

Research Article

The Effectiveness of Learning Platforms on Students' 6C Skills of Elementary School Students

Lailatun Najmiah

Universitas Nahdlatul Ulama Kalimantan Selatan, Indonesia
lailatunnajmiah@gmail.com

Fasihah Abidah binti Anoar

Sekolah Kebangsaan Taman Nusa Perintis 1, Malaysia
fasihahabidah@gmail.com

Abstract: This study examines the effectiveness of digital learning platforms in supporting the development of elementary school students' 6C skills, including critical thinking, creativity, collaboration, communication, citizenship, and character. Using a quantitative descriptive approach, data were collected from 382 students through 6C skills tests and questionnaires measuring students' perceptions of platform effectiveness. The data were analyzed using descriptive statistics, Pearson correlation, and one-way ANOVA to identify patterns and differences across schools. The results indicate a positive and significant relationship between the use of digital learning platforms and students' 6C skills, although the correlation strength is relatively low and varies between schools. These findings indicate that digital platforms contribute modestly to the development of students' 6C skills and that their effectiveness largely depends on pedagogical implementation and school readiness.

Keywords: digital learning platform, elementary education, six c skills, twenty-first century skills

Corresponding Author:

Lailatun Najmiah

lailatunnajmiah@gmail.com

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INTRODUCTION

The development of digital technology has driven significant transformations in learning practices across educational levels. Digital learning platforms support flexible, interactive, and student-centered learning processes (Lubis et al., 2021). Recent studies emphasize that the strategic integration of digital learning not only enhances accessibility and personalization but also promotes pedagogical innovation that supports the development of 21st-century competencies among students (Zou et al., 2023). The use of learning platforms is not only aimed at improving cognitive learning outcomes but is also expected to develop 21st-century skills, including critical thinking, creativity, collaboration, communication, citizenship, and character, known as the 6Cs, which are core competencies that students must have in order to respond to global dynamics and the demands of the future world of work (Suartama, 2025).

Empirical evidence indicates that digital learning models integrated with structured pedagogical approaches are effective in strengthening students' 6C skills, particularly when learning activities emphasize collaboration, creativity, and critical inquiry (Zainil et al., 2024). A systematic review of 21st-century learning models shows that approaches emphasizing cognitive and collaborative skills are effective in elementary schools. Other studies show that educational technology supports the strengthening of critical, collaborative, and creative thinking skills in 21st-century education (Budiarto et al., 2024). Research further demonstrates that e-learning platforms can significantly enhance higher-order thinking and collaborative competencies through project-based and intensive collaborative activities. (Baziuk & Rupšien, 2025).

Current educational challenges require learning models focused not only on material mastery but especially on developing the 6C competencies critical thinking, communication, collaboration, creativity, citizenship, and character. However, learning platforms are still primarily used for content delivery and efficiency, while the intentional development of 6C abilities is often neglected in both design and implementation (Fandir & Nurfidah, 2024). Research on online and blended learning environments shows that without purposeful instructional design, digital platforms tend to emphasize procedural learning rather than deep cognitive and social skill development (Khadka et al., 2025). This means their impact on higher order thinking skills and character development remains limited. An integrated approach that directly targets 6C skill growth is essential to meet 21st-century educational demands (Zou et al., 2023).

The implementation of pedagogically designed learning platforms enables learning interactions that encourage active participation, problem solving, collaboration, and reflection among students (Salehudin, 2024). The use of technology in digital learning offers strategic opportunities to create interactive and collaborative experiences (Sinring et al., 2025). Platform facilitated activities may include collaborative tasks, online discussions, and authentic assessments that build 6C skills (Zainil et al., 2024). The field reality shows that the effectiveness of such platforms depends more on their use in learning than on the technology itself. Previous studies have mainly evaluated learning platforms based on motivation, user satisfaction, and cognitive outcomes, while those focusing specifically on platforms' influence on students' 6C skills remain limited (Mehta et al., 2021).

Additional findings suggest that gaps in digital literacy can weaken the effectiveness of learning platforms in promoting critical thinking, collaboration, and creativity, underscoring

the importance of holistic pedagogical design (Ndibalema, 2025). Some studies focus on only some aspects of 21st-century skills and do not provide a complete picture of 6C skill development (Sugiri et al., 2023). These gaps highlight a need for more research. This study offers a comprehensive, integrated analysis of how learning platforms impact students' 6C skills. It measures not only academic outcomes, but also uses 6C skills as the main indicator of learning effectiveness. The urgency of this study comes from the need for education to produce graduates with balanced thinking, social, and character skills.

This study provides an empirical basis for educators and learning developers to create learning platforms that promote 6C skill development. Limitations stem from the scope of the subject and research context, which may limit generalizability and require further study in wider contexts. The study examines how the use of learning platforms affects students' 6C skills in formal schools. It measures the impact on each dimension of 21st-century skills. This approach provides a new perspective on the role of learning platforms in developing these competencies. The study identifies which aspects of 6C skills are most affected and examines factors that may influence the platforms' effectiveness in supporting students' 6C skill development.

THEORETICAL FRAMEWORK

Digital learning platforms are technology-based environments that combine materials, interaction, collaboration, and evaluation through features such as online discussions, assignments, quizzes, and feedback (Felix & Bernanda, 2025). Research shows that integrating these platforms into learning boosts student engagement, strengthens academic social interaction, and enables independent and collaborative exploration in a relevant, 21st-century context. Digital platforms go beyond just delivering content; they facilitate student interaction, reflection, and higher-order thinking (Alshammary & Alhalafawy, 2023). In 21st-century learning, digital platforms influence students' critical thinking. Students must access, evaluate, and interpret information in complex digital environments.

These platforms offer diverse resources and situations that prompt students to think rationally, solve problems, and decide using online information (Eumbunnapong et al., 2022). Creating digital content and open-ended assignments builds creativity, letting students both receive and produce original academic work. Interactions between students facilitated by digital platforms also strengthen collaboration and communication skills (Patrick et al., 2021). Discussion forums, online teamwork, and student-teacher feedback facilitate structured collaboration and effective communication in a digital learning environment. These collaborative activities reflect the social skills essential for collaborating on tasks and communicating ideas clearly in the digital space, which are critical competencies in 21st-century education (Siddiqui et al., 2023).

Digital platforms help shape students' character and citizenship. Using digital technology in learning requires students to act responsibly, manage time well, and follow online ethics. Taking part in digital learning communities and open discussions helps students understand social issues and participate in activities that show citizenship: being critical, adaptive, and acting with integrity (Jr, 2025). Digital platforms in learning serve as content deliverers and as learning ecosystems. They support the holistic development of all dimensions of 6C abilities. The effectiveness of digital platforms is measured by how well they foster critical thinking, creativity, collaboration, communication, character, and citizenship (Karim et al., 2021). This framework uses the 6C competencies as the main indicators of success. Digital

platforms shape the quality of the learning process, which, in turn, affects students' overall 21st-century competencies (Zheng et al., 2023).

METHODS

Research Design

This study employed a quantitative descriptive design to examine the effectiveness of digital learning platforms and to assess elementary students' 6C skills. A descriptive approach was chosen because the primary objective of the research was to provide an empirical overview of students' competencies and their perceptions of digital platform use in real classroom contexts rather than to test causal relationships between variables. Quantitative descriptive analysis allows researchers to present objective numerical information regarding score distributions, average achievement levels, and patterns of student abilities across different schools. Through this approach, the study aims to map variations in students' 6C skills and illustrate how digital learning platforms are perceived and utilized within elementary school learning environments.

Sample

The research subjects were elementary school students in the city of Cirebon who participated in the learning process using a digital learning platform. There were 382 research subjects, consisting of 216 male students and 166 female students, representing the population of elementary school students in the context of digital learning. The subjects were selected based on their involvement in using digital learning platforms during the learning process. The number of research subjects was considered adequate to produce stable and representative statistical descriptions. The characteristics of the subjects reflected the actual conditions of digital learning in elementary schools, so the research results were expected to provide a relevant description of the effectiveness of the learning platform and the 6C abilities of students in a similar context.

Data Collection

Data collection was conducted using two types of instruments, namely tests and questionnaires. Tests were used to measure students' 6C skills, which include critical thinking, creativity, collaboration, communication, citizenship, and character. The tests were compiled based on 6C skill indicators relevant to the characteristics of elementary school students and adapted to the context of digital platform-based learning. The test results were used to provide a descriptive overview of students' mastery of the 6C skills. Questionnaires were used to collect data on the effectiveness of the digital learning platform based on students' perceptions. The questionnaires were designed as Likert scales covering ease of use, learning engagement, interaction, and platform support for the learning process. Questionnaire data were analyzed descriptively to illustrate students' perceived effectiveness of the digital learning platform.

Table 1. Convergent Validity

Construct	Item	Outer Loading	Decision	Composite Reliability	Decision
PEOU	P1	0.534	Not Valid	0.702	Unreliable
	P2	0.759	Valid		Reliable
	P3	0.701	Valid		Reliable
PU	P4	0.704	Valid	0.825	Reliable
	P5	0.702	Valid		Reliable

	P6	0.701	Valid		Reliable
	P7	0.701	Valid		Reliable
	P8	0.703	Valid		Reliable
	P9	0.704	Valid		Reliable
ATT	P10	0.825	Valid	0.798	Reliable
	P11	0.805	Valid		Reliable
BI	P12	0.496	Not Valid	0.768	Unreliable
	P13	0.918	Valid		Reliable
SS	P14	0.771	Valid	0.768	Reliable
	P15	0.702	Valid		Reliable
	P16	0.744	Valid		Reliable
ACC	P17	0.804	Valid	0.764	Reliable
	P18	0.768	Valid		Reliable

The evaluation of instrument quality in quantitative research is not solely determined by the high outer loading value of each indicator but also by the ability of these indicators to form a complete latent construct. Latent constructs represent theoretical concepts that cannot be measured directly, so they require more than one indicator to demonstrate stable shared variance. An outer loading value ≥ 0.70 indicates that an indicator has a strong relationship with its construct, but the construct's validity can be maintained only if the indicator is supported by other indicators that are equally valid. Without additional indicators, the construct's interpretation becomes weak and may not adequately represent the intended concept. This condition is evident in the Behavioral Intention (BI) construct in this study. Of the two indicators used, only one (P13) meets the validity criteria, with a high outer loading value, while the other (P12) does not meet the required threshold.

This situation results in the BI construct being represented by only one valid indicator. Methodologically, a construct with only one indicator does not allow testing of internal consistency and does not provide a sufficient basis for assessing the construct's overall reliability. The measurement methodology literature consistently emphasizes that at least two indicators are required to empirically test and interpret a latent construct. Based on these considerations, the BI construct was not used in further analysis, despite one indicator with a high outer loading value. This decision was made to maintain measurement accuracy and methodological integrity of the research. Retaining a construct with only one indicator can lead to unstable estimates and biased interpretations of the latent variables under study. Therefore, removing the BI construct is a necessary methodological step to ensure the measurement model remains valid, reliable, and in line with established quantitative research practices in the international and national literature.

Data Analysis

The data obtained from the 6C competency test and the learning platform effectiveness questionnaire were analyzed using descriptive statistics and Analysis of Variance (ANOVA). Descriptive statistics were used to calculate the mean, percentage, and standard deviation to provide an overview of the students' 6C competency achievements and the effectiveness level of the learning platform implemented. Furthermore, ANOVA was used to identify differences in average scores across student groups, as this study involved more than two comparison groups. The selection of ANOVA focused on analyzing variations between groups without interpreting cause-and-effect relationships, in line with the descriptive

statistics-based quantitative research design used. All data analysis was performed using SPSS software with a significance level set at 0.05.

RESULT

The research results were obtained through descriptive and inferential statistical analyses to provide a comprehensive picture of students' learning achievements and perceptions of the use of digital platforms. The results of the descriptive analysis regarding the effectiveness of digital platforms and 6C competencies are presented in **Table 2**.

Table 2. Data Description

	School	N	Mean	Median	SD	Min	Max
Platform Digital	School A	35	70.43	72	12.02	26	86
	School B	34	70.82	70.50	6.47	58	86
	School C	41	72.17	75	10.70	27	86
	School D	28	67.46	68.00	8.80	37	80
	School E	76	69.55	72.50	9.73	41	86
	School F	55	72.55	73	9.46	47	89
	School G	62	69.84	71.00	8.37	48	101
	School H	51	75.02	75	8.69	55	90
6C's Skill	School A	35	10.37	11	2.40	3	15
	School B	34	8.41	8.50	1.71	4	13
	School C	41	13.15	14	1.46	7	15
	School D	28	10.39	10.00	3.14	4	15
	School E	76	13.22	14.00	2.36	6	15
	School F	55	14.33	15	1.28	8	15
	School G	62	13.79	15.00	2.10	6	15
	School H	51	14.18	14	1.01	11	15

The results of the descriptive statistical analysis show variations in achievement across schools in both the effectiveness of digital learning platforms and students' 6C skills. In terms of digital platforms, School H had the highest average score (M = 75.02), while School D had the lowest (M = 67.46). The data distribution for this variable was relatively moderate, with a standard deviation ranging from 6.47 to 12.02, suggesting differences in students' perceptions of the effectiveness of digital learning platforms across schools.

The distribution of students' 6C competency scores also showed clear differences between schools. School F recorded the highest average score (M = 14.33), followed by School H (M = 14.18) and School G (M = 13.79), indicating a relatively high level of mastery of 21st-century skills. In contrast, School B showed the lowest average score (M = 8.41) and a narrower score range, as reflected in its relatively small standard deviation. The variation in the standard deviation of the 6C variable indicates differences in the homogeneity of student abilities between schools.

Table 3. Result of Correlations Analysis

	Platform	Test
Platform	Pearson Correlation	1
	Sig. (2-tailed)	.000

	N	382	382
	Pearson Correlation	.201	1
Test	Sig. (2-tailed)	.000	
	N	382	382
Correlation is significant at the 0.01 level (2-tailed).			

Based on the results of the Pearson correlation test in the Correlation Table, the correlation coefficient between the learning platform and test results (Test) variables was $r = 0.201$, with a significance value of $p = 0.000$ ($p < 0.01$). This finding indicates a positive and significant relationship between the use of learning platforms and student test results. The positive correlation indicates that the more intensive the use of learning platforms, the higher students' test results tend to be. However, the correlation coefficient, which falls in the low category, indicates that the relationship between the two variables is relatively weak. This means that although the learning platform contributes to student test results, its influence is not dominant, and other factors still influence them. The analysis included 382 students, so the correlation results are representative and highly reliable.

Students are presented in Table 2 to provide an overview of the level of mastery of 21st-century skills in each school. The analysis results show that the average 6C competency score ranges from 8.41 to 14.33 out of a maximum score of 15. Schools C, E, F, G, and H show relatively higher average scores, while Schools A, B, and D are in the lower category. This variation in achievement indicates differences in the level of development of students' 6C skills between schools in the context of utilizing digital learning platforms. To examine the differences in the effectiveness of digital learning platforms and 6C skills between schools in more depth, the analysis was continued using a One-Way ANOVA test as presented in **Table 4**.

Table 4. Result of ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Platform	Between Groups	988.442	7	141.206	2.216	0.032
	Within Groups	23,833.108	374	63.725		
	Total	24,821.550	381			
Test	Between Groups	1,323.575	7	189.082	48.133	0.000
	Within Groups	1,469.200	374	3.928		
	Total	2,792.775	381			

The ANOVA test results show a significant difference in students' perceptions of the effectiveness of digital learning platforms between schools, with an F value of 2.216 and a significance level of $p = 0.032$ ($p < 0.05$). The ANOVA test results on students' 6C skills also showed very significant differences between schools, with an F value of 48.133 and a significance level of $p < 0.001$. These findings confirm that both the effectiveness of digital learning platforms and students' 6C skills vary significantly between schools, reflecting differences in the quality of implementation and digital learning experiences in each school context.

Table 5. Post Hoc Result for Digital Platform

Tukey B ^{a,b}		
School	N	Subset for alpha = 0.05

		1	2
School A	35	58.8286	58.8286
School B	34	58.9706	58.9706
School C	41	60.4146	60.4146
School D	28	56.6429	
School E	76	58.114	58.1184
School F	55	60.4364	60.4364
School G	62	58.1935	58.1935
School H	51		62.3528

Based on Tukey’s post hoc test on the learning platform variable, schools were grouped into homogeneous subsets at $\alpha = 0.05$, indicating differences in the means between schools. Schools in Subset 1, namely School D (M = 56.64), School E (M = 58.11), School A (M = 58.83), School B (M = 58.97), School G (M = 58.19), School C (M = 60.41), and School F (M = 60.44), had means that were not significantly different from one another. Meanwhile, Subset 2 consists of School A, School B, School C, School E, School F, School G, and School H, with School H showing the highest mean (M = 62.35) and only appearing in the second subset, which indicates a significant difference compared to schools that are only in the first subset, especially School D, which has the lowest mean.

Table 6. Post Hoc Result for 6C’skills

School	N	Subset for alpha = 0.05		
		1	2	3
School A	35		10.3714	
School B	34	8.4118		
School C	41			13.1463
School D	28		10.3929	
School E	76			13.2237
School F	55			14.3273
School G	62			13.793
School H	51			14.1765

The post hoc results in the table show that schools can be grouped into several homogeneous subsets based on student test scores. School B forms a separate subgroup with the lowest average test score, which shows a significant difference compared to the other schools. Several schools, such as School A and School D, overlap in the middle subsets, indicating no significant differences in test results between them. Meanwhile, Schools C, E, F, G, and H are grouped in the subset with the highest average, with Schools F and H showing the highest average scores. These findings indicate that there is variation in test results between schools, with some schools showing better student performance, but there are also similarities in test results among certain groups of schools in relatively comparable learning contexts.

DISCUSSION

The use of digital learning platforms in the student learning process shows that digital platforms can increase activity and learning outcomes, as students find it easier to access learning materials anytime and anywhere (Zheng et al., 2023). Empirical studies show that interactive e-learning platforms contribute significantly to student engagement and

academic achievement, with higher engagement positively correlated with better academic achievement due to more flexible learning resources that are responsive to student needs. This positive impact is in line with literature reporting that increased use of digital classrooms or digital learning platforms has a significant impact on students' conceptual understanding and academic test scores at various levels of education (Bayley, 2022).

Meta-analytic evidence further confirms that digital learning platforms have an overall positive effect on learning outcomes, although the magnitude of the effect varies depending on contextual and instructional factors (Alshammary & Alhalafawy, 2023). Empirical evidence further suggests that digital learning platforms enhance student engagement and academic performance by offering interactive resources and learning flexibility that directly support improved learning outcomes (Brugliera, 2024). Additional findings indicate that the effectiveness of learning management systems contributes significantly to improved learning outcomes, particularly when supported by strong online interaction .

The varying test results between schools in this study show that in addition to the influence of learning platforms on academic outcomes, the context of implementation and the readiness of the school environment also affect the successful use of this technology (Rehman, 2023). Previous studies describe that the effectiveness of digital platforms in improving learning outcomes is influenced by content quality, user motivation, and infrastructure support, so schools with more mature technical readiness tend to have higher learning outcomes. Studies on online learning environments confirm that the impact of digital platforms varies significantly depending on instructional quality, teacher–student interaction, and learner motivation (Nabiem et al., 2024).

This is in line with the finding that digital learning does not only provide online material but also requires strong pedagogical strategies, competent teacher support, and adequate facilities for optimal effectiveness (Kusuma & Fauzi, 2025). However, not all studies have found consistent results; some literature shows that online learning alone does not always improve learning outcomes without effective interaction and adequate instructional support. Therefore, the results of this study emphasize that the implementation of digital learning platforms must be supported by a mature learning system, including teacher training, responsive learning design, and student adaptation to technology.

Research highlights that students' digital literacy and readiness for online learning significantly influence engagement levels and self-directed learning capacity, which in turn affect academic outcomes in digital learning environments (Alanoglu et al., 2025). Supporting this argument, research also demonstrates that open and interactive digital learning platforms can foster higher engagement and critical learning behaviors when aligned with appropriate instructional support (Mufron et al., 2025). The combination of effective digital platforms and a supportive learning context will encourage increased motivation, student engagement, and consistently better learning outcomes in various school environments (Zuhri et al., 2024).

Beyond improving access and engagement, digital learning platforms also provide opportunities to support the development of higher order thinking and 6C competencies when they are intentionally integrated into instructional practices (Gunduzalp, 2021). Platform features such as collaborative tasks, discussion forums, and formative feedback can encourage students to think critically, communicate ideas effectively, and work collaboratively with peers, which are essential skills in 21st-century learning (Suryanti & Utari,

2025). Quantitative evidence further shows that students' digital learning competence, including skills related to information management and evaluation, is positively associated with academic achievement (Muali & Karlina, 2025). Similar findings indicate that increased student engagement through digital platforms significantly predicts higher academic performance (Sappaile et al., 2023), reinforcing the importance of purposeful platform integration.

Quantitative evidence shows that students' digital learning competence, including skills related to information management and evaluation, is positively associated with academic achievement, reinforcing the importance of developing digital competencies alongside platform use (Song et al., 2025). However, the extent to which these competencies develop depends on how teachers design learning activities and facilitate interaction within the digital environment (Seprina & Lestari, 2026). Without purposeful pedagogical planning, digital platforms risk being reduced to tools for content distribution rather than meaningful learning spaces. Therefore, the findings of this study reinforce the view that the educational value of digital learning platforms lies not in the technology itself, but in their pedagogically informed use that aligns learning objectives, instructional strategies, and assessment to support holistic student development (Bulkis et al., 2025).

CONCLUSION

The results of this study indicate that the use of digital learning platforms positively affects student test scores, though the correlation is low and varies across schools. Post hoc findings indicate significant differences in test scores across several schools, confirming that the effectiveness of learning platforms is not uniform but is strongly influenced by implementation context, infrastructure readiness, and pedagogical support in each school. Schools with higher average test scores tend to have a learning environment that is more conducive to optimal use of the platform, through the integration of appropriate learning strategies and greater teacher and student involvement. This aligns with the view that learning technology does not automatically improve learning outcomes; rather, it must be accompanied by well-designed instruction and a supportive school ecosystem. Thus, digital learning platforms have great potential to improve student learning outcomes, but their effectiveness depends heavily on the quality of implementation and comprehensive support for the learning system.

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