Journal of Hunan University

(Natural Sciences)

Vol. 52 No. 3

March 2025

Available online at

https://jonuns.com

Open Access Article

https://doi.org/10.55463/issn.1674-2974.52.3.9

Integrating Digital Literacy, Critical Thinking, and Collaborative Learning: Addressing Contemporary Challenges in 21st Century Education

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Article History:

Received: December 21, 2024
Reviewed: January 14, 2025
Revised: February 25, 2025
Accepted: March 28, 2025
Published: April 30, 2025

Abstract: The unprecedented pace of technological advancement and intensification of globalization in the 21st century have fundamentally reshaped the demands placed on education systems worldwide. Addressing these evolving challenges requires a paradigm shift towards the cultivation of integrated competencies essential for navigating complex, technology-driven environments.

This study critically examined the synergistic integration of digital literacy, critical thinking, and collaborative learning as a strategic response to these demands. Distinct from prior research that has predominantly treated these competencies in isolation, this study introduces a comprehensive conceptual framework that explores their interdependencies and collective influence on educational outcomes. Using a quantitative survey design, data were gathered from 450 high school and university students in urban regions in technology-rich educational settings. Structured questionnaires were used to assess students' proficiency in digital literacy, critical thinking, and collaborative learning, with subsequent data analysis conducted using descriptive statistics, correlation, and regression methods. The findings reveal that, although the majority of students demonstrate high digital literacy (72%) and engagement in collaborative practices (70%), critical thinking proficiency remains comparatively underdeveloped (58%), with weak correlations observed among the three competencies. These results underscore the urgent need for integrated pedagogical models that can move beyond fragmented skill development. This study identifies key barriers, including limited evaluative reasoning, group coordination challenges, and critical analysis deficiencies, that inhibit effective competency integration. By proposing an innovative framework for embedding digital literacy, critical thinking, and collaborative learning into unified educational practices, this study contributes to the advancement of educational theory and practice. Policy and curriculum recommendations include the adoption of project-based learning methodologies, the incorporation of digital verification exercises, and targeted professional development initiatives for educators to foster a holistic skill set vital for future academic and professional success.

Keywords: Digital Literacy, Critical Thinking, Collaborative Learning, 21st-Century Education, Technology Integration.

数字素养、批判性思维与协作学习的整合路径研究——面向21世纪教育挑战的应对策略

摘要：
随着21世纪技术变革的加速与全球化进程的加深，教育体系正面临前所未有的复杂挑战。应对这一变革趋势，亟需教育领域实现范式转型，培养能够胜任复杂技术环境的综合核心素养。基于此，本研究从整体整合的视角，系统探讨数字素养、批判性思维与协作学习三项关键能力的协同机制及其对学生学习成效的影响。区别于以往对单一能力进行孤立考察的研究，本文构建了一个综合性概念模型，深入分析三者之间的相互关联与协同效应。采用量化研究方法，通过结构化问卷调查收集了来自城市地区、以技术为基础的教育环境中450名高中生及大学生的样本数据。数据分析采用描述性统计、相关性分析及回归分析方法。研究结果表明，大多数学生在数字素养（72%）和协作学习（70%）方面表现优异，然而批判性思维能力仍显薄弱（58%），且三项能力间的相关性较低，凸显当前教学模式中存在的碎片化问题。进一步分析发现，学生在信息评估推理、小组协作协调及批判性分析等方面存在明显短板。基于研究结果，本文提出整合数字素养、批判性思维与协作学习的创新教学框架，旨在为教育理论深化与教学实践改进提供理论支撑与实践路径。政策建议包括引入项目式学习方法、开展数字事实核查训练，并加强教师专业发展培训，以系统性提升学生应对未来学术与职业挑战的综合能力。

关键词： 数字素养；批判性思维；协作学习；21世纪教育；技术融合。

1. Introduction

Education in the 21st century faces various major challenges influenced by technological advances and rapid globalization. Amid these changes, there is an urgent need to prepare future generations with relevant skills, such as digital literacy, critical thinking, and collaborative skills (Saavedra & Opfer, 2012). Digital technology has changed the way we access information, interact, and learn, while an increasingly complex world demands individuals to have the ability to critically analyze information and work together in solving problems (OECD, 2019). Therefore, integrating digital literacy, critical thinking, and collaborative learning into the educational curriculum is an increasingly important issue for improving the quality of education in the 21st century (Zhao, 2012).

Digital Literacy refers to an individual's ability to use digital technology effectively, efficiently, and critically. In the ever-evolving information age, digital literacy has become an important skill in accessing, assessing, and utilizing digital resources (Buckingham, 2007). Digital literacy includes not only basic skills, such as the use of computer devices and the Internet, but also advanced skills in understanding and analyzing information found in cyberspace (Snyder & Tour, 2016). It involves understanding how technology affects social, economic, and political life as well as how information can be manipulated or misused.

As the use of technology increases around the world, it is important for individuals to have skills that can help them sort out valid and trustworthy information as well as recognize disinformation or hoaxes that are spreading across the Internet. Digital literacy also includes an awareness of privacy, data security, and ethical issues in interacting with the digital world. Mastering digital literacy is not only beneficial for personal life but also for professional development in various fields.

Critical Thinking is the ability to analyze, evaluate, and assess information objectively before making decisions or conclusions. In the context of education and learning, critical thinking is very important because it helps students not only take information for granted but also understand the context, reasons, and consequences of the information (Jonassen, 2000). Critical thinking includes the ability to identify assumptions, dig deeper to find evidence, and make decisions based on a deep understanding.

In a world filled with infinite information, the ability to think critically allows individuals to select relevant and accurate information. Students who are trained in critical thinking will be better prepared to face the challenges of an increasingly complex world in education, work, and daily life. Critical thinking also encourages students to not rely on just one source of information but to seek out different perspectives before concluding something.

Collaborative Learning is a learning approach that emphasizes the interaction between individuals and groups to achieve common goals. In collaborative learning, students learn not only from teachers, but also from their peers. They share knowledge, discuss, and work together to solve their problems. This approach encourages the development of social, communication, and problem-solving skills that are important in today's professional world. This collaboration can be performed face-to-face or with the help of digital technology, which expands the scope of collaboration worldwide (Vygotsky, 1978).

Collaborative learning is beneficial for the development of teamwork skills. Through group discussions and joint problem-solving, students can learn to value differences in opinions, work in a more effective way, and achieve better outcomes through collaboration. In collaborative learning, students are not only recipients of information, but also producers of information that is shared with other group members.

These three concepts–digital literacy, critical thinking, and collaborative learning–are interrelated and support one another in the current educational context. Digital literacy allows individuals to access and utilize technology for learning purposes, critical thinking helps them analyze the information obtained, and collaborative learning enriches the learning experience through interaction with others. All three, when applied simultaneously, can produce individuals who are not only skilled in using technology but also able to think deeply and work together to achieve greater goals.

Technological changes have had a significant impact on education. Digital literacy, which previously involved only basic skills such as the use of computers and the Internet, now extends to the ability to understand and evaluate information from a variety of sources, including social media, digital learning platforms, and various other technological applications (Eshet, 2004). This requires students not only to access information but also to be able to verify and utilize that information ethically and productively. However, despite widening access to technology, research shows that many students and educators have not fully mastered digital literacy effectively, thus increasing the digital skills gap in various countries (OECD, 2019).

Meanwhile, during a flood of easily accessible information, the ability to think critically has become increasingly important. Critical thinking teaches individuals not to passively receive information but to ask questions, analyze, and evaluate information based on evidence and logical reasoning (Facione, 1990). In a world filled with disinformation and hoaxes, the ability to think critically is not only an academic skill but also an essential life skill in avoiding decision-making mistakes that can harm individuals and society.

On the other hand, collaborative learning has emerged as an effective approach to solving these challenges. Collaborative learning not only encourages students to work together in problem solving but also

introduces a range of perspectives and facilitates the development of social and communication skills that are indispensable in the professional world (Johnson & Johnson, 2009). This approach integrates various elements of 21st century skills such as creativity, communication, and collaboration, which are relevant in facing increasingly complex global challenges.

However, even though the importance of these three elements has been increasingly recognized, the application of digital literacy, critical thinking, and collaborative learning in daily education still faces many obstacles. Many curricula do not fully cover these skills in an integrated manner, and most educators are still limited by their optimal use of technology in the learning process (Saavedra & Opfer, 2012). Therefore, efforts are needed to integrate these three skills into the framework of 21st century education in order to create more relevant learning and be ready to face the challenges of ever-evolving times.

Several previous studies that have discussed Digital Literacy, Critical Thinking and Collaborative Learning include research conducted by Short (2012), showing that the use of technology in learning communities helps students develop critical thinking, collaboration, and digital literacy skills. This collaborative approach encourages students to interact, share knowledge, and solve various problems. In conclusion, this study confirms that integrating technology in learning can improve skills such as problem solving and effective communication, as well as provide a dynamic and open learning space, which is important to prepare students for the challenges of the digital world (Short, 2012).

Another study conducted by Kocak et al. (2021) showed that critical thinking and the ability to work together play an important role in improving 21st century skills, such as problem solving and communication, among college students. Both serve as mediators that link factors such as digital literacy and social skills to better learning outcomes. In conclusion, the development of critical thinking and collaborative skills in higher education is essential to preparing students for the challenges of the increasingly complex world of work (Kocak et al., 2021).

Rajaram and Rajaram (2021) stated that collaborative learning, supported by the development of critical thinking skills, can increase student engagement and understanding. Additionally, real-time participation assessments provide useful feedback to improve student performance and support effective collaboration. In conclusion, these interventions are highly effective in creating innovative learning environments and improving 21st century skills, as well as contributing greatly to improving student learning outcomes in 21st century classrooms (Rajaram & Rajaram, 2021).

Overall, these three studies confirm that integrating technology, collaboration, and critical thinking in education is essential for preparing students to face the demands and challenges of the increasingly complex digital world and the world of work. This study aims to delve deeper into Digital Literacy, Critical Thinking, and Collaborative Learning to be integrated into current education.

Therefore, this study aims to explore the potential for the integration of digital literacy, critical thinking, and collaborative learning in the context of 21st century education, evaluate its impact on the quality of learning, and provide recommendations for the development of curriculum and teaching methods. This research provides benefits for educators by offering insights into how to integrate these three skills to improve teaching effectiveness, as well as for the development of a curriculum that is more relevant to the needs of the times. For students, this research is expected to strengthen their ability to access and evaluate information, work together, and utilize technology productively so that they can face global challenges and develop in various professional contexts.

2. Method

This study uses a quantitative method with a survey approach to measure and analyze the relationship between digital literacy, critical thinking, and collaborative learning in the context of 21st century education (Creswell & Creswell, 2017). The survey approach was chosen because it allows for the collection of large amounts of data from a wider population and provides a more objective and measurable picture of how the three elements are applied to learning in various educational settings (Gay et al., 2012). This study aimed to explore the influence of digital literacy and critical thinking skills on collaborative learning, as well as to identify the factors that contribute to the improvement of 21st century skills among students.

2.1 Research Design

This study used a correlational descriptive design to identify the relationship between digital literacy, critical thinking, and collaborative learning, and explored the influence of digital literacy and critical thinking skills on the application of collaborative learning in the 21st century education era (Likert, 1932). Questionnaire data were analyzed through descriptive analysis to describe the distribution of data and respondent characteristics, as well as correlational analysis, such as the Pearson or Spearman test, to test the relationship between variables. In addition, regression analysis was used to evaluate the extent to which digital literacy and critical thinking significantly affect collaborative learning (Hyun, 2014).

2.2 Population and Sample

The population of this study was high school and college students who were involved in technology-based and collaborative learning. The research sample was subjected to stratified random sampling, where samples were selected from several schools and colleges in urban areas that have technology-based teaching programs and focus on developing 21st century skills.

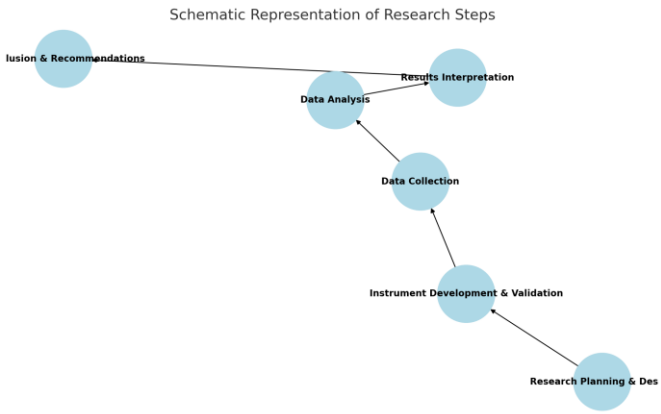

Figure 1. Research Process

The total population consisted of 450 students, considering their willingness to participate in this study. The sample selection was carried out based on certain criteria, namely those who were directly involved in learning that integrated digital literacy and collaborative learning.

2.3 Research Instruments

The instrument used to collect data in this study was a structured questionnaire comprising three main parts. The first part aimed to measure students' digital literacy level, with a focus on knowledge and skills in using information and communication technology to acquire, evaluate, and use information effectively. This questionnaire uses a 5-point Likert scale to assess how often students use technology in learning, as well as the extent to which they are comfortable with it. The second part focused on measuring students' critical thinking skills, that is, their ability to analyze, evaluate, and interpret information logically and systematically. As in the first part, a 5-point Likert scale was used to assess the frequency of use of critical thinking skills in the context of learning. The third part measures aspects of collaborative learning by identifying students' ability to work together in teams, share information, and solve problems. Again, a 5-point Likert scale was used to assess the extent to which students engaged in collaborative activities during the learning process. The validity and reliability of the instrument were tested through trials on a smaller sample group before it was fully used in the main study.

2.4 Data Collection

The data collection was conducted in two stages. The first stage involved distributing questionnaires to students and college students through an online survey platform, which allowed for efficient and anonymous data collection. Each respondent was asked to complete the questionnaire honestly and provide answers based on their experience in technology-based learning and collaboration. The second stage consisted of additional data collection through brief interviews with several selected respondents. The purpose of these interviews was to delve into their perceptions of their learning experiences, although this study focused on quantitative data collection.

2.5 Research Schedule

The study was designed to be conducted over a period of six months, with clear and structured stages to ensure the smooth implementation and achievement of the research objectives. Each stage is planned in detail to optimize time and resources, from instrument development to the publication of research results.

Month	Activity
First Month	Development and testing of questionnaire instruments
Second to Fourth Month	Data collection through surveys and interviews
Fifth Month	Data analysis and result interpretation
Sixth Month	Preparation and publication of research report

3. Results and Discussion

This study explores the role of social media as a source of educational information in the context of integrating digital literacy, critical thinking, and collaborative learning in 21st century education. Data were collected from 450 student respondents from various educational institutions in Jakarta, Bandung, and Yogyakarta. This study aimed to analyze how students utilize social media platforms such as Facebook, Twitter, Instagram, and YouTube to access educational materials, develop critical thinking skills, and collaborate with fellow students. The results of this research are expected to provide insight into how social media can be used to support the development of digital literacy and collaborative learning skills, as well as contribute to the development of more effective teaching strategies in the digital era.

3.1 Respondent Description

This study involved 450 respondents consisting of students from various levels of education in Indonesia, namely high schools, universities, and vocational programs in Jakarta, Bandung, and Yogyakarta. Respondents were randomly selected from educational institutions that have implemented technology-based learning and collaboration. As many as 60% of the respondents came from college, while the other 40% were high school students with an age range of 16–25 years. Of the total respondents, 55% were women, and 45% were men. Sixty% of respondents were enrolled in courses focused on technology, science, or business, while another 40% were from the social sciences and humanities. Most respondents used social media and digital tools to search for educational information, interact with classmates, and collaborate on group assignments. This study aims to explore how social media can support the development of digital literacy, critical thinking, and collaborative skills in 21st century education.

3.2 Validity Test and Reliability Test

The validity test was conducted by asking for opinions from several competent experts in the fields of education, technology, and learning in the 21st century. Experts were asked to evaluate the suitability of the items in the questionnaire with the constructs to be measured, namely, digital literacy, critical thinking, and collaborative learning. This process involves analyzing the relevance of each questionnaire item to the research objectives and the clarity of the language used. The opinions of the experts were used to revise and refine the questionnaire so that the items reflected the construct to be measured validly. With this step, it is hoped that the research instrument can precisely measure the targeted concept.

Reliability tests were conducted to assess the internal consistency of the research instruments, ensuring that the questionnaire items provided consistent results. Reliability testing uses Cronbach's alpha coefficient, which is a standard statistical method for measuring the reliability level of an instrument. Cronbach's alpha scores were calculated for each of the questionnaire's main dimensions: digital literacy, critical thinking, and collaborative learning. An alpha value higher than 0.70. considered to indicate an adequate level of reliability, which means that the items in the questionnaire have good internal consistency. The results of this reliability test indicated that the research instrument could be used to collect valid and reliable data.

3.3 Descriptive Analysis

This research aims to measure the level of digital literacy, critical thinking skills, and collaborative learning abilities of students in the context of 21st century education. Data were collected from 450 respondents by using a structured questionnaire.

Most respondents (72%) showed a good level of digital literacy, with high scores for the ability to use technological devices to search for information, communicate, and complete academic tasks. However, only 58% of the respondents were able to consistently evaluate the accuracy and credibility of information, indicating a gap in their evaluative skills. Respondents with a background in technology or science education recorded higher scores than those from social and humanities fields.

The level of critical thinking skills varied, with 65% of the respondents demonstrating adequate ability to analyze, evaluate, and draw conclusions from the information provided. Respondents from higher education generally scored higher than high school students, indicating the development of critical thinking skills with an increase in education level. Nonetheless, some students tend to receive information without much analysis or verification of the source, especially when dealing with complex or abstract information.

As many as 70% of the respondents reported engaging in collaborative learning, such as group discussions, team projects, and information-sharing activities. Most respondents felt that collaboration helped them understand the material better and improved their communication skills. However, 30% of the respondents face challenges in task division and coordination, especially within large groups, which sometimes leads to an imbalance in contributions between members.

The results showed a significant positive relationship between digital literacy, critical thinking, and collaborative learning. Respondents with a high level of digital literacy tended to be better at critical thinking and were more active in collaboration. By contrast, respondents with low digital literacy often face difficulties in using information critically and contributing effectively to the team.

As many as 85% of respondents admitted using social media to support their learning, access educational resources, discuss with friends, and share ideas. YouTube, Instagram, and WhatsApp are the most commonly used platforms. However, about 40% of respondents also admitted that social media can be a distraction, especially when there are no clear usage limits.

Table 1. Analysis Results for Digital Literacy, Critical Thinking, and Collaborative Learning

No	Aspect	Average score	Percentage of respondent in high category	Challenges identified
1	Digital literacy	4.1	72	Limited evaluation skills
2	Critical thinking	3.8	65	Difficulty analyzing complex information
3	Collaborative learning	4.0	70	Coordination issues in large groups

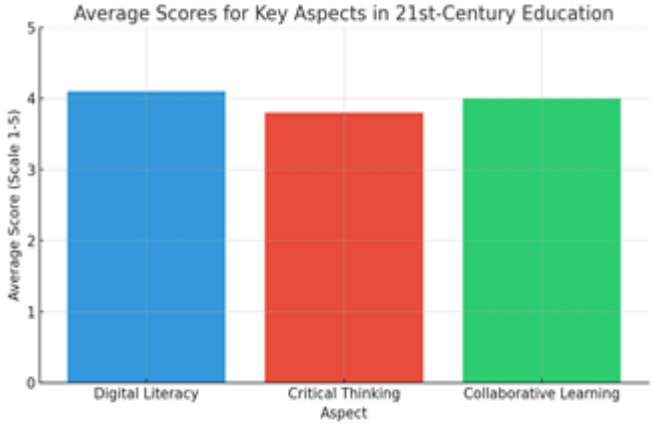

Figure 2. Average scores for key aspect in 21st century education

3.4 Correlation Analysis Results

Table 2. Correlation Analysis Results

No	Variable Pair	Pearson Correlation	Spearman Correlation
1	Digital Literacy & Critical Thinking	0.04552957629530413	0.04536233100739593
2	Digital Literacy & Collaborative Learning	-0.031593162638960955	-0.03183153167834574
3	Critical Thinking & Collaborative Learning	-0.0627959312501189	-0.06377453715820819

The results of the correlational analysis between digital literacy, critical thinking, and collaborative learning showed varied relationships between these variables. The Pearson's correlation between digital literacy and critical thinking showed a small positive value (r = 0.045), indicating a weak but still relevant relationship. This means that while students with higher digital literacy tended to be slightly better at critical thinking, the relationship was not significant. Spearman's correlation on the same variable pair supports this result, with a similar value (r = 0.045), indicating consistency between the two analysis methods.

Meanwhile, the correlation between digital literacy and collaborative learning showed a weak negative relationship (r = -0.032 for Pearson and r = -0.032 for Spearman). These results indicate that digital literacy does not significantly influence student engagement in collaborative learning. This may be due to challenges in utilizing technology optimally in the context of collaboration, such as a lack of group management or limited access to technology, which can hinder the positive potential of digital literacy for collaboration.

The correlation between critical thinking and collaborative learning also showed a small negative relationship (r = -0.063 for Pearson and r = -0.064 for Spearman). These findings indicate that critical thinking skills are not always in line with collaborative learning success. This could be due to differences in how students use critical thinking skills in group situations, where a focus on individual analysis can reduce the social interactions that support collaboration. These results show the need for more effective teaching strategies to integrate digital literacy, critical thinking, and collaborative learning so that each variable can support each other more synergistically to improve the quality of learning in the 21st century.

3.5 Discussion

The findings of this study provide crucial insights into the relationship between digital literacy, critical thinking, and collaborative learning in modern education. Although students demonstrated high levels of digital literacy, 72% exhibited strong digital skills, and 70% actively engaged in collaborative learning, their critical thinking skills were relatively weaker, with only 58% consistently demonstrating the ability to effectively analyze and evaluate information. Furthermore, the weak correlations among these three variables suggest that digital literacy does not automatically enhance critical thinking or collaborative learning, challenging the conventional assumption that these skills are inherently interconnected. This result necessitates a deeper exploration of the factors influencing these relationships along with a comparative analysis of prior studies and broader implications for education, curriculum design, and pedagogical strategies.

One of the most significant findings of this study was the weak correlation between digital literacy and critical thinking. Despite the widespread use of digital tools in education, many students have not yet developed the analytical reasoning skills necessary to critically assess online information. This is consistent with the findings of Eshet (2004), who argued that digital literacy extends beyond technical competence and should encompass higher-order cognitive skills such as evaluating information credibility and synthesizing multiple sources. However, in many educational contexts, digital literacy is still predominantly taught as a technical skill, focusing on the ability to navigate search engines, use digital applications, and communicate through online platformswithout an emphasis on deeper analytical engagement.

This lack of integration between digital literacy and critical thinking aligns with Buckingham's (2007) argument that modern education often treats digital literacy as a standalone skill that is disconnected from broader cognitive competencies. As a result, students may become proficient in using technology, but lack the ability to critically assess the reliability of digital content. In the current digital landscape, where misinformation and disinformation proliferate rapidly, the ability to discern facts through manipulation is more crucial than ever. Snyder and Tour (2016) support this concern, emphasizing that the mere ability to access digital information does not equate to the capacity to critically evaluate it. Digital literacy education should include structured activities that promote source verification, bias detection, and logical reasoning.

The weak relationship between digital literacy and critical thinking could also be attributed to information overload. In an era of constant digital stimulation, students are often bombarded with large volumes of online content, which makes it difficult to engage in deep analytical thinking. Facione (1990) noted that critical thinking requires deliberate reflection and systematic evaluation; however, the rapid consumption of digital media often encourages surface-level engagement rather than in-depth analysis. Many students rely on quick information retrieval strategies rather than engaging in rigorous inquiries, which ultimately diminishes their ability to assess the validity of online sources. To address this issue, educational institutions must adopt pedagogical approaches that integrate digital literacy with analytical reasoning such as fact-checking exercises, media literacy training, and structured digital debates.

Another surprising finding of this study was the weak negative correlation between digital literacy and collaborative learning. Although digital tools are often assumed to facilitate teamwork, the results suggest that students with higher digital proficiency are not necessarily more inclined to engage in collaborative learning. This finding aligns with the work of Saavedra and Opfer (2012), who highlighted that while technology enhances access to information, it can also promote individualistic learning behaviors. Many highly digitally literate students prefer to work independently, utilizing technology for self-directed learning rather than collaborative problem solving.

Rajaram and Rajaram (2021) further support this notion, emphasizing that technology enhances collaborative learning only when structured group interactions are actively incorporated into the educational process. Without intentional strategies to promote teamwork, digital platforms can lead to isolation, rather than connectivity. Johnson and Johnson (2009) similarly argued that effective collaborative learning requires social interdependence, whereby students must rely on each other's contributions to achieve common goals. However, in many digital learning environments, students engage in asynchronous discussions, which may reduce opportunities for real-time interaction and shared decision making.

One possible explanation for the negative correlation between digital literacy and collaborative learning is that many digital platforms are designed for individualized engagement rather than collective problem-solving. While tools such as search engines and digital archives enhance individual research skills, they do not inherently foster teamwork, unless they are used in structured collaborative settings. Additionally, some students may lack training in digital collaboration strategies, leading to ineffective teamwork. To improve digital collaborative learning, educators must implement structured activities that require meaningful peer interaction such as shared research projects, real-time group discussions, and peer-led digital workshops.

The integration of platforms such as Google Workspace, Miro, and Trello into the learning process can help bridge this gap by enabling students to co-create and co-manage projects in a more interactive manner.

This study also found a weak negative correlation between critical thinking and collaborative learning, suggesting that students who exhibit strong analytical reasoning skills do not necessarily thrive in team-based learning environments. This finding aligns with the work of Short (2012), who found that while collaborative learning increases student engagement, it does not always enhance deep critical analysis. One possible explanation for this phenomenon is that group settings often encourage consensus building, which can sometimes suppress individual critical thoughts.

Groupthink, as discussed by Kocak et al. (2021), is a major challenge in collaborative learning environments because students may conform to dominant perspectives rather than challenge assumptions or propose alternative viewpoints. In some cases, students with strong critical thinking skills may find group discussions frustrating, particularly if they perceive the process to be inefficient or lacking intellectual rigor. Additionally, power imbalances within groups can lead to some students dominating discussions, while others remain passive, reducing the overall effectiveness of collaborative learning.

OECD (2019) highlighted that while collaboration enhances social learning, it does not automatically foster critical thinking unless students are explicitly taught to engage in structured argumentation. Encouraging debate-based learning, interdisciplinary problem-solving activities, and Socratic questioning in group settings can help to bridge this gap. Incorporating peer review mechanisms into collaborative assignments allows students to critique each other's reasoning and refine their analytical skills within a team-based framework.

The results highlight the need for a more integrated approach to digital literacy, critical thinking, and collaborative learning. Instead of treating these as separate competencies, educational institutions must design curricula that incorporate all three competencies in a cohesive manner. This can be achieved by embedding digital literacy training within critical thinking courses, ensuring that students develop the ability to rigorously analyze digital content while engaging in collaborative research projects. Furthermore, teacher training programs should equip educators with strategies to effectively facilitate digital collaboration, ensuring that students use technology not just as an individual tool but as a medium for collective learning.

The broader implications of these findings suggest that educational policymakers should consider how digital skills are taught in schools and universities. Traditional digital literacy courses should evolve to include the components of media analysis, logical reasoning, and ethical digital engagement. In addition, schools should prioritize project-based learning models that require students to apply digital tools in collaborative, critical inquiry settings. Future research should explore innovative pedagogical approaches such as AI-assisted learning environments and virtual reality collaboration to determine their effectiveness in bridging the gaps identified in this study.

In conclusion, this study underscores the complexities of integrating digital literacy, critical thinking, and collaborative learning in 21st-century education. Although digital proficiency is essential, it does not automatically lead to improved analytical reasoning or teamwork skills. Instead, these competencies must be cultivated deliberately through structured learning experiences that emphasize deep inquiry, peer collaboration, and responsible digital engagement. By redesigning curricula, adopting evidence-based teaching strategies, and leveraging technology as a tool for critical engagement, educators can prepare students for the challenges and opportunities of the digital age.

4. Conclusion

The study concludes that digital literacy, critical thinking, and collaborative learning are key skills in 21st century education. However, the integration of the three still faces several challenges, such as a weak relationship between technical and analytical capabilities and a lack of synergy between individual capabilities and collaboration within teams. Technology that is expected to support learning sometimes becomes an obstacle to collaboration if it is not used optimally. Therefore, an integrated learning approach is required to ensure that these three skills support each other in preparing students for the challenges of the digital era.

The findings of this study have significant implications for educators, curriculum developers, policymakers and future researchers. Educators must rethink their teaching strategies to ensure that digital literacy is not merely a technical skill, but one that enhances critical thinking and collaboration. This can be achieved by incorporating interdisciplinary projects, blended learning methods and inquiry-based activities. In addition, teachers require adequate training in digital pedagogy to effectively integrate technology into classroom discussions and collaborative learning environments.

For curriculum developers, a shift towards project-based learning and AI-driven educational models is necessary. Courses should be designed to include fact-checking exercises, digital peer collaboration, and structured critical discussions to strengthen the

analytical and teamwork abilities of students. This approach ensures that students actively engage with digital content while developing their ability to critically assess and apply information in collaborative settings.

Policymakers must revisit the current educational frameworks to expand digital literacy programs beyond technical competencies and incorporate elements of critical digital engagement. Investments in educational technology infrastructure are crucial for facilitating interactive technology-supported collaborative learning. Furthermore, teacher training initiatives should be expanded to equip educators with tools needed to foster a learning environment that nurtures both independent and team-based critical thinking skills.

Future research should examine the long-term impacts of integrating digital literacy, critical thinking, and collaborative learning on students' academic and professional success. Studies should also explore how emerging technologies, such as artificial intelligence, virtual reality, and gamified learning environments can enhance these skills. Additionally, cultural and socioeconomic factors influencing the effectiveness of these strategies should be investigated to ensure equitable access to quality education across diverse learning environments.

Declarations

Author's Contributions

The authors collaboratively contributed to all aspects of the study by conceptualizing the research framework and designing the methodology for data collection, analysis, and interpretation. Efforts have focused on refining the literature review, formulating research questions, and integrating key insights into pedagogical and policy recommendations. Additionally, expertise in digital literacy education and statistical analysis ensured the relevance and rigor of the study. All authors participated in revising and finalizing the manuscript and ensuring clarity and coherence in presenting the findings.

Ethical Approval

This study was conducted in accordance with the principles outlined in the Declaration of Helsinki. Participation was voluntary, and informed consent was obtained from all respondents prior to data collection. Consent was obtained from the participants' legal guardians. The study protocol did not involve any intervention, clinical procedures, or collection of sensitive personal information; therefore, formal approval from an institutional ethics committee was not required in accordance with the local regulations.

Funding

This study received no external funding.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this manuscript. All ethical considerations, including plagiarism, informed consent, research misconduct, data fabrication and/or falsification, duplicate publication and/or submission, and redundancy, were fully adhered to by the authors.

Data Availability Statement

No new datasets were generated or analyzed in the current study. Therefore, data sharing was not applicable to this study.

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Word count: 6500 words, excluding references.

Peer review information:
Is the manuscript tracked quickly? - No
Number of reviewer reports submitted in the first round: 3 reports.
Number of revision rounds: 3 rounds
Final revised version submitted: March 20, 2025