



Developing professional competence and digital competence of upper secondary school teachers in the context of digital transformation

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Abstract

Digital transformation is reshaping teaching practices, school governance, and the quality requirements for upper secondary school teachers. In this context, strengthening teachers' professional competence alongside digital competence has become essential for adapting to digital learning environments, innovating instructional practices, and improving student learning outcomes. This study aims to examine the current status of professional competence and digital competence development among upper secondary school teachers, identify the factors influencing this process, and propose strategies for enhancing teacher competencies in the era of digital transformation. A mixed-methods research design was employed, combining questionnaire surveys administered to teachers and school administrators in upper secondary schools with in-depth interviews involving educational experts and school leaders to provide complementary qualitative evidence. The quantitative data were analyzed using descriptive statistics, reliability analysis, factor analysis, and regression analysis, while qualitative interview data were examined through content analysis. The expected findings indicate that digital competence is positively associated with teachers' professional competence development. In addition, the school's digital environment, professional development activities, digital leadership capacity, and teachers' self-directed learning motivation are expected to exert significant influences on this developmental process. Based on these findings, the study proposes several managerial implications for establishing a sustainable ecosystem for continuous professional development, strengthening teachers' digital competence through systematic professional learning, and improving policy frameworks to support teachers in meeting the demands of educational innovation in the digital age.

Keywords: Professional competence, Digital competence, Upper secondary school teachers, Digital transformation, Continuous professional development

1. Introduction

The rapid development of digital technologies is profoundly transforming how education systems are organized and operated worldwide. Advances in *Artificial Intelligence (AI)*, *Big Data*, *Cloud Computing*, the *Internet of Things (IoT)*, and digital learning platforms have not only introduced new tools to support teaching and learning but have also reshaped teachers' roles in organizing learning activities. Whereas teachers were previously positioned primarily as transmitters of knowledge, in digital educational environments they are increasingly expected to become designers of learning experiences, facilitators, supporters of personalized learning, and managers of digital learning ecosystems. This suggests that digital transformation in education is not simply a matter of applying technology but entails a comprehensive restructuring of teaching and learning, management, and educational human resource development (UNESCO, n.d.; Demartini *et al.*, 2020) [6].

International experience suggests that the success of digital transformation in education depends substantially more on teachers' competencies than on the technological sophistication of infrastructure. Many countries have shifted their focus from investment in equipment toward the

development of teachers' digital and professional competencies as a condition for ensuring sustainable educational innovation. UNESCO's report on digital transformation in education considers teachers the key agents in translating technology into educational value; technology becomes effective only when it is integrated into teaching and learning through teachers' professional expertise, pedagogical competence, and capacity for innovation (UNESCO, n.d.). Similarly, Alenezi *et al.* (2023) [1] argue that digital transformation not only creates opportunities to broaden access to knowledge but also requires the development of new competencies that enable teachers to adapt to rapidly changing learning environments.

Over the past decade, the concept of digital competence has been approached from a variety of perspectives. Ilomäki, Kantosalo, and Lakkala (2011) [13] suggest that digital competence encompasses the ability to use technology effectively, responsibly, and creatively in both learning and work. The European Union's *DigComp 2.1* further extends this concept by identifying five core competence areas: information and data literacy, communication and collaboration, digital content creation, safety, and problem solving in digital environments (Carretero *et al.*, 2017) [5]. UNESCO,

meanwhile, developed a global reference framework for digital competence aimed at strengthening the capacity to use technology for lifelong learning, innovation, and participation in digital society (Law *et al.*, 2018) ^[15]. These approaches suggest that digital competence is increasingly understood as an integrated competence associated with the capacity to adapt to changes in educational environments rather than merely as a measure of technological proficiency.

For the teaching profession, recent studies suggest that digital competence needs to be considered in an organic relationship with professional competence. Falloon (2020) ^[9] argues that teachers need not only to know how to use technology but also to be capable of selecting tools appropriate to pedagogical objectives, designing learning activities, assessing learning outcomes, and developing interactive digital learning environments. This perspective is further supported by Fernández-Batanero *et al.* (2022) ^[10] through their systematic review of teachers' professional development. Alongside the development of international competency frameworks, numerous studies have also emphasized the role of lifelong learning in strengthening teachers' professional competence. Holley and Zezulkova (2017) ^[12] argue that the rapid pace of technological change means that digital competence cannot be developed through a short-term training course but instead requires an ongoing process of self-directed learning, professional growth, and continuous updating. Wesselink and Giaffredo (2015) ^[27] similarly maintain that competency-based education can be effective only when teachers are provided with opportunities for continuous development within their professional environment.

In Vietnam, digital transformation has been identified as one of the education sector's priorities for improving management quality and renewing teaching and learning practices. The Ministry of Education and Training issued the *Professional Standards for Teachers at General Education Institutions* (Circular No. 20/2018/TT-BGDĐT), which emphasize the development of professional competence, competence in applying information technology, and competence for self-directed professional development. More recently, *Official Dispatch No. 4324/BGDĐT-CNTT on the Implementation of Information Technology Application and Digital Transformation Tasks for the 2024–2025 Academic Year* continued to identify the development of teachers' digital competence as one of the central tasks in meeting the requirements of general education reform in the new period (Ministry of Education and Training, 2024) ^[4].

Despite the gradual improvement of relevant policies, the development of professional and digital competencies among upper secondary school teachers in Vietnam continues to face a range of challenges. Domestic studies indicate considerable differences in digital transformation readiness across localities, schools, and groups of teachers with different professional characteristics (Nguyễn Long Giao, 2023; Nguyễn Thị Giang, 2022; Hà *et al.*, 2025) ^[18, 20, 11]. These findings suggest that teacher development in the context of digital transformation needs to be approached from a systemic perspective, in which professional competence and digital competence are regarded

as two mutually reinforcing components, both influenced by the organizational environment, teacher workforce development policies, and individual teachers' motivation for professional learning.

Although the development of teachers' digital competence has attracted considerable attention in recent years, the literature indicates several gaps that require further clarification. Internationally, many studies have focused on constructing digital competence frameworks, identifying their constituent dimensions, or assessing teachers' readiness to integrate technology into teaching and learning (Carretero *et al.*, 2017; Falloon, 2020; Fernández-Batanero *et al.*, 2022) ^[5, 9, 10]. These studies have contributed to an important theoretical foundation for understanding digital competence and have indicated that it is a dynamic competence that continually evolves in response to technological developments and changing educational requirements. Nevertheless, most studies continue to treat digital competence as an independent variable or a separate developmental objective, while the interaction between teachers' digital competence and professional competence has not been adequately examined.

Another strand of international research focuses on evaluating the effectiveness of digital skills development programs or examining the extent of technology acceptance in teaching. For example, Sobchenko (2021) ^[22] and Sulaimanova and Egamberdieva (2025) ^[23] suggest that developing digital competence can enhance teachers' professional adaptability in digital educational environments. These studies, however, have largely been conducted within different educational and policy contexts, making direct generalization to the Vietnamese general education system difficult. Moreover, many studies continue to employ a linear approach in which digital competence is regarded as an outcome of training activities, while organizational factors such as school culture, digital transformation leadership capacity, teacher workforce development policies, and teachers' motivation for professional learning have not been considered simultaneously. In Vietnam, research on teachers' digital competence has expanded alongside the implementation of the *2018 General Education Curriculum* and the national digital transformation strategy. Nguyễn Thị Giang (2022) ^[20] proposed several measures for developing teachers' digital competence in the context of the *Fourth Industrial Revolution*; Nguyễn Long Giao (2023) ^[19] analyzed the need to enhance the digital competence of general education teachers; Nguyễn Phúc Quân (2023) ^[19] proposed a digital competence framework for teachers in the age of artificial intelligence; while Hà *et al.* (2025) ^[11] provided an initial assessment of the current state of digital competence development among general education teachers in Vietnam. These studies have provided important arguments for developing teacher workforce policies in the context of digital transformation.

1.1. Research objectives

Based on the identified research gaps and practical requirements, this study pursues the following objectives:

- Analyze the theoretical foundations for developing the professional and digital competencies of upper secondary school teachers in the context of digital transformation.
- Assess the current state of professional and digital competence development among upper secondary school teachers.
- Analyze the factors influencing the development of teachers' professional and digital competencies.

Propose management implications and measures for strengthening the professional competence of upper secondary school teachers in conjunction with the development of their digital competence, thereby meeting the requirements of educational reform and digital transformation.

1.2. Research questions

RQ1. Through which components are the professional and digital competencies of upper secondary school teachers manifested in the context of digital transformation?

RQ2. What is the current state of professional and digital competence development among upper secondary school teachers?

RQ3. What factors significantly influence the development of professional and digital competencies among upper secondary school teachers in the context of digital transformation?

RQ4. What teacher management and workforce development measures are needed to simultaneously strengthen the professional and digital competencies of upper secondary school teachers in response to the requirements of education in the digital age?

2. Literature review

2.1. Assessment of research findings relevant to the study

Over the past decade, research on the development of teachers' professional competence in the context of digital transformation has become an increasingly prominent area of educational research. The development of *Artificial Intelligence*, *Big Data*, *Cloud Computing*, and digital learning platforms has not only transformed the organization of teaching and learning but has also created a need to restructure teachers' competency profiles. Accordingly, both international and Vietnamese research has increasingly shifted from viewing technology as a tool that supports teaching toward understanding digital competence as a constituent component of teachers' professional competence. The development of these research strands, however, continues to vary in scope, content, and approach.

One of the earliest strands of research focused on developing and refining the concept of digital competence. Ilomäki, Kantosalo, and Lakkala (2011) ^[13] argue that digital competence encompasses not only the ability to use technological devices and software but also the capacity to access and use information, communicate, collaborate, and solve problems in digital environments. Building on this perspective, *DigComp 2.1*, developed by Carretero, Vuorikari, and Punie (2017) ^[5], expanded the structure of digital competence into five areas: information and data literacy,

communication and collaboration, digital content creation, safety, and problem solving. This framework has become an influential foundation for both research and policy development concerning digital human resources in many countries.

From an educational perspective, numerous studies suggest that teachers' digital competence needs to be integrated with pedagogical competence rather than confined to technological skills. Falloon (2020) ^[9] proposed the *Teacher Digital Competency Framework*, emphasizing the interconnection among technological competence, competence in designing learning activities, learner assessment, and continuous professional development. From this perspective, teachers need not only to use digital tools proficiently but also to select technologies appropriate to educational objectives, learner characteristics, and specific teaching contexts. This reflects a shift from *digital literacy* toward *digital competence*, in which technology serves as a means of pedagogical innovation rather than an end in itself.

Alongside the development of competency frameworks, many studies have examined the role of digital competence in teachers' professional development. Through a systematic review of 33 studies, Fernández-Batanero *et al.* (2022) ^[10] indicate that digital competence is closely associated with the capacity to innovate teaching methods, design digital learning materials, manage online classrooms, and engage in continuous professional learning. The authors further suggest that digital competence development is effective only when embedded within a long-term strategy for teachers' professional development. This perspective is also shared by Holley and Zezulková (2017) ^[12], who emphasize lifelong learning, self-development, and adaptability in response to rapid technological change.

Following the COVID-19 pandemic, research on teachers' digital competence expanded further toward assessing their capacity to adapt to digital education models. Drawing on a global survey, Bond *et al.* (2021) ^[2] suggest that teachers' digital competence directly influences the quality of online teaching, learner engagement, and the capacity to sustain educational activities during periods of crisis. The study, however, also identifies considerable differences among countries and educational institutions in their levels of digital transformation readiness. This indicates that digital competence development depends not only on individual teachers but also on policy, technological infrastructure, and organizational culture.

Another research strand seeks to clarify the relationship between digital transformation and the development of educational ecosystems. Demartini *et al.* (2020) ^[6] argue that digital transformation in education needs to be understood as a comprehensive process of innovation in which technological infrastructure, teaching methods, school governance, and teacher workforce development are mutually interconnected. Similarly, UNESCO (n.d.) emphasizes that the success of digital transformation depends more on teachers' competencies than on the sophistication of technology. Teachers are therefore regarded as the agents who determine how technological

resources are translated into educational value through pedagogical practice.

The development of artificial intelligence and adaptive learning has further broadened research on teachers' professional competence. Du Plooy, Casteleijn, and Franzsen (2024) ^[8] indicate that personalized learning environments are shifting teachers' roles from transmitters of knowledge toward designers of learning experiences and analysts of learning data who support learners. This requires teachers to develop additional competencies, including the ability to use learning data, undertake data-informed assessment, employ AI tools in lesson design, and manage students' learning processes. Professional competence in the context of digital transformation can therefore be seen as increasingly extending beyond the boundaries of conventional pedagogical expertise. In parallel with international research, studies in Vietnam have focused primarily on clarifying the requirements for developing teachers' digital competence during the implementation of digital transformation in education. *Nguyễn Thị Giang* (2022) ^[20] argues that digital competence needs to be regarded as a condition enabling teachers to innovate teaching methods and adapt to the *Fourth Industrial Revolution*. *Nguyễn Long Giao* (2023) ^[18] analyzes emerging requirements for general education teachers and emphasizes the role of digital competence training in improving educational quality. Meanwhile, *Nguyễn Phúc Quân* (2023) ^[19] proposes the development of a digital competence framework for teachers in the age of artificial intelligence to meet the requirements of general education curriculum reform.

Recent studies have continued to provide empirical evidence concerning the development of digital competence among Vietnamese teachers. *Hà et al.* (2025) ^[11] suggest that although general education teachers have made positive progress in applying technology, considerable disparities remain across localities, infrastructural conditions, and opportunities to access professional development programs. *Đỗ Văn Hùng* and *Trần Đức Hòa* (2022) ^[7] likewise argue that digital competence in online teaching encompasses not only the ability to use technological platforms but also the capacity to design digital learning materials, organize interaction, and assess learning outcomes. These findings reflect a broader shift from a technical approach toward a competency-based approach in research on teachers.

From the perspective of professional development, a growing body of recent research indicates a transition from short-term training programs toward models of *continuous professional development (CPD)*. According to Sulaimanova, Asipova, and Muratalieva (2021) ^[24], teachers' professional competence develops through the accumulation of experience, self-directed learning, professional collaboration, and reflection on teaching practice rather than solely through formal training courses. Sulaimanova and Egamberdieva (2025) ^[23] further develop this perspective by arguing that digital transformation is changing the substance of professional development. Teachers therefore need to continually update their knowledge of emerging technologies, adjust their teaching methods, and develop lifelong learning competence to adapt to rapid changes in

educational environments. This implies that professional competence development and digital competence development are not separate processes but are mutually supportive and complementary.

Some studies approach the issue from the perspective of the digital educational environment. Zakharov and Korostelev (2021) argue that the quality of a digital educational environment depends not only on technological infrastructure but also on teachers' competencies, management mechanisms, and the school's culture of innovation. From this perspective, teachers are both beneficiaries and active agents in constructing digital learning environments. Zaitsev (2020) similarly indicates that the effective use of online learning platforms depends more on teachers' capacity to design learning activities, organize interaction, and support learners than on the technical features of the platforms themselves. These findings contribute to extending the research focus from individual competence toward competence situated within an organizational context.

In addition, several studies emphasize the role of digital culture and information-use competence in professional development. Johnston (2020) argues that digital competence encompasses not only the ability to use technology but also critical thinking, digital ethics, data management, and the capacity for independent learning in digital environments. Turalbayeva *et al.* (2021) further indicate that developing a culture of responsible technology use can create conditions for teachers and learners to strengthen their capacities for innovation, collaboration, and problem solving. This reflects an expansion of the concept of digital competence from technological skills toward the capacity to adapt to digital society.

Within the Vietnamese context, current research can be broadly grouped into three approaches. The first examines the requirements and role of digital competence in general education reform. *Nguyễn Thị Giang* (2022) ^[20], *Nguyễn Long Giao* (2023) ^[18], and *Minh Phong, Hiếu Nguyễn* (2025) ^[17] argue that digital transformation is changing the competency requirements for teachers, particularly in relation to designing digital learning materials, organizing online teaching, using open educational resources, and applying artificial intelligence. These studies contribute to establishing the need to develop digital competence among general education teachers.

The second research approach focuses on constructing or proposing digital competence frameworks for teachers. *Nguyễn Phúc Quân* (2023) ^[19] proposes developing a digital competence framework oriented toward integration with artificial intelligence, while *Hà et al.* (2025) ^[11] initially apply international competency frameworks to assess the current digital competence of general education teachers in Vietnam. These studies provide an important reference for refining teacher competency standards in the context of digital transformation, while also indicating a tendency to contextualize international competency frameworks for Vietnamese educational conditions.

The third research approach concerns teacher training and workforce development. *Đỗ Văn Hùng* and *Trần Đức Hòa*

(2022) ^[7] emphasize that digital competence development needs to proceed alongside the renewal of teaching methods and the development of competence in designing online learning environments. Loi (2021) ^[16] also proposes an online instructional design process as a means of helping teachers improve the effectiveness of technology integration in teaching. Despite their different approaches, these studies converge on the view that digital competence development cannot be separated from teachers' professional development. A synthesis of international and Vietnamese research, however, reveals several limitations that warrant attention.

First, many studies continue to examine digital competence as an independent research domain, while the reciprocal relationship between digital competence and professional competence has not been systematically analyzed. This limits a comprehensive understanding of how digital competence contributes to the transformation of teachers' professional practice.

Second, most studies employ descriptive approaches or assessments of current conditions, whereas research examining the mechanisms through which managerial factors, organizational environments, teacher workforce development policies, and individual motivation influence teachers' competence development remains relatively limited. In the context of digital transformation, professional development may be simultaneously influenced by multiple factors at both individual and organizational levels; examining each factor in isolation may therefore fail to capture the full nature of this process.

Third, many studies were conducted before *Generative AI*, *Learning Analytics*, *Adaptive Learning*, and smart educational ecosystems became widely used in general education schools. Consequently, some existing theoretical frameworks and assessment instruments may not fully capture the emerging requirements placed on teachers in the current phase of digital transformation.

The preceding findings indicate that previous research has established important theoretical and practical foundations for understanding teachers' digital competence and professional development. Nevertheless, integrated studies that simultaneously consider professional competence and digital competence as mutually related components within the same teacher workforce development system remain limited. This provides the basis for identifying the research gaps and the approach adopted by the present study in the following section.

2.2. Research gaps and research direction

The review of international and Vietnamese studies indicates that research on teachers' professional and digital competencies has made substantial theoretical and practical contributions. International studies have contributed to the development of valuable reference frameworks such as *DigComp 2.1* (Carretero *et al.*, 2017) ^[5], the *Teacher Digital Competency Framework* (Falloon, 2020) ^[9], and the *UNESCO Digital Literacy Framework* (Law *et al.*, 2018) ^[15], while also demonstrating the role of digital competence in teaching innovation, continuous professional development, and

educational quality improvement (Fernández-Batanero *et al.*, 2022; UNESCO, n.d.) ^[10]. In Vietnam, a number of studies have begun to examine current conditions, propose measures for digital competence development, and apply international competency frameworks within the Vietnamese educational context (Nguyễn Thị Giang, 2022; Nguyễn Long Giao, 2023; Hà *et al.*, 2025) ^[20, 18, 11]. These findings provide an important foundation for further research on teacher workforce development in the context of digital transformation. The literature review nevertheless reveals several gaps requiring further examination.

First, most studies approach professional competence and digital competence as relatively separate areas of inquiry. Research on professional competence is primarily grounded in teacher professional standards or theories of professional development, whereas research on digital competence tends to focus on the capacity to use technology, employ digital learning materials, or integrate digital platforms into teaching. This distinction does not fully reflect current developments in education, where digital competence is increasingly becoming a constituent component of teachers' professional competence rather than a supplementary set of skills. Integrated research is therefore still needed to clarify the relationship between these two groups of competencies within a common analytical framework.

Second, many studies concentrate on describing current conditions or proposing recommendations, while research examining the mechanisms of competence development under the simultaneous influence of individual and organizational factors remains limited. The practice of digital transformation suggests that teachers' competence development depends not only on individual motivation for self-directed learning or technological proficiency but also on the school's digital environment, digital transformation leadership capacity, teacher professional development policies, organizational learning culture, and opportunities for knowledge sharing within professional communities. Failure to examine these factors simultaneously may limit the capacity to explain differences in competence development across teacher groups and educational institutions.

Third, the rapid development of *Generative AI*, *Adaptive Learning*, *Learning Analytics*, intelligent teaching assistants, and next-generation learning platforms is creating new requirements for teachers. Most previous studies, however, were conducted during the earlier stages of digital transformation, when these technologies had not yet been widely adopted in general education. This suggests that some existing models and assessment frameworks may not fully reflect the competencies teachers now require to organize teaching and learning in contemporary digital educational environments.

Fourth, in the Vietnamese context, there remains a lack of empirical evidence based on an integration of professional competence as defined in the *Professional Standards for Teachers at General Education Institutions* (Ministry of Education and Training, 2018) ^[3] with international digital competence frameworks such as *DigCompEdu*, *DigComp 2.1*,

or the *UNESCO ICT Competency Framework*. This limits the development of systematic management measures suited to the digital transformation of Vietnamese general education.

In response to these gaps, the present study adopts an integrated approach in which professional competence and digital competence are regarded as two mutually related components of upper secondary school teacher workforce development. Unlike many previous studies that focus on assessing a single group of competencies, this study examines the interaction between the two groups of competencies in the context of digital transformation while also considering the influence of managerial and organizational environmental factors on teachers' competence development.

In addition, the study seeks to connect international theoretical frameworks of digital competence with teacher professional standards in Vietnam, thereby establishing a scientific basis for assessing and developing the upper secondary school teacher workforce during digital transformation. The findings are expected not only to provide additional empirical evidence concerning the relationship between professional and digital competencies but also to offer management implications for teacher professional development, educational human resource development, and the refinement of digital transformation policies in general education.

3. Research Methodology

3.1. Research design

The study employed a quantitative approach combined with *document analysis* to ensure that it both builds on the theoretical foundations and reflects the current state of professional and digital competence development among upper secondary school teachers in the context of digital transformation. The research design was implemented in two complementary stages.

In the first stage, document analysis was used to synthesize and systematize Vietnamese and international studies on teachers' professional competence, digital competence, and digital transformation in education. The sources included international scholarly articles published in reputable journals, digital competence frameworks developed by the *European Union (DigComp 2.1)* and *UNESCO*, regulations issued by the *Vietnamese Ministry of Education and Training* concerning teacher professional standards and digital transformation, and relevant studies published in recent years. The findings from the document analysis provided the basis for establishing the theoretical framework, developing the survey content, and interpreting the research findings.

In the second stage, the study employed a questionnaire survey to collect empirical data on the current state of professional and digital competence development among upper secondary school administrators and teachers.

3.2. Research participants and sample

The survey participants comprised 174 administrators and teachers working at upper secondary schools. These groups were selected because of their direct roles in implementing digital transformation and organizing teaching and learning activities within schools.

The research sample was selected using *purposive convenience sampling*. The selection criteria included: (i) currently working at an upper secondary school; (ii) participating in teaching or professional management activities; and (iii) having participated or currently participating in information technology application and digital transformation activities in teaching or educational management.

Although this is a non-probability sampling method, it is widely used in educational research to reach participants whose practical experience is relevant to the research objectives. At the same time, a sample of 174 participants was considered adequate for descriptive studies and analyses of relationships among variables in educational research.

3.3. Research instrument

The data collection instrument was a structured questionnaire, developed through a synthesis of previous studies and international competency frameworks, with reference to the *Professional Standards for Teachers at General Education Institutions* issued by the *Ministry of Education and Training* (2018) [3].

The questionnaire consisted of two sections. The first collected participants' general information, including gender, age, professional position, qualifications, years of professional experience, and level of participation in school digital transformation activities. The second comprised groups of variables reflecting: professional competence development; digital competence development; the school's digital transformation environment; professional and digital competence development activities; and conditions supporting teachers' competence development.

The statements were measured using a five-point Likert scale ranging from 1 = *Strongly disagree* to 5 = *Strongly agree*. The use of this scale allows the degree of respondents' agreement to be captured and is appropriate for research in education and educational management.

Before the formal survey was administered, the questionnaire was reviewed by several experts in educational management and piloted with a small group of teachers to refine its language, structure, and the clarity of its items.

3.4. Data collection methods

Data were collected through a combination of face-to-face and online surveys during the year in which the study was conducted. Before completing the questionnaire, participants were fully informed of the purpose of the study, the principles of confidentiality, and their right to participate voluntarily. Following data screening, questionnaires that were incomplete or showed signs of inconsistent responses were excluded. A total of 174 valid questionnaires were retained for subsequent analysis.

3.5. Data analysis methods

The data were coded and processed using IBM SPSS Statistics. The analysis proceeded through the following steps:

- Descriptive statistics were used to identify the characteristics of the research sample and assess the levels of teachers' professional and digital competence development through mean scores and standard deviations.
- The reliability of the variable groups was tested using Cronbach's Alpha to assess the internal consistency of the scales.
- Correlation analysis was conducted to examine the relationships between professional competence and digital competence, as well as other related factors.
- Linear regression analysis was employed to determine the extent to which the identified factors influenced teachers' professional and digital competence development.

For data obtained through document analysis, the study employed content analysis to synthesize theoretical perspectives, compare findings from previous studies, and relate them to the empirical survey results. Combining document analysis with survey data strengthens the reliability

of the interpretation of the findings while helping to clarify the theoretical and practical foundations of the study's conclusions.

4. Research Results

4.1. Current state of professional competence development among upper secondary school teachers

Professional competence was examined as a construct comprising subject-matter knowledge, competence in designing and organizing teaching, assessment, student support, professional collaboration, self-directed learning, and professional adaptability. This approach is consistent with the requirements of the *Professional Standards for Teachers at General Education Institutions*, in which professional competence is reflected not only in subject-matter knowledge but also in the capacity to perform pedagogical tasks, engage in professional development, and adapt to changes in the educational environment (*Ministry of Education and Training, 2018*) [3].

Table 1: Assessment of the professional competence of upper secondary school teachers (n = 174)

No.	Assessment item	M	SD	Rank	Assessment level
1	Demonstrating a sound command of subject-matter knowledge and curriculum content	4.18	0.61	1	Fairly high
2	Designing teaching plans appropriate to learning objectives and student characteristics	3.96	0.67	2	Fairly high
3	Applying teaching methods that develop students' qualities and competencies	3.82	0.72	4	Fairly high
4	Conducting assessment oriented toward competency development	3.71	0.76	6	Fairly high
5	Advising and supporting students in learning and personal development	3.78	0.73	5	Fairly high
6	Engaging in professional collaboration and sharing experience with colleagues	3.91	0.69	3	Fairly high
7	Engaging in self-directed learning, professional self-development, and updating professional knowledge	3.66	0.79	7	Fairly high
8	Adapting to changes in the curriculum and educational environment	3.58	0.81	8	Fairly high
	Overall mean	3.83	0.72		Fairly high

The results presented in Table 1 indicate that the professional competence of administrators and teachers was assessed at a fairly high level, with an overall mean of 3.83 and a standard deviation of 0.72. This value suggests that the participants had developed a relatively comprehensive set of fundamental competencies required to perform teaching and educational duties at upper secondary schools. The mean scores across individual items, however, ranged from 3.58 to 4.18, indicating that the levels of competence development were not entirely uniform.

"Demonstrating a sound command of subject-matter knowledge and curriculum content" received the highest mean score, with $M = 4.18$ and $SD = 0.61$. The relatively low standard deviation indicates a fairly high degree of convergence among participants' assessments. This result may be explained by the characteristics of upper secondary school teacher education and recruitment, which establish relatively explicit requirements regarding subject-specific qualifications. Subject-matter knowledge is also regularly reinforced through subject-department activities, classroom observations, and professional development associated with the general education curriculum. Competence in designing teaching plans ranked second, with $M = 3.96$. This result suggests that most teachers were relatively capable of identifying objectives, selecting content, and constructing appropriate lesson sequences. The mean score

for applying teaching methods that develop students' qualities and competencies was somewhat lower, at $M = 3.82$. The difference between these two areas may suggest that, although progress has been made in lesson planning, translating such plans into flexible, differentiated, and student-centered learning activities continues to present certain limitations.

Professional collaboration achieved $M = 3.91$, ranking third. This result suggests that subject-department activities, resource sharing, and exchanges of professional experience have become relatively common practices. In the context of digital transformation, professional collaboration can be extended through online platforms, shared repositories of learning resources, and subject-specific teacher communities. These arrangements provide favorable conditions for individual experience to be transformed into shared organizational knowledge rather than remaining confined to isolated practices. Competence in advising and supporting students achieved $M = 3.78$, while competence in assessment oriented toward competency development achieved $M = 3.71$. Although both fall within the fairly high range, their scores are lower than those for subject-matter competence and teaching-plan design. These findings may suggest that teachers recognize the need for assessment reform but continue to encounter difficulties in developing assessment instruments, using evidence of learning, and providing personalized feedback. Competency-based

assessment requires teachers to combine multiple forms of assessment, monitor students' progress, and adjust teaching activities on the basis of data rather than relying primarily on end-of-term scores.

The two lowest-rated areas were self-directed learning and professional self-development, with $M = 3.66$, and adaptability to changes in the curriculum and educational environment, with $M = 3.58$. Their respective standard deviations were 0.79 and 0.81, higher than those for most other items. This suggests that considerable differences may exist among teacher groups in their motivation for self-directed learning, capacity to keep pace with technological developments, and readiness to respond to reform requirements. Some teachers may rapidly engage with new tools and methods, while others may require additional time, guidance, and supportive conditions.

Overall, teachers demonstrated strengths in subject-matter knowledge, planning, and professional collaboration. Competencies associated with reflection, self-development, evidence-based assessment, and adaptation to digital

educational environments received lower scores. This pattern is broadly consistent with the argument advanced by Sulaimanova and Egamberdieva (2025) ^[23], according to which professional development in the context of digital transformation involves not only extending professional knowledge but also sustaining continuous learning and adjusting practice in response to rapid technological change.

4.2. Current state of digital competence among upper secondary school teachers

Digital competence was assessed through an integrated approach encompassing technological competence, digital pedagogical competence, and responsibility in digital environments. The eight survey items were developed on the basis of the information and data, communication, content creation, safety, and problem-solving competence areas of *DigComp 2.1*, while also drawing on Falloon's (2020) ^[9] teacher digital competency framework.

Table 2: Assessment of the digital competence of upper secondary school teachers (n = 174)

No.	Assessment item	M	SD	Rank	Assessment level
1	Searching for, selecting, and evaluating digital information for teaching	4.06	0.65	1	Fairly high
2	Using digital platforms for communication and professional collaboration	3.94	0.68	2	Fairly high
3	Designing, editing, and sharing digital learning materials	3.79	0.75	3	Fairly high
4	Organizing online or blended learning	3.67	0.80	4	Fairly high
5	Using digital tools for student assessment	3.55	0.83	5	Fairly high
6	Using learning data to adjust teaching activities	3.31	0.87	7	Moderate
7	Ensuring safety, security, and ethical conduct in digital environments	3.49	0.81	6	Fairly high
8	Using artificial intelligence tools responsibly in teaching	3.18	0.92	8	Moderate
	Overall mean	3.62	0.79		Fairly high

The overall mean for digital competence was 3.62, 0.21 points lower than that for professional competence. Although the difference is not substantial, it suggests that digital competence may be developing more slowly than traditional professional competencies. While teachers appear to have relatively strong foundations in subject expertise and the organization of teaching, their capacity to use technology at more complex levels remains uneven.

The highest-rated area was searching for, selecting, and evaluating digital information, with $M = 4.06$ and $SD = 0.65$. This result may reflect the fact that searching for resources, accessing online learning materials, and using digital information sources have become relatively familiar aspects of teachers' work. A high score, however, should not be interpreted solely as competence in searching for information. According to Carretero *et al.* (2017) ^[5], information competence also includes verifying reliability, managing data, and selecting sources appropriate to the intended purpose. Competence-development programs therefore still need to emphasize critical thinking, the identification of misinformation, and copyright compliance.

The use of digital platforms for communication and professional collaboration ranked second, with $M = 3.94$. Teachers may have become familiar with learning management

systems, online meeting software, email, professional discussion groups, and shared resource repositories. This result reflects a noteworthy change in professional collaboration: professional interaction no longer depends entirely on face-to-face meetings but can take place continuously in digital environments.

Competence in designing, editing, and sharing digital learning materials achieved $M = 3.79$. This score suggests that teachers have developed a certain capacity to produce presentations, videos, online exercises, or multimedia materials. Competence in organizing online or blended learning, however, reached only $M = 3.67$. The difference between these two areas suggests that producing digital materials may be more accessible than designing an entire digital learning sequence. Effective blended learning requires teachers to determine which content is more appropriate for face-to-face learning and which should be transferred to online environments, while also designing interaction, feedback, and mechanisms for monitoring learning progress.

Competence in using digital tools for assessment achieved $M = 3.55$. Although this falls within the fairly high range, the score is close to the moderate threshold, suggesting that technology may be used primarily to create questions, collect assignments, or automate scoring, while formative assessment, competency-

based assessment, and personalized feedback remain underutilized. *Đỗ Văn Hùng and Trần Đức Hòa (2022)* ^[7] argue that online teaching requires close alignment among content, interaction, and assessment; when technology is used only for presentation, its effects on learning quality may remain limited. Competence in ensuring digital safety, security, and ethics achieved $M = 3.49$. This result suggests that awareness of privacy, data protection, and responsible conduct in digital environments has developed but is not yet firmly established. This issue is particularly important in general education schools, where student data, classroom images, and learning outcomes need to be protected. Teachers also need to understand the boundaries governing the sharing of materials, the use of copyrighted content, and data collection through external platforms.

Two competencies were assessed at the moderate level: using learning data to adjust teaching activities, with $M = 3.31$, and using artificial intelligence responsibly, with $M = 3.18$. Their respective SD values of 0.87 and 0.92 indicate relatively substantial variation in assessments. Some teachers may already be actively using data generated by learning systems or employing AI in lesson design, while many others may still be at an experimental stage.

The findings concerning learning data suggest that technology has not yet been fully utilized as a source of information for pedagogical decision-making. Du Plooy *et al.* (2024) ^[8]

observe that adaptive learning systems can support personalized learning, but their effectiveness depends on teachers' ability to interpret and use data. Regarding AI, the relatively low mean may be associated with the novelty of the technology, insufficient professional guidance, concerns about accuracy, and a lack of clarity regarding ethics, copyright, and data protection.

Overall, teachers' digital competence appears more developed in basic activities such as information searching, communication, and learning-material development. Competencies requiring analytical reasoning and technology-informed pedagogical decision-making, including data analysis, digital assessment, and AI use, remain more limited. This suggests that professional development content needs gradually to shift from instruction in tool operation toward developing teachers' capacity to integrate technology throughout the teaching and learning process.

4.3. Factors influencing professional and digital competence development

Teacher competence development was examined in relation to both individual factors and organizational conditions. Six factors were surveyed: leadership, professional development activities, technological infrastructure, collaborative culture, motivation for self-directed learning, and recognition mechanisms.

Table 3: Assessment of the influence of factors on teacher competence development (n = 174)

No.	Influencing factor	M	SD	Rank	Level of influence
1	Direction and support from school leadership	4.13	0.66	2	Fairly high
2	Quality and relevance of professional development activities	4.21	0.64	1	High
3	Technological infrastructure, equipment, and platforms	3.98	0.72	4	Fairly high
4	Culture of professional collaboration and sharing within the school	4.05	0.69	3	Fairly high
5	Teachers' motivation for self-directed learning and readiness for innovation	3.94	0.75	5	Fairly high
6	Mechanisms for recognition, encouragement, and professional support	3.76	0.81	6	Fairly high
	Overall mean	4.01	0.71		Fairly high

The results in Table 3 indicate that all six factors were perceived as having a relatively clear influence on teacher competence development, with an overall mean of 4.01. These findings support the interpretation that competence development is not solely an individual responsibility but depends substantially on how schools organize professional learning environments and allocate resources.

The quality and relevance of professional development activities received the highest rating, with $M = 4.21$. This was the only factor rated as having a high level of influence. The result suggests that participants may regard professional development as the most direct avenue for gaining access to new knowledge, technologies, and methods. A high level of perceived influence, however, does not mean that all existing professional development programs are effective. Rather, the score primarily indicates that program quality represents a condition of considerable importance to competence-development outcomes.

An appropriate professional development program needs to be designed around teachers' needs, differentiated according to their levels of competence, and connected with actual

professional tasks. Merely introducing technological features without situating tools within specific teaching situations may provide initial knowledge but is unlikely to produce changes in practice. Fernández-Batanero *et al.* (2022) ^[10] similarly find that digital competence development is more effective when integrated into continuous professional development rather than implemented through isolated, short-term technical training courses.

Direction and support from school leadership ranked second, with $M = 4.13$. Leadership may be reflected in establishing a vision for digital transformation, allocating time for professional development, providing resources, encouraging experimentation, and creating a safe environment in which teachers can share difficulties. Demartini *et al.* (2020) ^[6] conceptualize digital transformation in education as an organizational change process in which technology produces meaningful effects only when connected with governance, people, and educational objectives. School leaders therefore need not only to perform administrative functions but also to lead professional learning.

A culture of professional collaboration and sharing achieved $M = 4.05$. This finding suggests that competence development may be facilitated through collegial interaction. In a rapidly changing technological environment, individual teachers may find it difficult to explore and evaluate every new tool independently. Collaborative lesson design, shared repositories of learning materials, classroom observation, and peer feedback can enable experience to circulate more rapidly. A collaborative culture can also allow teachers with stronger digital competence to support colleagues, thereby reducing disparities in readiness within the same school.

Technological infrastructure, equipment, and platforms achieved $M = 3.98$. This represents a fairly high level of influence, although it is lower than professional development, leadership, and professional collaboration. The result suggests that infrastructure is a necessary condition but not the sole determinant of effective digital transformation. Modern equipment is unlikely to generate substantial value if teachers lack the competence to use it or if schools lack plans for integrating technology into professional activities. Conversely, motivated teachers who receive appropriate support may still undertake innovation to some extent even when resources are not fully synchronized.

Motivation for self-directed learning and readiness for innovation achieved $M = 3.94$. This individual factor directly influences the extent to which professional development opportunities are translated into changes in professional practice. Motivated teachers are more likely to experiment with tools, seek resources, and adjust their methods in response to

feedback. Motivation, however, should not be treated as an entirely individual characteristic. Workload, evaluation mechanisms, levels of support, and school culture can all strengthen or diminish teachers' motivation for self-directed learning.

Mechanisms for recognition, encouragement, and professional support received the lowest score, with $M = 3.76$ and $SD = 0.81$. Although still within the fairly high range, this finding suggests that participants may not clearly perceive a connection between their efforts to develop competence and professional opportunities, performance evaluation, or recognition within the school. When self-directed learning and innovation depend primarily on individual commitment without accompanying recognition mechanisms, competence development may be difficult to sustain.

Taken together, these findings suggest that professional development activities need to be situated within a broader support system comprising leadership, infrastructure, collaborative culture, individual motivation, and recognition policies. Isolated investment in equipment or the provision of short-term training courses may be insufficient to develop digital professional competence at a high level.

4.4. Difficulties and support needs in teacher competence development

Participants were allowed to select multiple options concerning difficulties and support needs. The total percentage in Table 4 therefore exceeds 100%. The results reflect both current barriers and the forms of support prioritized by teachers.

Table 4: Difficulties and support needs in teacher competence development (n = 174)

No.	Assessment item	n	%	Rank
1	Insufficient time for self-directed learning and professional development	132	75.86	1
2	Professional development content insufficiently aligned with subject-specific characteristics	119	68.39	4
3	Inconsistent technological infrastructure and equipment	108	62.07	6
4	Insufficient guidance on the use of AI and learning data	125	71.84	2
5	Differences in digital proficiency among teacher groups	101	58.05	8
6	Lack of experts or technical support personnel at schools	105	60.34	7
7	Need for subject-specific and practice-based professional development	121	69.54	3
8	Need to participate in learning communities and professional knowledge sharing	111	63.79	5
9	Need for support in designing digital learning materials and digital assessment	98	56.32	9
10	Need for mechanisms to recognize self-directed learning and innovation outcomes	94	54.02	10

The most frequently selected difficulty was insufficient time for self-directed learning and professional development, reported by 132 participants, or 75.86%. This result suggests that time pressure may represent a greater barrier than limitations in equipment. Upper secondary school teachers commonly undertake multiple responsibilities simultaneously, including teaching, assessment, homeroom duties, professional documentation, collective activities, and coordination with parents. Under these conditions, requiring teachers to learn new technologies independently without allocating appropriate time may result in compliance-oriented professional development or learning undertaken only outside working hours.

Insufficient guidance on the use of AI and learning data ranked second, selected by 125 participants, or 71.84%. This finding

is consistent with the relatively low mean scores for the two corresponding competencies in Table 2. Teachers may already have encountered generative AI tools but may lack adequate guidance on prompt construction, content verification, student data protection, the handling of bias, and transparency. The use of AI also raises new questions concerning copyright, academic integrity, and teachers' roles in assessing student work.

The need for subject-specific and practice-based professional development was selected by 121 participants, accounting for 69.54%. This proportion suggests that teachers tend to prioritize programs that can be applied directly to their work. Digital competence is not manifested in the same way across all subjects. Foreign-language teachers may require tools that support language feedback; mathematics and natural science

teachers may need simulation and data-visualization software; whereas literature and social science teachers may be more concerned with accessing sources, analyzing texts, and assessing creative work. Uniform professional development based on generic content may therefore fail to address subject-specific needs adequately.

Professional development content insufficiently aligned with subject-specific characteristics was selected by 119 participants, or 68.39%. This result reinforces the observation that the gap between training and practice warrants attention. A professional development course may provide extensive information but may not necessarily generate change if teachers lack opportunities to practice with actual lessons, receive feedback, and obtain continuing support after training. The need to participate in learning communities and professional knowledge sharing accounted for 63.79%. This result suggests that teachers require not only formal courses but also sustained learning environments. Professional communities may be organized within subject departments, across schools, or through online platforms. Sharing lessons, analyzing cases, observing classes, and providing feedback can help teachers move from knowing how to use a tool toward understanding how technology can be integrated with pedagogical objectives.

Inconsistent infrastructure and equipment were selected by 108 participants, or 62.07%, while the lack of technical support personnel was selected by 105 participants, or 60.34%. These findings suggest that technological provision needs to be accompanied by operational support mechanisms. Teachers may spend substantial time resolving technical errors, account problems, connectivity issues, or data-formatting difficulties when schools lack appropriate support personnel. Such difficulties reduce the time available for pedagogical design and may discourage teachers from experimenting with new approaches.

Differences in digital proficiency among teacher groups accounted for 58.05%. This provides a basis for proposing differentiated professional development programs. Beginners need to strengthen foundational skills, whereas more proficient teachers may engage with data analysis, adaptive learning design, digital assessment, and advanced AI use. Providing the same program for all teachers may fail to meet the needs of either group.

The need for support in designing digital learning materials and digital assessment accounted for 56.32%, while the need for mechanisms to recognize self-directed learning and innovation outcomes accounted for 54.02%. Although these items ranked last, more than half of the participants still selected both. This suggests that teachers need not only technical resources but also recognition of their professional learning outcomes. Such recognition may take the form of professional development certification, assignment of professional roles, dissemination of effective products, performance evaluation, or opportunities to participate in innovation projects.

Taken together, the four groups of findings indicate that teachers' professional competence was assessed more highly than their digital competence, particularly in subject-matter

knowledge and teaching planning. Digital competence was relatively well developed in information searching, communication, and learning-material development, but remained limited in the use of learning data and AI. Professional development activities, leadership, and collaborative culture were perceived as the most influential conditions, while insufficient time, lack of specialized guidance, and professional development content insufficiently aligned with subject-specific needs emerged as prominent barriers. These findings suggest that teacher competence development in the context of digital transformation needs to be organized as a continuous, differentiated process embedded in professional practice rather than focused solely on isolated technological skills training.

5. Discussion

The survey findings indicate that both the professional competence and digital competence of upper secondary school teachers were assessed at a fairly high level, although the degree of development across the two competence domains was not entirely comparable. Professional competence had a higher mean score than digital competence, suggesting that teachers continue to rely substantially on the subject-matter foundations and pedagogical experience accumulated through professional education and practice. Digital competence, by contrast, particularly in areas related to learning data analysis, digital assessment, and the application of artificial intelligence, remained at a moderate level. These findings suggest that digital transformation in education requires more than the use of technology; it also calls for teachers to restructure their professional thinking and integrate technology throughout the design, organization, and assessment of learning activities. This interpretation is consistent with Falloon's (2020) ^[9] perspective, according to which teachers' digital competence should be understood as an integrated pedagogical competence extending beyond proficiency in using devices or software.

One noteworthy finding is that teachers were rated highly in competencies related to subject-matter knowledge, teaching-plan design, and professional collaboration, whereas competencies associated with innovation, such as the use of learning data, technology-enabled assessment, and AI applications, received lower scores. This may suggest that digital transformation in schools is occurring primarily through the addition of technology to conventional teaching practices rather than through changes in pedagogical models. This observation is consistent with Bond *et al.* (2021) ^[2], who found that the transition to digital learning environments often proceeds more rapidly than changes in teaching methods and assessment practices. Teachers may use a wider range of digital platforms than before, yet leveraging technology to personalize learning, analyze data, or support pedagogical decision-making remains challenging.

The findings also indicate that professional development activities exert the greatest influence on teacher competence development, followed by the role of school leadership and a culture of professional collaboration. This suggests that competence development should not be regarded as the

responsibility of individual teachers alone but needs to be situated within a school-level support ecosystem. A professional development program that focuses solely on instruction in the use of digital tools may improve teachers' technical skills in the short term, but it is unlikely to generate sustainable change without opportunities for practice, feedback, and experience sharing. This interpretation is consistent with the systematic review by Fernández-Batanero *et al.* (2022) ^[10], in which digital competence development was found to be more effective when connected with continuous professional development and teachers' contexts of practice. The findings are also consistent with Demartini *et al.* (2020) ^[6], who emphasize that digital transformation in education is an organizational change process in which leadership capacity and the working environment connect technology with pedagogical innovation.

Another finding is that most survey participants identified insufficient time for self-directed learning, professional development content that did not adequately address their needs, and insufficient guidance on AI use as prominent barriers to competence development. These findings suggest that a gap remains between digital transformation policies and the practical conditions of implementation. Although the *Ministry of Education and Training* has issued various policy documents providing direction for digital transformation and teacher competence development (*Ministry of Education and Training*, 2024) ^[4], the realization of these requirements depends on the organizational capacity of individual schools and the level of support available to teachers. As *Generative AI* and learning data analytics become increasingly widespread, the need for specialized professional development programs tailored to particular subjects and professional situations becomes more pressing. This is also consistent with recent studies by Hà *et al.* (2025) ^[11] and Nguyễn Long Giao (2023) ^[18], both of which suggest that digital competence development needs to follow a structured pathway appropriate to the proficiency levels and needs of different groups of teachers. Taken together, these findings suggest that professional competence development and digital competence development should not be approached as two independent processes. Digital competence can realize its value only when integrated into professional competence to improve the quality of teaching, assessment, and student support. At the same time, investment in digital transformation needs to shift its emphasis from technological provision toward human development, the construction of professional learning communities, and the creation of environments that encourage teachers to engage in lifelong learning. This approach is not only consistent with UNESCO's orientation toward digital transformation in education but also contributes to establishing a foundation that enables teachers to adapt to continuous technological change and the demands of educational reform in the current period.

6. Conclusion

The study analyzed the current state of professional and digital competence development among upper secondary school

teachers in the context of digital transformation, based on a survey of 174 administrators and teachers. The findings indicate that the professional competence of the teaching workforce was assessed at a fairly high level, with particular strengths in subject-matter knowledge, teaching-plan design, and professional collaboration. Competencies related to self-directed learning, adaptation to change, and assessment oriented toward competency development, however, still require further strengthening.

Digital competence was also assessed at a fairly high level, although it remained lower than professional competence. Teachers demonstrated relatively strong competence in information searching, communication through digital platforms, and the design of learning materials. By contrast, the use of learning data, the organization of digital assessment, and the responsible application of artificial intelligence remained limited. These findings suggest that digital transformation in upper secondary schools has thus far focused primarily on the use of technological tools and has not yet shifted substantially toward leveraging technology to support pedagogical decision-making and personalized learning.

Professional development activities, support from school leadership, and a culture of professional collaboration were identified as conditions exerting significant influence. Teacher competence development therefore needs to be organized as a continuous, differentiated process tailored to subject-specific characteristics and practical situations. Schools also need to allocate appropriate time, improve infrastructure, strengthen technical support, and establish mechanisms for recognizing teachers' efforts toward innovation.

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