AN INTERDISCIPLINARY APPROACH TO PROMOTING DIGITAL LEARNING INNOVATION

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Abstract: This study aims to analyze the role of an interdisciplinary approach in fostering digital learning innovation in 21st-century education. The interdisciplinary approach is considered relevant as it enables the integration of knowledge across disciplines, allowing students to gain more contextual, critical, and creative learning experiences. The research employed a descriptive qualitative method by examining digital learning practices in several educational institutions. The findings reveal that interdisciplinary integration enhances students' critical thinking, creativity, and collaboration skills. Moreover, the use of project-based digital media strengthens social competencies such as communication and teamwork. Nevertheless, the study also identified several challenges, including limited digital literacy among teachers, inadequate infrastructure, and the need for stronger stakeholder collaboration. These findings highlight the importance of continuous teacher training, inclusive educational policies, and sufficient technological support. Thus, the interdisciplinary approach serves not only as an innovative strategy for digital learning but also as a foundation for establishing a sustainable and adaptive educational ecosystem in response to global changes.

Keywords: interdisciplinary approach, digital learning, educational innovation, 21st century

Abstrak: *Penelitian ini bertujuan untuk menganalisis peran pendekatan interdisipliner dalam mendorong inovasi pembelajaran digital pada era pendidikan abad 21. Pendekatan interdisipliner dipandang relevan karena memungkinkan integrasi pengetahuan lintas bidang, sehingga peserta didik dapat memperoleh pengalaman belajar yang lebih kontekstual, kritis, dan kreatif. Metode penelitian yang digunakan adalah kualitatif deskriptif dengan menelaah praktik pembelajaran digital pada beberapa institusi pendidikan. Hasil penelitian menunjukkan bahwa integrasi lintas disiplin mampu meningkatkan kemampuan berpikir kritis, kreativitas, serta kolaborasi siswa. Selain itu, penggunaan media digital berbasis proyek memperkuat keterampilan sosial seperti komunikasi dan kerja sama. Namun, penelitian juga menemukan sejumlah tantangan, antara lain keterbatasan literasi digital guru, keterbatasan infrastruktur, dan kebutuhan akan kolaborasi antar pemangku kepentingan. Temuan ini menegaskan pentingnya dukungan pelatihan guru, kebijakan pendidikan yang inklusif, serta penyediaan teknologi yang memadai. Dengan demikian, pendekatan interdisipliner tidak hanya berfungsi sebagai strategi inovatif dalam pembelajaran digital, tetapi juga sebagai landasan untuk menciptakan ekosistem pendidikan yang berkelanjutan dan adaptif terhadap perubahan global.*

Kata kunci: pendekatan interdisipliner, pembelajaran digital, inovasi pendidikan, abad 21

Introduction

The acceleration of digital transformation requires new approaches to education, one of which is an interdisciplinary approach that combines competencies from various disciplines. This approach aims to create learning that is more holistic and relevant to current developments. According to Pieters (2024), collaboration between art and technology opens up significant opportunities to develop students' digital skills while simultaneously motivating teachers to innovate with technology. This model serves as an important framework for interdisciplinary digital learning innovation, as it enhances creativity, critical thinking, and cross-disciplinary skills. Thus, the integration of art and

technology not only enriches the learning experience but also strengthens students' readiness to face future challenges in an increasingly digital and connected world.

An interdisciplinary approach has proven effective in increasing the relevance of learning. Azizah et al. (2025) found that integrating interactive digital learning media with a contextual approach significantly improved elementary school students' literacy and learning outcomes. This approach provides a more realistic and effective learning experience, enabling students to more easily understand and apply concepts in their daily lives. By combining various disciplines and interactive digital media, the learning process becomes more engaging, relevant, and meaningful, while strengthening students' skills in facing 21st-century challenges. This approach encourages more contextual and applicable learning, tailored to the needs of the times.

In the context of STEM and STEAM, an interdisciplinary approach is crucial for enriching students' creativity. Salmawati (2023) emphasized that integrating arts and science into the learning process not only increases students' active engagement but also strengthens their creative and critical thinking skills. By incorporating artistic aspects into science and technology learning, students can understand scientific concepts more deeply and meaningfully. Furthermore, innovations in STEM/STEAM-based digital learning can address cognitive and affective aspects, as well as develop 21st-century skills, such as collaboration, communication, and problem-solving. Overall, this approach supports the creation of more enjoyable and relevant learning, and prepares students to face the challenges of a dynamic and innovative future.

An interdisciplinary approach is also an effective solution to the curriculum fragmentation that often occurs in the education system. Arif Wibowo (2024) demonstrated that implementing this approach in Social Studies (IPS) can overcome the limitations that arise from silos between various subjects. By integrating content from various disciplines, learning becomes more relevant and contextual for students, enabling them to see the relationships between concepts and apply them in real life. However, a challenge that needs to be addressed is the lack of teacher competence in effectively managing and organizing interdisciplinary materials. Therefore, ongoing training and collaboration between teachers are essential to improve their ability to develop holistic and integrative learning. This approach is expected to improve the quality of learning and overall student learning outcomes.

Islamic education has also adopted an interdisciplinary approach as a strategy to strengthen the integration of the curriculum and students' learning experiences. Olfah (2024) emphasized that integrating religious studies with other fields, such as social sciences, culture, and technology, can create a more inclusive, contextual, and real-life learning experience. This approach not only enriches students' understanding of Islamic values but also helps them connect religious teachings with the social and cultural aspects around them. Furthermore, this integration provides direction for the development of digital innovations that are not solely technology-based but also instill local values and culture as part of the learning process. Thus, Islamic education that adopts an interdisciplinary approach can produce a generation that is not only academically intelligent but also highly moral and cultural.

An interdisciplinary approach can be practically applied in the development of innovative teaching modules. Triana et al. (2023), through a research and development (R&D) process, successfully created an Indonesian language module linked to the subjects of Natural Sciences (IPA) and Social Sciences (IPS). The results of the study showed that the use of this module significantly improved the reading comprehension of lower-grade students. This success is evidence that an interdisciplinary approach not only enriches learning content but also enables the creation of real and effective digital learning innovations. The integration of various disciplines in teaching modules can increase student interest and understanding, as well as support a more contextual and enjoyable learning process. Top of Form

Indeed, implementing an interdisciplinary approach in vocational education is not without its challenges. Studies by ASK and others, as cited by Kikgilu & John (2021), indicate that the success of interdisciplinary implementation is heavily influenced by several key factors, such as adequate time allocation, teachers' ability to effectively integrate various disciplines, and sufficient resource support. This suggests that developing interdisciplinary-based digital innovations in the context of vocational

education requires comprehensive system readiness and strengthened human resource capacity. Without adequate support and preparation, these innovations could potentially face obstacles in their implementation and long-term success.

Thus, an interdisciplinary approach is the primary foundation for creating relevant, creative, and impactful digital learning innovations. However, the sustainability of this strategy requires a comprehensive support framework, such as ongoing teacher training, flexible curriculum policies that support cross-disciplinary integration, and the development of a collaborative culture in schools. Through this synergy, education oriented toward interdisciplinary collaboration can usher in a more adaptive, inclusive, and holistic future, thus meeting the challenges and opportunities of a constantly evolving era.

Based on the background description, several key issues can be identified that hinder the optimization of an interdisciplinary approach in driving digital learning innovation. First, the majority of teachers still have limited digital literacy and interdisciplinary skills, resulting in less than optimal implementation of cross-disciplinary collaboration-based learning. Second, uneven school infrastructure and technology access hinder the implementation of digital media that support interdisciplinary integration. Third, the lack of a flexible and systematic curriculum framework to accommodate interdisciplinary strategies in a digital context. Fourth, the weak culture of collaboration among teachers and minimal support from educational policies worsen practical implementation. These issues require further study to ensure that the interdisciplinary approach can truly drive sustainable digital learning innovation.

Research methodology

This research uses a descriptive qualitative approach with the aim of deeply understanding how the application of an interdisciplinary approach can foster innovation in digital learning. This method was chosen because it allows researchers to explore the dynamics of interdisciplinary collaboration in learning practices, from the perspective of teachers, students, and educational institutions. According to Santosa (2022), a qualitative approach is relevant for studying complex educational phenomena, especially those involving multi-actor and multidisciplinary interactions. Through this design, the research focuses not only on outcomes but also on the process of integrating knowledge across disciplines in the context of digital learning.

The research subjects involved teachers from various subjects at the secondary school level who had tried implementing digital-based learning with interdisciplinary collaboration. Informants were selected through purposive sampling, taking into account their experience in integrating technology into cross-disciplinary learning. According to Rahmawati (2023), purposive sampling is effective in educational research because it can attract participants directly related to the research focus. The research was conducted in several schools in Central Java that already have collaborative curriculum-based digital learning development programs.

Data collection techniques included in-depth interviews, participant observation, and document analysis. Interviews were used to explore teachers' experiences in developing interdisciplinary digital learning models, while observations were conducted to observe actual classroom practices. Document analysis included curricula, lesson plans, and digital media products developed by teachers. According to Kurniawan (2021), triangulation of data collection methods is essential to ensure the validity of findings in qualitative research, particularly in the field of technology-based education.

Data analysis was conducted using thematic analysis techniques, which identify key patterns from field data to identify themes relevant to the research focus. The analysis process involved data reduction, data presentation, and systematic conclusion drawing. To maintain data validity, the study employed source triangulation and member checking techniques with participants. According to Lestari (2024), thematic analysis is highly suitable for

interdisciplinary educational research because it can illustrate complex relationships between concepts. Therefore, this methodology supports the research objective of generating a comprehensive understanding of interdisciplinary integration in digital learning innovation.

Discussion

A. Interdisciplinary Synergy in Digital Innovation

The integration of various disciplines is a crucial foundation for creating digital learning innovations. Collaboration between educational science, information technology, and educational psychology produces a new, more comprehensive approach. According to Nugraha (2022), the success of digital innovation in schools is determined not only by the availability of technological devices, but also by the cross-disciplinary ability to integrate learning theory with technical solutions. This interdisciplinary approach makes learning more adaptive to the diverse needs of students and emphasizes the meaningfulness of the process, not just mastery of the material. Therefore, synergy between disciplines can bridge the gap between traditional educational theory and the demands of 21st-century learning.

An interdisciplinary approach to digital learning innovation emphasizes collaboration across disciplines to create more meaningful learning experiences. The synergy between education, psychology, and technology enables learning designs that are responsive to students' needs. According to Nugraha (2022), cross-disciplinary integration provides teachers with the opportunity to utilize technology not merely as a tool but also as a means of internalizing learning theories in real-world practice. In this context, digital technology acts as a bridge connecting theoretical abstractions with practical applications, making it easier for students to understand the material. Interdisciplinary synergy also fosters 21st-century skills, such as critical thinking, creativity, and collaboration, which are unlikely to develop if the learning approach is monodisciplinary.

Digital innovation in education requires contributions from various disciplines to be more relevant to the dynamics of the 21st century. For example, communication science plays a role in designing engaging interactive media, while educational psychology helps ensure the approach is appropriate to students' cognitive developmental stages. According to Yuliani (2023), without interdisciplinary involvement, digital learning innovation is limited to the use of technological tools without deep pedagogical meaning. Through collaboration between various fields, teachers can develop learning models that address cognitive, affective, and psychomotor aspects in a balanced manner. This demonstrates that an interdisciplinary approach not only adds variety but also strengthens the essence of education as a holistic process that shapes students' personalities.

In addition to enriching teaching methods, interdisciplinary synergy also increases the effectiveness of digital resource utilization. For example, combining educational management with information technology can result in a more structured digital learning system. According to Hidayat (2023), interdisciplinarity enables the development of a digital curriculum that aligns with the needs of the school organization and is easy for teachers to implement. This integration not only addresses academic content but also managerial aspects such as evaluating learning outcomes, monitoring attendance, and managing online classes. Thus, an interdisciplinary approach provides a comprehensive solution, where digital education is not only about media innovation but also about efficient learning management.

An interdisciplinary approach to digital innovation also serves as a means of bridging the gap between academic theory and practice. According to Lestari (2024), teachers often face difficulties in applying traditional learning theories to digital contexts without the support of other disciplines. This is where interdisciplinary collaboration comes into play, bringing new perspectives from technology, sociology, and pedagogy to strengthen implementation. For example, combining constructivist theory with digital programming can create interactive simulations that facilitate students' construction of their own knowledge. This not only makes theory more applicable but also encourages the emergence of learning innovations that align with real-world needs and global technological developments.

Interdisciplinary synergy in digital learning innovations also improves students' collaborative skills. For example, combining science with digital art can create interactive projects that combine analytical logic and visual creativity. According to Pratama (2022), this approach trains students to work in cross-disciplinary teams, a crucial skill in the modern workplace. By engaging diverse scientific perspectives, students learn how to integrate different ideas into an innovative product. Activities like this not only enrich the learning experience but also foster an awareness of the complementary nature of science. This kind of synergy reinforces the goal of digital education as a means of developing 21st-century competencies.

In addition to providing pedagogical benefits, an interdisciplinary approach also contributes to the development of digital education research. According to Widodo (2023), research that combines technology and social science disciplines can produce more contextual digital learning models. For example, the use of data analysis in computer science combined with learning motivation theory from psychology can create a more accurate evaluation system. Thus, interdisciplinarity not only enriches learning practices but also broadens the horizons of educational research. This collaboration allows for the birth of new theories that are more relevant to technological developments and societal needs, preventing digital innovation from being trapped in partial or sectoral approaches.

An interdisciplinary approach also emphasizes the importance of human values in digital innovation. According to Rahayu (2024), technology without a touch of humanities disciplines risks creating a mechanical and dehumanizing education. Integrating humanities disciplines such as philosophy and ethics with digital technology ensures that innovation is not solely oriented toward efficiency, but also considers moral and social aspects. For example, the use of artificial intelligence in learning needs to be guided by the values of justice and inclusivity to avoid discrimination. In other words, interdisciplinarity is not merely technical but also normative, ensuring that digital learning innovations remain aligned with human interests as the primary subject of education.

Finally, interdisciplinary synergy in digital innovation emphasizes the importance of ongoing collaboration among educational stakeholders. According to Syamsudin (2025), digital innovation will only survive if there is an interdisciplinary ecosystem involving teachers, researchers, technology developers, and policymakers. This collaboration enables the creation of content and technology updates that align with curriculum needs and societal dynamics. Furthermore, this approach also encourages sustainable innovation because each party contributes according to their respective competencies. Therefore, interdisciplinary synergy is not just a method, but a long-term strategy to ensure that digital learning innovations truly have a transformative impact on education.

B. Transforming the Role of Teachers in Interdisciplinary Learning

An interdisciplinary approach demands a paradigm shift in the role of teachers, from mere conveyors of information to facilitators of cross-disciplinary collaboration. Teachers need to master digital literacy, critical thinking, and collaborative management skills to integrate diverse scientific perspectives into learning. According to Rahman (2023), teachers who are skilled at utilizing interdisciplinarity can design more varied learning activities, for example, combining science with digital art to foster student creativity. This demonstrates that the transformation of the teacher's role is not only technical but also conceptual, where teachers become catalysts in bridging the needs of the digital world with a humanistic pedagogical understanding.

The transformation of teachers' roles in the era of interdisciplinary digital learning demands that they transcend their traditional role as knowledge transmitters. Teachers now function as facilitators, mediators, and learning designers, capable of integrating perspectives from various disciplines. According to Pratomo (2023), teachers need to master digital literacy, pedagogical skills, and an understanding of student psychology to be able to guide students in facing the challenges of the 21st century. Therefore, teachers are not only tasked with delivering material but also ensuring that the integration of knowledge into learning can be applied effectively and relevantly. This requires improving teacher competency through ongoing interdisciplinary training.

In an interdisciplinary context, teachers must be able to design learning that is not only curriculum-based but also integrates insights from technology, society, and culture. According to Rahmawati (2022), the role of teachers in connecting different disciplines is crucial to encouraging

students to understand the relevance of knowledge. For example, when teaching mathematics, teachers can link it to digital graphic design, so students see the practical benefits of abstract concepts. This transformation requires teachers to be more creative in designing learning scenarios that involve multidisciplinary collaboration. With this approach, students learn to see the interconnectedness of knowledge, rather than simply studying separate fields.

In addition to acting as learning designers, teachers also serve as bridges between digital technology and human values. According to Santoso (2024), teachers play a crucial role in ensuring that the use of learning technology does not neglect ethical, spiritual, and social aspects. In interdisciplinary learning, teachers must be able to balance the use of digital media with the development of student character. Thus, the transformation of the teacher's role extends beyond mastering technology to instilling moral and ethical values in every learning process. This is particularly relevant in the digital era, when students are vulnerable to the negative impacts of technology. Teachers are required to be present as mentors who guide the use of technology in a positive direction.

The transformation of teachers' roles is also evident in their role as collaborators in digital learning communities. According to Nugroho (2023), teachers no longer work individually, but rather collaborate with fellow educators, technology developers, and policymakers. This collaboration aims to create more relevant and effective digital learning innovations. Teachers become part of a growing interdisciplinary ecosystem, where the exchange of knowledge across disciplines is key. This change not only improves the quality of classroom learning but also strengthens teachers' professional capacity as agents of change in education.

In the context of digital learning, teachers also take on the role of evaluators, using technology-based data to assess student progress. According to Wibowo (2022), the use of AI-based learning analytics allows teachers to more accurately identify student strengths and weaknesses. This role shifts the evaluation paradigm from merely assessing outcomes to a more process-oriented formative assessment. Teachers are required to understand how data from various disciplines can be used to support decision-making. This transformation makes teachers not just assessors but also analysts who use cross-disciplinary information to design more effective learning strategies.

Teachers' transformation in interdisciplinary learning also encompasses their role as innovators who encourage the exploration of new methods. According to Dewi (2023), creative teachers are able to integrate scientific disciplines with digital arts technology to create more engaging learning experiences. This innovation helps students develop critical and creative thinking skills, core 21st-century competencies. The role of teachers as innovators requires openness to change and the courage to adopt new approaches. Thus, teachers not only teach existing knowledge but also encourage the emergence of fresh ideas that support the development of interdisciplinary digital learning.

Furthermore, teachers act as mentors, assisting students in facing the challenges of digital learning. According to Kurniawan (2024), the role of teachers as mentors is crucial in helping students develop self-management skills, digital literacy, and media ethics. Through an interdisciplinary approach, teachers can provide more contextual guidance on how to use technology responsibly. With this mentoring, students become not only consumers of technology but also producers of knowledge capable of integrating various fields of study. This transformation ensures that students are prepared to face increasingly complex real-world challenges.

Finally, the transformation of the teacher's role in an interdisciplinary approach emphasizes the importance of reflective competence. According to Putri (2025), teachers are required to continually conduct self-evaluations to adapt their learning methods to current developments. Reflective competence enables teachers to identify the strengths and weaknesses of the interdisciplinary strategies they have implemented. Thus, teachers are able to continuously improve and enhance the quality of learning. This transformation demonstrates that teachers are not merely agents of knowledge transmission but also lifelong learners who continue to develop. This changing role makes teachers the primary focus in driving innovation in interdisciplinary-based digital learning.

C. Digital Media and Content Innovation

Media and digital content innovation in interdisciplinary learning is a key aspect that enriches students' learning experiences. The use of multimedia-based technologies, such as interactive video, augmented reality, and digital simulations, can create a more engaging and contextual learning environment. According to Suryana (2023), interactive digital media can improve student knowledge retention by engaging more senses in the learning process. This proves that media innovation is not merely a tool but an integral part of modern pedagogical strategies. With the development of digital content, learning can be more personalized, flexible, and tailored to the needs of each student in an interdisciplinary context.

The innovative use of digital content also broadens the scope of material accessible to students. According to Hidayat (2022), digital content enables integration between various scientific fields through comprehensive visual representations, narratives, and simulations. For example, in science lessons, teachers can integrate digital art illustrations to explain biology concepts, making it easier for students to understand through a visual approach. This kind of integration fosters students' critical and creative thinking skills. Thus, digital content innovation emphasizes not only information transfer but also building in-depth cross-disciplinary understanding.

Furthermore, innovative digital media can serve as a collaborative learning tool that involves interaction between students and between students and teachers. According to Pramono (2023), digital platforms that provide discussion features, group simulations, and project-based learning can strengthen cross-disciplinary collaboration. This innovation fosters collaborative skills that are highly relevant to the demands of the 21st century. By utilizing digital technology, teachers can design interactive activities that encourage students to learn through direct experience. Innovative media not only presents information but also creates a space for dialogue that brings together multidisciplinary perspectives.

Digital content innovation also helps students develop increasingly needed digital literacy skills. According to Utami (2024), students' ability to critically evaluate, produce, and use digital content is an integral competency of interdisciplinary learning. Innovatively developed digital media enables students to engage as knowledge producers, not just consumers. For example, students can create educational vlogs, science animations, or social infographics that integrate disciplines. In this way, learning becomes more active and meaningful, while equipping students with digital literacy skills that support their future.

The presence of artificial intelligence technology is also increasingly enriching innovation in learning media. According to Syahrial (2023), AI can be used to generate automated content such as adaptive questions, educational chatbots, and material recommendations tailored to students' needs. This innovation not only increases teachers' efficiency in preparing materials but also provides a personalized learning experience. With AI integration, students can receive rapid feedback and ongoing learning support. This demonstrates that digital media innovation is not simply a variety of formats, but involves intelligent technology that facilitates more effective interdisciplinary learning.

In addition to improving the quality of learning, digital media innovation also supports educational inclusivity. According to Amalia (2022), digital content can be designed with accessibility features such as subtitles, audio narration, or alternative text to assist students with special needs. This way, interdisciplinary learning can be accessed by all groups without discrimination. This innovation demonstrates the enormous social potential of digital media in creating fair and equitable education. Teachers can ensure that every student, without exception, has an equal opportunity to understand the learning material.

Digital media innovation also contributes to building a sustainable learning ecosystem. According to Widodo (2023), digital content developed collaboratively by teachers, researchers, and education practitioners can be continuously updated in line with scientific developments. Interdisciplinary learning supported by digital media is dynamic and always relevant to current needs. This enables schools and educational institutions to maintain fresh and contextual learning quality. Thus, digital media innovation plays a role as a driving force for the sustainability of interdisciplinary education.

Ultimately, innovations in digital media and content serve as catalysts for educational transformation toward a more open and participatory approach. According to Lestari (2024), digital

media provides space for students to actively participate in creating and disseminating knowledge. This reinforces the principle of student-centered learning, a hallmark of 21st-century learning. Through innovative digital content, students can integrate various disciplines and present their ideas in creative ways. Thus, digital media innovation not only expands teaching methods but also strengthens students' position as the primary subjects in interdisciplinary learning.

D. Challenges and Prospects of an Interdisciplinary Approach

Despite its potential, the implementation of an interdisciplinary approach in digital innovation faces significant obstacles, such as limited teacher competency, resistance to change, and inadequate infrastructure. According to Lestari (2025), successful implementation requires a phased strategy that includes teacher training, school policy support, and collaboration with universities. Furthermore, a collaborative culture among teachers across disciplines needs to be built to ensure sustainable interdisciplinary practices. Implementation strategies must also address the diverse contexts of Indonesian schools, both in terms of resources and digital readiness. This way, an interdisciplinary approach can be implemented realistically, not only as academic discourse but also as a practical learning experience in schools.

Interdisciplinary approaches to digital learning innovation face major challenges in terms of infrastructure readiness and curriculum integration. According to Firmansyah (2023), schools across regions are still unequally equipped with digital resources, so the implementation of interdisciplinary learning is often limited to specific schools. This creates disparities in educational quality between regions. However, the outlook remains bright, as government policies supporting digital transformation in education are strengthening. With strong synergy between curriculum, infrastructure, and technology, an interdisciplinary approach can truly have a broad impact.

Besides infrastructure, challenges also arise in the area of teacher competency. According to Rahayu (2022), many teachers still struggle to integrate different subjects into digital learning designs. Limited pedagogical competence and digital literacy often hinder the optimal implementation of interdisciplinary approaches. On the other hand, the prospect presents significant opportunities for the development of interdisciplinary teacher training programs. With structured training, teachers can act as creative facilitators in connecting various disciplines through digital media.

Another challenge is resistance to changes in learning culture. According to Hasanah (2023), some teachers and students tend to be comfortable with traditional methods, making them reluctant to adapt to interdisciplinary digital learning models. This situation can hinder comprehensive educational transformation. However, the prospect is that, when proven effective, these models can improve student engagement and learning outcomes. With increasing empirical evidence, this resistance can gradually be reduced through best practices and continuous innovation.

An interdisciplinary approach also poses challenges in learning evaluation. According to Putra (2024), traditional assessment instruments struggle to measure the cross-disciplinary skills developed through digital learning. This requires teachers to design more authentic assessments, such as collaborative projects, digital portfolios, or performance-based assessments. The prospect is that these interdisciplinary assessments can provide a more comprehensive picture of students' abilities, including 21st-century skills such as critical thinking, collaboration, and creativity.

From a policy perspective, coordination between stakeholders also poses a challenge. According to Wulandari (2023), implementing an interdisciplinary approach requires collaborative support between schools, universities, government, and industry. This synergy is often hampered by bureaucracy or conflicting interests. However, the prospects are promising, as more educational institutions are partnering with external parties to develop digital media. This collaboration has the potential to enrich the quality of interdisciplinary learning content while increasing its relevance to the needs of the workplace.

The issue of the digital divide also needs attention. According to Nasution (2022), students from low-income families often struggle to access devices or a stable internet connection, making it difficult to engage in interdisciplinary digital learning. However, the prospect of expanding digital

device assistance programs from both the government and the private sector is promising. These programs offer an opportunity to bridge the digital divide, enabling students from diverse social backgrounds to equally benefit from interdisciplinary educational innovations.

In addition to technical challenges, interdisciplinary approaches also face sustainability issues. According to Santoso (2024), many learning innovations are short-term projects without consistent follow-up. This results in innovations having little significant impact on the overall education system. The prospect is that if sustainability is well managed through integrated policies and programs, interdisciplinary approaches can become the foundation for long-term educational transformation relevant to the digital age.

Finally, ethical challenges and humanitarian values are also important to consider. According to Lestari (2023), the use of interdisciplinary digital media must uphold the values of inclusivity, ethical data use, and fair access. The prospect is that, with appropriate regulations and ethical education for teachers and students, this approach can build a healthy and meaningful digital learning ecosystem. Thus, the existing challenges are not obstacles, but rather opportunities to strengthen the prospects of interdisciplinary education as a key strategy for 21st-century innovation.

Research result

The research results show that implementing an interdisciplinary approach in digital learning significantly increases student engagement. Observational data shows that students are more enthusiastic when subject matter is integrated across disciplines, for example, integrating mathematics with science through digital simulations. According to Pratama (2023), cross-disciplinary integration provides a more contextual learning experience, enabling students to understand concepts holistically. These findings confirm that digital-based interdisciplinarity not only facilitates academic skills but also fosters stronger learning motivation in the classroom.

In addition to engaging students, this study also found that a digital interdisciplinary approach strengthens students' critical thinking skills. Interviews showed that students were encouraged to connect various concepts, analyze problems, and formulate creative solutions. According to Dewi (2022), digital learning with an interdisciplinary approach encourages the development of reflective thinking because students are faced with situations that require them to examine the relationships between knowledge. Thus, this approach not only sharpens cognitive aspects but also enriches students' interpretation of phenomena.

This study also found a positive impact on collaboration between students. Through digital project-based activities, students were more open to discussions, complemented each other's ideas, and learned to respect others' perspectives. Qualitative findings indicate that the group work process serves as a social learning platform that strengthens communication and cooperation. This aligns with Handayani's (2024) view that an interdisciplinary approach provides space for the development of soft skills, including collaboration skills. Thus, learning emphasizes not only academic outcomes but also social interaction processes that support 21st-century competencies.

Other findings highlight technical challenges and teacher preparedness. Some teachers still face difficulties in designing engaging and integrated interdisciplinary digital content. However, the training provided during the study helped improve their ability to adapt technology. According to Nugraha (2023), the success of an interdisciplinary approach is greatly influenced by the teacher's readiness as a facilitator. Therefore, despite these challenges, this study confirms that the prospects for implementing interdisciplinary digital learning are quite promising if supported by continuous teacher competency development.

Conclusion

This study concludes that an interdisciplinary approach to digital learning can drive significant innovation in 21st-century educational practices. Cross-disciplinary integration provides a more contextual and meaningful learning experience, enabling students to not only understand concepts in isolation but also connect knowledge across fields. These findings suggest that interdisciplinary digital learning acts as a bridge connecting theory with practice and supports the development of critical, creative, and collaborative thinking skills.

In addition to providing cognitive benefits, interdisciplinary approaches have also been shown to strengthen students' social skills. Digital project-based activities enable them to collaborate, discuss, and respect differing perspectives. This fosters soft skills relevant to the needs of the digital age, particularly communication, collaboration, and collective problem-solving. Thus, digital learning innovations impact not only academic achievement but also essential character development and social competence.

However, this study also identified implementation challenges. Teachers as facilitators still require technological competency support and the ability to design innovative, interdisciplinary content. Limited infrastructure is also a barrier in some schools. This underscores the importance of ongoing training for educators and education policies that support the provision of adequate digital learning resources. With systematic support, implementation barriers can be minimized, enabling this approach to be more widely adopted.

Overall, this research confirms that an interdisciplinary approach to digital learning holds promising prospects for improving the quality of education. Learning innovations arise not only from technology alone, but also from cross-disciplinary collaborations that combine diverse perspectives. Therefore, going forward, educational strategies need to integrate interdisciplinary approaches more systematically, involving teachers, students, and other stakeholders in the education ecosystem. This way, digital education can develop sustainably, relevantly, and adaptively to changing times.

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