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Interdisciplinary teaching as a strategy for developing digital competence in primary school teachers

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***Abstract*---**Digital competence has become an essential professional requirement for primary school teachers in the context of educational digital transformation. At the same time, interdisciplinary teaching has increasingly been recognized as an innovative pedagogical approach that supports integrated learning and professional collaboration. This study investigates the role of interdisciplinary teaching as a strategy for developing digital competence among primary school teachers through a qualitative documentary research approach. Secondary data were collected from books, peer-reviewed journal articles, conference proceedings, and academic publications indexed in Scopus and Web of Science between 2020 and 2025. The study employed qualitative content analysis to identify major themes related to digital competence frameworks, interdisciplinary instructional practices, technology integration, professional development, and implementation challenges. The findings indicate that interdisciplinary teaching contributes significantly to the enhancement of teachers' technological, pedagogical, collaborative, and reflective competencies. In addition, interdisciplinary approaches encourage innovation, learner-centered instruction, and professional adaptability in digitally transformed educational environments. However, several barriers remain, including insufficient technological infrastructure, limited professional training, workload pressures, and institutional constraints. The study suggests that educational institutions should strengthen interdisciplinary collaboration and

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provide continuous professional support to promote sustainable digital competence development among primary school teachers.

***Keywords*---**digital competence, interdisciplinary teaching, primary school teachers, educational innovation, digital transformation, teacher professional development.

1. Introduction

The digital transformation of education has significantly changed the roles and responsibilities of teachers in contemporary schools. In the twenty-first century, teachers are no longer expected only to deliver subject knowledge but also to create flexible, technology-supported, and learner-centered educational environments. As digital technologies continue to influence teaching practices, digital competence has become an essential component of teachers' professional development. Falloon (2020) explained that teacher digital competence includes technological knowledge, pedagogical application, critical thinking, communication, and the ability to use digital tools effectively in educational contexts. For primary school teachers, these competencies are especially important because they contribute to the development of students' early digital awareness and learning skills.

At the same time, educational reform has increasingly emphasized interdisciplinary teaching as an effective strategy for improving learning quality and fostering holistic development. Interdisciplinary teaching allows teachers to integrate knowledge and methods from different subject areas in order to create meaningful and connected learning experiences. According to Wang and Sang (2024), interdisciplinary competence supports teachers' flexibility, creativity, and collaborative problem-solving abilities, which are considered essential in modern education systems. In primary schools, interdisciplinary teaching is particularly suitable because children tend to learn more effectively through integrated themes and practical experiences rather than through isolated academic subjects. The combination of interdisciplinary teaching and digital technology has created new opportunities for educational innovation. Through interdisciplinary learning activities, teachers are encouraged to apply digital tools such as multimedia resources, interactive applications, online collaboration platforms, and project-based learning technologies. Johannesen and Øgrim (2020) argued that multidisciplinarity contributes to the development of teachers' professional digital competence by encouraging collaboration, reflective practice, and experimentation with technological resources. In this context, interdisciplinary teaching becomes not only a pedagogical approach but also a pathway for strengthening teachers' digital skills and professional adaptability.

Previous studies have also highlighted the positive relationship between digital literacy and interdisciplinary instructional competence. Huang and Pan (2023) found that teachers with stronger digital competence are more capable of designing integrated learning activities and managing collaborative learning environments supported by technology. Similarly, Kusumawati and Pratama (2025) emphasized that interdisciplinary approaches encourage innovation in

digital teaching practices and support the development of creative educational strategies. These findings indicate that interdisciplinary teaching can play an important role in helping teachers respond to the demands of digital transformation in education.

Despite these advantages, many teachers still face significant challenges in implementing interdisciplinary digital teaching practices. Limited technological infrastructure, insufficient professional training, lack of institutional support, and heavy workloads continue to affect teachers' ability to integrate digital tools effectively into classroom instruction (Dele-Ajayi et al., 2021). In primary education, these challenges may become more complex because teachers must select technologies and instructional methods appropriate to young learners' developmental characteristics. Consequently, there is a growing need to examine how interdisciplinary teaching can support sustainable digital competence development among primary school teachers.

This study therefore investigates interdisciplinary teaching as a strategy for developing digital competence in primary school teachers through documentary research and literature analysis. By synthesizing recent academic studies, the research aims to clarify theoretical perspectives, identify practical approaches, examine implementation challenges, and discuss implications for teacher professional development in digitally transformed educational environments.

2. Literature Review

2.1. Research on Teacher Digital Competence

Teacher digital competence has become an important topic in educational research because digital technologies increasingly influence teaching, learning, and school management. Early studies mainly focused on teachers' technical abilities to use computers and educational software. However, recent research has expanded the concept to include pedagogical integration, communication skills, ethical awareness, and digital problem-solving abilities. Falloon (2020) emphasized that digital competence should be understood as a comprehensive professional capacity that enables teachers to apply technology effectively in different educational contexts. This broader understanding highlights the relationship between technology use and pedagogical quality rather than simple technical proficiency.

Research has also shown that digital competence directly affects teaching effectiveness and student engagement. Teachers with strong digital competence are more likely to design interactive lessons, facilitate collaborative learning, and employ diverse digital resources to support students' learning experiences. Johannesen and Øgrim (2020) argued that professional digital competence is closely linked to teachers' reflective practices and collaborative professional learning. In this sense, digital competence is not static but continuously develops through professional experience, institutional support, and interaction with colleagues.

At the same time, several studies have identified difficulties in developing teacher digital competence. Dele-Ajayi et al. (2021) reported that many teachers

experience anxiety and uncertainty regarding the use of information and communication technologies in classrooms. Challenges such as limited training opportunities, lack of confidence, and insufficient technological infrastructure continue to affect teachers' ability to integrate digital tools effectively. These challenges are particularly significant in primary education, where teachers must adapt technology to young learners' developmental characteristics.

2.2. Research on Interdisciplinary Teaching Practices

Interdisciplinary teaching has emerged as an important educational approach for promoting holistic learning and addressing complex real-world issues. Unlike traditional subject-centered instruction, interdisciplinary teaching combines knowledge, methods, and perspectives from multiple disciplines to create integrated learning experiences. Wang and Sang (2024) noted that interdisciplinary competence has become increasingly important for teachers because modern education requires flexibility, creativity, and collaboration across subject boundaries.

In primary education, interdisciplinary teaching is especially relevant because young students tend to learn through integrated experiences rather than isolated academic disciplines. Teachers can connect language, mathematics, science, arts, and social studies within common themes or projects, helping students develop broader understanding and practical problem-solving skills. Interdisciplinary approaches also encourage active learning, inquiry-based activities, and collaborative participation, all of which support competency-based education.

Several studies have highlighted the professional benefits of interdisciplinary teaching for teachers themselves. Through interdisciplinary collaboration, teachers exchange pedagogical ideas, share instructional resources, and engage in collective problem-solving. Vorontsova et al. (2022) emphasized that interdisciplinary projects provide opportunities for teachers to develop creativity, communication skills, and digital abilities simultaneously. These collaborative experiences contribute to professional growth and encourage teachers to adopt innovative teaching strategies in their classrooms.

Moreover, interdisciplinary teaching has increasingly been associated with educational innovation and digital transformation. Kusumawati and Pratama (2025) found that interdisciplinary learning environments encourage experimentation with digital learning tools and support the development of innovative teaching practices. As a result, interdisciplinary teaching is no longer viewed solely as a curriculum design strategy but also as an approach for strengthening teachers' professional competencies in digitally transformed educational contexts.

2.3. Interdisciplinary Teaching and the Development of Digital Competence

Recent literature suggests a strong connection between interdisciplinary teaching and the development of teachers' digital competence. Interdisciplinary learning activities often require teachers to integrate digital technologies into collaborative, project-based, and inquiry-oriented instruction. Consequently, teachers become more familiar with digital platforms, multimedia resources, online communication

tools, and interactive applications used to support integrated learning experiences.

Johannesen and Øgrim (2020) argued that multidisciplinarity contributes to the development of professional digital competence because teachers learn to apply technology in authentic pedagogical situations. Interdisciplinary collaboration encourages teachers to experiment with digital tools, reflect on instructional practices, and adapt technology to different learning objectives. This process helps teachers develop both technical and pedagogical dimensions of digital competence.

Similarly, Huang and Pan (2023) found that digital literacy positively influences interdisciplinary teaching competence among educators. Teachers with higher levels of digital competence were more capable of organizing collaborative learning activities, managing digital learning environments, and integrating technological resources into interdisciplinary lessons. These findings indicate that interdisciplinary teaching and digital competence development reinforce each other in mutually supportive ways.

Interdisciplinary teaching also promotes innovation in digital pedagogy. Teachers involved in interdisciplinary instruction are often required to design creative learning tasks that combine different forms of knowledge and student interaction. According to Kusumawati and Pratama (2025), such experiences encourage teachers to adopt innovative digital teaching models and student-centered pedagogical approaches. Therefore, interdisciplinary teaching can function as an effective strategy for strengthening teachers' readiness for digital transformation in education.

2.4. Research Gap

Although previous studies have examined teacher digital competence and interdisciplinary teaching separately, limited research has specifically explored interdisciplinary teaching as a strategic approach for developing digital competence among primary school teachers. Existing studies often focus on higher education contexts or emphasize technological integration without analyzing the pedagogical role of interdisciplinary practices in teacher professional development.

In addition, many studies discuss digital competence in general terms but pay insufficient attention to the unique characteristics of primary education. Primary school teachers face specific challenges related to curriculum integration, classroom management, and age-appropriate technology use. Therefore, more research is needed to understand how interdisciplinary teaching can support digital competence development within primary educational settings.

Furthermore, the majority of previous studies emphasize practical implementation while providing limited theoretical synthesis regarding the relationship between interdisciplinary pedagogy and digital competence. This study addresses this gap by reviewing and synthesizing recent academic literature to clarify conceptual perspectives, practical applications, challenges, and

implications associated with interdisciplinary teaching as a strategy for developing digital competence among primary school teachers.

3. Methodology

This study was conducted using a qualitative documentary research approach in order to examine the role of interdisciplinary teaching in developing digital competence among primary school teachers. The research relied entirely on secondary data collected from academic books, peer-reviewed journal articles, conference proceedings, and scholarly reports related to digital competence, interdisciplinary teaching, and teacher professional development. Most of the selected sources were indexed in Scopus and Web of Science to ensure academic reliability and research quality.

The study was implemented through several stages. First, a systematic search of academic databases was carried out using keywords such as “digital competence,” “teacher digital skills,” “interdisciplinary teaching,” “integrated learning,” “teacher education,” and “primary school.” These keywords were combined in different ways to identify publications closely related to the research topic. The search mainly focused on studies published between 2020 and 2025 because this period reflects recent developments in educational digital transformation and interdisciplinary instructional innovation.

After the identification stage, the collected documents were reviewed and screened according to relevance and academic quality. The study selected publications that discussed at least one of the following aspects: theoretical frameworks of digital competence, interdisciplinary teaching practices, technology integration in primary education, or professional development for teachers in digital learning environments. Articles that lacked clear academic contributions or were not directly connected to the research objectives were excluded from the analysis.

The selected studies were then examined through qualitative content analysis. During this process, important concepts, recurring themes, theoretical perspectives, and practical findings were identified and compared across the literature. Special attention was given to the ways interdisciplinary teaching supports teachers’ use of digital technologies, collaborative instructional practices, and innovative pedagogical approaches. The analysis also focused on identifying challenges related to technological infrastructure, teacher readiness, and institutional support.

Finally, the analyzed findings were synthesized into major thematic groups in order to provide a comprehensive understanding of the research issue. The themes included conceptual understandings of digital competence, characteristics of interdisciplinary teaching, the relationship between interdisciplinary instruction and digital competence development, implementation challenges, and implications for educational practice and teacher professional development. Through this methodological process, the study generated a systematic overview of current academic discussions concerning interdisciplinary teaching as a strategy for strengthening digital competence among primary school teachers.

4. Findings

4.1. Development of Teacher Digital Competence in Contemporary Education

The literature demonstrates that teacher digital competence has evolved from a narrow focus on technical operation toward a broader understanding of professional capability. Digital competence is now widely understood as the combination of technological, pedagogical, communicative, ethical, and collaborative skills necessary for effective teaching in digital learning environments. Teachers are expected to use technology not only for presenting information but also for facilitating interaction, supporting collaborative learning, conducting assessment, and encouraging student creativity.

Studies reviewed in this research also indicate that digital competence directly influences teaching quality and student engagement. Teachers with stronger digital competence tend to create more interactive and learner-centered classrooms through the use of multimedia resources, online learning platforms, and collaborative digital activities. In primary education, digital competence is particularly significant because teachers are responsible for helping students develop foundational digital awareness and responsible technology use from an early age.

Another important finding is that teachers' digital competence develops gradually through continuous professional learning and practical teaching experiences. Collaborative professional communities, interdisciplinary instructional activities, and reflective teaching practices contribute significantly to teachers' confidence and adaptability in using educational technologies. Therefore, digital competence should be considered a dynamic professional process rather than a fixed technical skill.

Table 1. Summary of Previous Studies on Digital Competence and Interdisciplinary Teaching

Authors	Research Focus	Main Findings	Implications for This Study
Johannesen and Øgrim (2020)	Professional digital competence	Interdisciplinary collaboration supports teachers' digital skills and reflective practices	Demonstrates the relationship between collaboration and digital competence
Falloon (2020)	Teacher digital competence framework	Digital competence includes pedagogical, ethical, and technological dimensions	Provides theoretical foundation for understanding digital competence
Wang and Sang (2024)	Interdisciplinary competence	Modern teachers require interdisciplinary flexibility and collaboration	Supports the significance of interdisciplinary teaching

Authors	Research Focus	Main Findings	Implications for This Study
Huang and Pan (2023)	Digital literacy and interdisciplinary teaching	Digital literacy positively affects interdisciplinary teaching competence	Shows the connection between technology use and interdisciplinary instruction
Kusumawati and Pratama (2025)	Digital learning innovation	Interdisciplinary approaches encourage innovative digital teaching	Highlights the role of innovation in professional development
Vorontsova et al. (2022)	Interdisciplinary projects	Interdisciplinary projects improve collaboration and digital skills	Supports project-based learning approaches
Dele-Ajayi et al. (2021)	ICT integration challenges	Teachers face technological and institutional barriers	Identifies implementation difficulties in digital teaching

4.2. Interdisciplinary Teaching as an Innovative Educational Approach

The reviewed studies suggest that interdisciplinary teaching contributes significantly to educational innovation in primary schools. Unlike traditional subject-based instruction, interdisciplinary teaching connects concepts and methods from different disciplines in order to create more meaningful learning experiences. Such approaches allow students to understand relationships between different areas of knowledge and apply learning to authentic contexts.

In primary education, interdisciplinary teaching appears particularly effective because young learners naturally engage with knowledge in integrated ways rather than through isolated academic subjects. Teachers can combine language, science, mathematics, arts, and social studies through thematic projects and collaborative activities. As a result, students are encouraged to develop creativity, communication skills, critical thinking, and problem-solving abilities simultaneously.

The findings also indicate that interdisciplinary teaching promotes active learning and student participation. Instead of relying solely on traditional lecture-based methods, teachers are encouraged to organize inquiry-based, collaborative, and project-oriented activities supported by digital technologies. This instructional flexibility enables teachers to create more engaging learning environments while strengthening their own professional competencies.

Moreover, interdisciplinary teaching encourages professional collaboration among educators. Teachers participating in interdisciplinary instruction often cooperate in lesson planning, instructional design, and resource sharing. Such collaborative experiences contribute to professional learning and encourage teachers to experiment with innovative pedagogical approaches and digital teaching tools.

4.3. Contributions of Interdisciplinary Teaching to Digital Competence Development

One of the most significant findings of this study is that interdisciplinary teaching serves as an effective strategy for developing teachers' digital competence. The literature consistently demonstrates that interdisciplinary instructional activities require teachers to integrate digital technologies more actively into classroom practice. Through interdisciplinary projects and collaborative learning activities, teachers become more familiar with digital platforms, multimedia applications, and online communication tools.

The reviewed studies reveal several dimensions through which interdisciplinary teaching strengthens digital competence. First, interdisciplinary instruction improves teachers' technological skills because teachers must use digital resources to organize integrated learning activities and facilitate collaboration. Second, it enhances pedagogical competence by encouraging teachers to design innovative and learner-centered educational experiences. Third, interdisciplinary teaching supports communication and teamwork skills through professional collaboration and shared instructional planning.

The findings also indicate that interdisciplinary teaching contributes to teachers' adaptability and reflective practice. Teachers involved in interdisciplinary learning environments frequently evaluate and modify their use of technology according to specific educational goals and classroom conditions. This process helps teachers become more flexible and confident in responding to changes associated with digital transformation in education.

Another important contribution of interdisciplinary teaching is its support for creativity and innovation. Teachers are encouraged to experiment with different technological tools and instructional methods in order to design engaging learning experiences for students. Such innovation strengthens both teachers' digital competence and their professional identity as active participants in educational change.

Table 2. Major Themes Identified from the Literature

Themes	**Key Issues**	**Representative Studies**	**Educational Implications**
Digital competence frameworks	Technological, pedagogical, ethical, and collaborative skills	Falloon (2020)	Expands understanding of teacher digital competence
Interdisciplinary collaboration	Cross-subject teaching and teamwork	Wang & Sang (2024)	Promotes integrated and collaborative instruction
Technology integration	Use of digital tools in teaching and learning	Johannesen & Øgrim (2020)	Supports innovative pedagogical practices

Themes	Key Issues	Representative Studies	Educational Implications
Professional development	Continuous learning and reflective practice	Vorontsova et al. (2022)	Encourages sustainable teacher development
Educational innovation	Creative and student-centered learning	Kusumawati & Pratama (2025)	Strengthens digital transformation in education
Implementation barriers	Infrastructure, training, and workload challenges	Dele-Ajayi et al. (2021)	Highlights the need for institutional support

4.4. Challenges in Implementing Interdisciplinary Digital Teaching

Despite the positive contributions identified in the literature, the implementation of interdisciplinary teaching for digital competence development still faces several barriers. One major challenge concerns technological infrastructure. Many schools continue to experience limitations related to internet access, digital devices, and technological support systems. Such conditions reduce opportunities for teachers to implement interdisciplinary digital activities effectively.

The literature also identifies professional readiness as a significant issue. Some teachers lack confidence in applying digital technologies or have limited experience with interdisciplinary instructional design. Insufficient training programs and limited opportunities for hands-on practice further restrict teachers' ability to adopt innovative teaching approaches. These difficulties are particularly significant in primary education, where technology use must be adapted carefully to students' developmental characteristics.

Another challenge involves workload and curriculum organization. Interdisciplinary teaching often requires extensive planning, collaboration, and preparation of teaching materials. Teachers must coordinate across subject areas and integrate digital resources into learning activities, which can increase professional pressure and time demands. In educational systems where subjects remain separated within rigid curricular structures, interdisciplinary collaboration may become difficult to sustain consistently.

Finally, the findings indicate that successful implementation of interdisciplinary digital teaching requires strong institutional support. School leadership, professional development opportunities, technological infrastructure, and supportive educational policies all play important roles in helping teachers develop digital competence through interdisciplinary practices. Without these conditions, teachers may struggle to maintain innovative instructional approaches despite recognizing their educational value.

5. Conclusion

This study examined interdisciplinary teaching as a strategy for developing digital competence among primary school teachers through documentary research and literature analysis. The findings demonstrate that interdisciplinary teaching plays

an important role in strengthening teachers' technological, pedagogical, collaborative, and reflective competencies in digitally transformed educational contexts. By integrating knowledge across disciplines and encouraging collaborative instructional practices, interdisciplinary teaching creates opportunities for teachers to apply digital technologies more effectively and creatively in classroom environments.

The study also indicates that interdisciplinary approaches support educational innovation by promoting learner-centered instruction, active learning, and project-based educational activities. Teachers involved in interdisciplinary teaching are more likely to experiment with digital resources, adopt innovative pedagogical methods, and engage in collaborative professional learning. As a result, interdisciplinary teaching contributes not only to teachers' digital competence development but also to their professional adaptability and continuous learning capacity.

However, the findings reveal that several challenges continue to affect the implementation of interdisciplinary digital teaching practices. Limitations related to technological infrastructure, insufficient professional training, heavy workloads, and rigid curriculum structures may reduce teachers' opportunities to integrate digital tools effectively into interdisciplinary instruction. These challenges highlight the importance of institutional support, professional development programs, and educational policies that encourage innovation and collaboration in schools.

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