024), examining the process of forming the information-digital competence of modern educators in the context of implementing the New Ukrainian School Concept, emphasised the necessity of integrating digital technologies into the educational process as a key component of teachers' professional activity. The concept of "information-digital competence", its structure and functional components have been clarified, including technological literacy, the ability to critically process information, and the use of digital resources for learning and communication. The authors underline the importance of creating an information-educational environment that promotes the development of digital culture, enhances the quality of educational services, and fosters new pedagogical practices.

Another important aspect is digital communication and collaboration. N.V. Morze & A.B. Kocharian (2023) defined this competence as the ability to effectively use digital tools for interaction with students, colleagues, and parents. Under these conditions, it should be understood as encompassing the organisation of virtual classrooms, the delivery of online lessons, file sharing, and collaborative work on educational projects. According to the Naurok (2025), digital communication has become an integral

part of the educational process, especially during periods of distance learning. V. Lymarenko (2024) highlighted that digital interaction contributes to shaping an open learning environment, where the teacher acts not only as a source of knowledge but also as a facilitator of learning.

The third component of DIC is digital content creation. This includes the educator's ability to design and implement educational resources in digital form – presentations, video lessons, electronic documents, interactive tests, etc. N.V. Morze & A.B. Kocharian (2023) noted that high-quality digital content increases student motivation and ensures individualisation of the learning process, proving that the use of multimedia materials has a positive impact on knowledge acquisition and the development of students' creative potential. I. Vdovenko *et al*. (2023), studying the development of information-digital competence of vocational education teachers in the context of digitalisation of the educational environment, defined key components of this competence – reflective, technological, methodological, and motivational – and proposed a model for its development. The model includes theoretical and methodological foundations, content-structural components, technological approaches, evaluative-reflective criteria, and organisational-pedagogical conditions. Importantly, through analysis of regulatory documents, international models (including DigCompEdu), surveys, and pedagogical experiments, special attention is paid to adapting European approaches to the Ukrainian context of vocational education. This has practical value for the development of professional development programs, modernisation of educational standards, and implementation of digital technologies in vocational training. Findings by O. Zhukova *et al*. (2021) also highlighted the potential of web-based tasks for strengthening digital competence. Although their study targeted students, the mechanisms they describe – structured work with digital information, creation of online materials, and organisation of interactive digital activities – are directly applicable to teachers' professional practice. These results underscore that integrating well-designed web-based tasks into teaching can enhance educators' ability to use digital tools purposefully and develop pedagogically meaningful digital content.

Another important component is digital safety and ethics. In the context of active use of the Internet and digital technologies, educators must possess knowledge of cybersecurity, personal data protection, and ethical standards for working with information. Diia.Osvita (2021) stressed the importance of fostering a responsible attitude towards the digital environment, emphasising that ethical behaviour online is essential for a safe educational process, especially in conditions of online interaction. The final component to consider is the ability to solve problems and engage in professional development. This competence involves a teacher's readiness for lifelong learning, adapting to new technologies, using digital tools for self-development, and improving professional skills. Diia.Osvita (2021) notes that digital literacy is not only a tool but also a prerequisite for professional mobility. L. Tkachenko *et al*. (2023) pointed out that continuous updating of digital skills allows educators to remain competitive and effective amid the digital transformation of education. These structural components correspond to the categories defined in the European framework for the digital competence of educators (European Commission, n.d.).

Overall, the results of the study demonstrate that IDC of technology teachers is shaped through the interaction of individual, methodological, and institutional factors. Despite the availability of various digital tools and a generally positive attitude towards innovation, teachers still face substantial barriers related to infrastructure, methodological support, and the practical use of digital technologies. At the same time, international experience and the analysed national monitoring data indicate that consistent professional development, access to high-quality digital resources, and participation in professional communities significantly enhance teachers' readiness for digital transformation. Thus, strengthening IDC requires a systemic approach that integrates continuous professional learning, institutional support mechanisms, and a stable digital infrastructure, ensuring not only the development of teachers' skills but also the formation of a sustainable digital culture within educational institutions.

CONCLUSIONS

IDC of technology teachers is a determining factor in their professional effectiveness in the context of educational digital transformation. The conducted study confirmed that IDC levels directly influence the quality of the educational process, teachers' ability to implement innovations, utilise digital resources, and create a modern learning environment. At the same time, identified infrastructure and methodological challenges-such as limited access to digital platforms, fragmented professional development programs, and the lack of systematic IDC monitoring-highlight the need for a comprehensive update of approaches to teacher professional development.

In response to these challenges, a multi-level model for improving IDC has been proposed, combining the principles of continuity, individualisation, and contextual adaptation. The model encompasses a basic level of digital literacy, a functional level of integrating digital tools into learning practices, and an innovative level, which includes STEAM-oriented activities, educational data analytics, and participation in professional communities. This approach allows for the creation of personalised IDC development trajectories, enhances teacher motivation, and ensures quality improvements in the educational process. Promising directions for further research include: the development of a Ukrainian platform for IDC monitoring to ensure data reliability and adaptation of professional development programs; integration of STEAM methodologies into the professional growth of technology teachers; and empirical studies to assess the impact of the proposed

model on student learning outcomes. Implementing these directions will contribute to the formation of a digital culture in general secondary education institutions, improve teaching quality, and foster the innovative potential of the education system.

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REFERENCES

[1] Arbook. (n.d.). *Digital technologies in education: Challenges and features*. Retrieved from https://arbook.info.

[2] Berezhna, T.I., & Bessarab, N.A. (2024). Formation of information-digital competence of a modern teacher of the New Ukrainian school. *Problems of Modern Transformations. Series: Pedagogy and Psychology*, 3. doi: 10.54929/2786-9199-2024-3-02-01.

[3] Cabero-Almenara, J., Guillén-Gámez, F.D., Ruiz-Palmero, J., & Palacios-Rodríguez, A. (2021). Digital competence of higher education professor according to DigCompEdu. Statistical research methods with ANOVA between fields of knowledge in different age ranges. *Education and Information Technologies*, 26(4), 4691-4708. doi: 10.1007/s10639-021-10476-5.

[4] Chung, J. (2023). Research-informed teacher education, teacher autonomy and teacher agency: The example of Finland. *London Review of Education, 21*(1), article number 13. doi: 10.14324/LRE.21.1.13.

[5] Diia.Osvita. (2021). *Conceptual-reference framework of digital competence for pedagogical and scientific-pedagogical workers*. Retrieved from https://osvita.diia.gov.ua.

[6] Diia.Osvita. (n.d.). Retrieved from https://osvita.diia.gov.ua.

[7] European Commission. (n.d.). *Digital competence framework for educators (DigCompEdu)*. Retrieved from https://joint-research-centre.ec.europa.eu.

[8] Experience Workshop. (2025). *Teacher training course: Bringing Finnish STEAM innovation to our classrooms*. Retrieved from https://experienceworkshop.org.

[9] Finnish National Agency for Education. (2025). *Exploring Finnish digital education*. Retrieved from https://www.oph.fi.

[10] Ivaniuk, I., & Ovcharuk, O. (2022). The analysis of survey results regarding teacher's digital competence in distance education organization. *Image of the Modern Pedagogue*, 1(4), 101-104. doi: 10.33272/2522-9729-2022-4(205)-101-104.

[11] Ivaniuk, I.V. (2019). Teachers' digital competency development: Experience of Scandinavian countries. *Information Technologies and Learning Tools*, 72(4), 81-90. doi: 10.33407/itlt.v72i4.3081.

[12] Kiianovska, N.M., Rashevska, N.V., & Semerikov, S.O. (2018). The theoretical and methodical foundations of usage of information and communication technologies in teaching higher mathematics engineering students in universities of the United States. *Theory and Methods of E-learning*, 1(5). doi: 10.48550/arXiv.1809.09557.

[13] Kolomiiets, D., Brovchak, L., Shwets, O., & Babchuk, Y. (2018). Steam-projects in the design activities of pupils and students. *Society. Integration. Education. Proceedings of the International Scientific Conference*, 1, 248-258. doi: 10.17770/sie2018vol1.3076.

[14] Kulyk, Y., Kravchenko, L., Blyzniuk, M., Chystiakova, L., Orlova, N., & Bukhun, A. (2022). Pedagogical technologies for competent training of teachers in Ukrainian professional education. *International Journal of Education and Information Technologies*, 16, 29-38. doi: 10.46300/9109.2022.16.3.

[15] Lymarenko, V. (2024). Development of digital competence of teachers in higher education institutions: Prospects and challenges. *Pedagogical Education: Theory and Practice*, 37(2), 129-142. doi: 10.32626/2309-9763.2024-37-129-142.

[16] Meinel, C., Galbas, M., & Hagebölling, D. (2023). Digital sovereignty: Insights from Germany's education sector. *Technical Reports*, 157.

[17] Morze, N.V., & Kocharian, A.B. (2023). Model of the ICT competence standard for university teachers in the context of improving education quality. *Information Technologies and Learning Tools*, 43(5), 27-39.

[18] Naurok. (2025). *Digital literacy and critical thinking: How teachers became role models*. Retrieved from https://naurok.com.ua.

[19] Order of the Ministry of Education and Science of Ukraine No. 1225 "*On the Approval of the Professional Standard 'Teacher of a General Secondary Education Institution'". (2024, August)*. Retrieved from https://mon.gov.ua.

[20] Ovcharuk, O.V. (Ed.). (2024). *Digital competence of the New Ukrainian school teacher – 2024: Innovation for change.* Kyiv: Institute for Digitalisation of Education of the NAES of Ukraine.

[21] Ponomarenko, A. (2024). The essence of digital competence of masters of professional education. *Pedagogical Education*, 4(61), 29-33. doi: 10.15587/2519-4984.2024.319002.

[22] Redecker, C. (2017). *European framework for the digital competence of educators*. Luxembourg: Publications Office of the European Union.
[23] Resolution of the Cabinet of Ministers of Ukraine No. 988-2016 "On the Approval of the Concept for Implementing State Policy in the Reform of General Secondary Education 'New Ukrainian School' for the Period up to 2029". (2016, December). Retrieved from https://zakon.rada.gov.ua.
[24] Sakhno, O.V. (2020). Digital competence and technologies for education: Principles and tools. *The Image of a Modern Teacher*, 6(195), 10-14.
[25] Samoylenko, O., Ivashev, E., & Matsko, V. (2022). Features of forming teacher digital competence in the context of modern educational challenges. *Current Issues in the Humanities*, 56(3), 189-194.
[26] Shpak, V.P., & Bardadym, O.V. (2022). Formation of information and digital competence of science teachers: Activity component. *Higher Education in Ukraine in the Context of Integration into the European Educational Area*, 90(1), 153-170. doi: 10.38014/osvita.2022.90.14.
[27] Soroko, N., & Mykhailenko, L. (2019). Teachers' digital competence development as an important factor for the creation and support of the STEAM-based educational environment. *Comparative Pedagogical Studies, 2, 47-58*. doi: 10.31499/2306-5532.2.2019.186784.
[28] Spirin, O., Ivanova, S., Franchuk, N., & Kilchenko, A. (2024). Main components of digital competence of academic and scientific-pedagogical staff of higher education institutions in Ukraine. *UNESCO Chair Journal Lifelong Professional Education in the XXI Century, 2*(10), 91-103. doi: 10.35387/ucj.2(10).2024.0007.
[29] State Service for Education Quality of Ukraine. (2025). *Report on the monitoring of the formation of teachers' information and digital competence in Kyiv (2024/2025 academic year)*. Retrieved from https://sqe.gov.ua.
[30] Storonska, O., & Vorobel, M. (2023). Professional competence of a teacher under conditions of digitalization of education. *Youth & Market*, 10(218), 72-76. doi: 10.24919/2308-4634.2023.290462.
[31] Tkachenko, L., Kushevska, N., & Kabysh, M. (2023). Evaluating future teacher competencies in the face of contemporary global challenges: A comprehensive analysis. *Futurity Education*, 3(2), 105-118. doi: 10.57125/FED.2023.06.25.06.
[32] Tkachov, S., Tkachova, N., & Shcheblykina, T. (2023). Developing digital competence of future teachers in the modern digital learning space. *Educational Challenges,* 28(1), 149-160. doi: 10.34142/2709-7986.2023.28.1.12.
[33] Tolochko, S. (2021). Digital competence of teachers in the conditions of digitalization of educational establishments and distance learning. *Bulletin of the T.H. Shevchenko National University "Chernihiv Collegium"*, 13(169), 28-35. doi: 10.5281/zenodo.5077823.
[34] Tretiak, O.P. (2023). Digital competence of the modern teacher: 2023 (Searching for solutions in wartime). *In Digital competence collection (pp.* 168-171). Kyiv: Institute of Digitalization of Education of the National Academy of Pedagogical Sciences of Ukraine.
[35] UID. (2021). *Methodological recommendations for the formation of teachers' information and digital competence*. Retrieved from https://uied.org.ua.
[36] UNESCO. (2021). *UNESCO strategy on technological innovation in education (2022-2025)*. Retrieved from https://unesdoc.unesco.org.
[37] UNESCO. (2023). *ICT competency framework for teachers: Version 3*. Retrieved from https://www.unesco.org.
[38] University of Tübingen. (n.d.). *Competence centers for digital and digitally supported teaching in schools and continuing education*. Retrieved from https://uni-tuebingen.de.
[39] Vdovenko, I., Vdovenko, O., & Vdovenko, S. (2023). Features of the formation of information-digital competence of a vocational training teacher. *Bulletin of the T.H. Shevchenko National University "Chernihiv Collegium"*, 24(180), 140-146. doi: 10.58407/visnik.232423.
[40] Zhukova, O., Nalyvaiko, O., Shvedova, Ya., & Nalyvaiko, N. (2021). Creating webquests as a tool for developing students' digital competence. *Professional Education: Methodology, Theory and Technologies*, 7(2), 172-195. doi: 10.13140/RG.2.2.11522.96965.

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Методичні аспекти вдосконалення інформаційно-цифрової компетентності вчителів технологій навчального закладу загальної середньої освіти

Анотація. Метою дослідження був комплексний аналіз рівня сформованості інформаційно-цифрової компетентності вчителів технологій закладів загальної середньої освіти та обґрунтування методичних підходів до її вдосконалення. У межах дослідження було застосовано методи контент-аналізу наукових джерел, нормативно-правових актів, а також узагальнення результатів національних і міжнародних моніторингових досліджень. Було визначено ключові бар'єри, що стримують розвиток інформаційно-цифрової компетентності вчителів технологій у закладах загальної середньої освіти. Серед них – застаріла матеріально-технічна база, обмежений доступ до сучасного цифрового обладнання та ресурсів, фрагментарне і несистемне підвищення кваліфікації, а також відсутність адаптованих методик оцінювання цифрових навичок. Ці чинники ускладнюють інтеграцію цифрових технологій у навчальний процес, знижують ефективність освітніх практик і гальмують професійне зростання педагогів. Для подолання виявлених проблем запропоновано багаторівневу модель вдосконалення цифрової компетентності. На інституційному рівні вона передбачає створення цифрової стратегії закладу освіти, розвиток внутрішньої підтримки цифрових ініціатив, формування цифрової культури та забезпечення доступу до цифрових ресурсів. Індивідуальний рівень охоплює персоналізовані траєкторії професійного розвитку, врахування мотиваційних чинників, стартового рівня компетентності, доступу до ресурсів, а також впровадження менторських програм і цифрового коучингу. Методичний рівень включає системне впровадження інструментів у навчальний процес, адаптацію навчальних матеріалів до онлайн-форматів, розвиток професійних спільнот практики, формування цифрової педагогіки та підтримку інноваційних освітніх рішень. Практична значущість роботи полягає у формулюванні конкретних рекомендацій для адміністрацій закладів загальної середньої освіти, методичних служб та самих педагогів щодо створення сприятливого освітнього середовища, яке стимулює сталий розвиток цифрових навичок. Запропоновані підходи можуть бути інтегровані в програми підвищення кваліфікації, внутрішні системи оцінювання та стратегічне планування цифрової трансформації освітніх закладів

Ключові слова: DigCompEdu; методичні підходи; професійний розвиток; цифрова трансформація