

Development of a Digital Ecosystem Based on a Combination of Wordwall and Kahoot to Accelerate Literacy-Numeracy Competency of Dasa School Students

Tri Yudha Alamsyah

Universitas Pakuan, Bogor, Indonesia

Corresponding Authors: Tri Yudha Alamsyah: triyudhaalamsyah2111@gmail.com

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ABSTRACT

The development of literacy and numeracy of elementary school students is crucial in the digital era, but the use of learning technology is still not optimally integrated. This study aims to analyze the effectiveness of the combination of Wordwall and Kahoot in accelerating literacy-numeracy competencies and the relationship between student involvement and learning outcomes. The method used was quantitative with a quasi-experimental design, involving 60 students, using tests, observations, and questionnaires, and analyzed by inferential statistical tests. The results showed a significant increase of 18% in the experimental group and a positive correlation between engagement and learning outcomes. It was concluded that the integration of Wordwall and Kahoot is effective in improving literacy-numeracy competencies and supporting interactive learning in elementary schools.

INTRODUCTION

Digital transformation in education has driven significant changes in learning strategies, especially in strengthening basic literacy and numeracy competencies in elementary schools. Literacy and numeracy are the main foundations for critical thinking, problem-solving, and decision-making skills in daily life (OECD, 2022). However, globally and nationally, the achievement of these two competencies is still a serious challenge. The results of the Programme for International Student Assessment (PISA) show that the reading and mathematics literacy skills of Indonesian students are still below the OECD average, which signals the need for more innovative and effective learning interventions.

At the national level, this condition is exacerbated by the phenomenon of learning loss after the COVID-19 pandemic which has a significant impact on student learning achievements. Various reports show that students' literacy and numeracy skills have not fully recovered, thus widening the gap in the quality of basic education. In addition, data shows that most Indonesian students are still at a low level in numeracy literacy, even up to 82% below the minimum standard of PISA (Kusuma & Rosmilawati, 2024). This shows the urgency of developing technology-based learning strategies that are able to significantly increase student engagement and learning outcomes.

In the context of 21st century learning, the use of digital technology such as interactive learning platforms is one of the potential solutions. Wordwall and Kahoot are two digital platforms that have been widely used to increase student motivation and participation through a gamification approach. Previous research has shown that the use of digital game-based media can increase student engagement and strengthen conceptual understanding (Sari et al., 2022; Rahmawati, 2023). However, the implementation of the two platforms still tends to be carried out separately and has not been integrated into a systematic learning ecosystem.

A number of previous studies have examined numeracy literacy in various learning approaches. For example, Zainudin et al. (2023) examined the trend of implementing numeracy literacy in elementary schools, while Sholihah and Susanti (2023) highlighted the influence of learning models on improving mathematical literacy. In addition, Kusuma and Rosmilawati (2024) through a systematic literature review found that there is still little research that focuses on improving numeracy literacy based on PISA indicators comprehensively. These findings show that research integrating innovative digital approaches with global numeracy literacy frameworks is still limited.

The research gap in this study lies in the lack of studies that develop an integrated digital ecosystem based on a combination of interactive learning platforms to improve literacy and numeracy simultaneously. Most previous studies have focused on only one specific medium or approach, without exploring the potential synergies between digital platforms. In addition, there have not been many studies that associate the use of digital technology with student involvement as a mediating variable in improving literacy-numeracy learning outcomes.

Based on these gaps, this study aims to develop and analyze the effectiveness of a digital ecosystem based on the combination of Wordwall and Kahoot in accelerating the literacy-numeracy competencies of elementary school students. In particular, this study also aims to examine the relationship between student engagement levels and improved learning outcomes in the context of interactive digital learning.

Theoretically, this research is expected to enrich the study of the integration of digital technology in literacy and numeracy learning, especially through a gamification-based learning ecosystem approach. This research also contributes to developing a conceptual framework that connects learning technologies, student engagement, and learning outcomes in the context of basic education.

Practically, the results of this research are expected to be a reference for teachers, schools, and policymakers in designing more innovative, interactive, and technology-based learning. The development of a digital ecosystem based on Wordwall and Kahoot can be an alternative solution to overcome students' low literacy-numeracy competencies and support the implementation of learning that is relevant to the demands of the digital era.

LITERATURE REVIEW

Literacy and numeracy are fundamental competencies in basic education that play an important role in shaping students' critical, analytical, and problem-solving skills. In the global context, strengthening these two competencies is a top priority, as reflected in various international assessments such as PISA. However, various studies show that students' literacy and numeracy achievements, especially in Indonesia, are still relatively low and do not meet the expected standards. This condition is caused by various factors, including less innovative learning approaches and limited use of contextual and interactive learning media (Apipah et al., 2023; Rahmanuri et al., 2023). In addition, the implementation of learning based on Higher Order Thinking Skills (HOTS) that supports strengthening numeracy literacy is also still not optimal at the elementary school level (Fajriyah, 2022).

The development of digital technology has brought significant changes in the world of education, especially in the transformation of the learning paradigm from teacher-centered to student-centered learning. Digital-based learning allows for a more flexible, interactive, and adaptive learning environment to students' needs. Studies show that the use of digital technology can significantly increase student motivation, participation, and learning outcomes (Cenita & De Guzman, 2023). However, the implementation of technology in learning still faces various obstacles, such as the lack of integration between platforms and the lack of optimal pedagogical use of technology. Therefore, the development of an integrated digital ecosystem is needed to support more effective and sustainable learning.

One of the approaches that is developing in digital learning is gamification, which is the application of game elements in the learning process to increase student engagement. Research shows that gamification can increase students' motivation to learn, participation, and concept understanding (Dellos, 2021; Di Blasi et al., 2023). Platforms like Kahoot have been widely used in learning

because they are able to create a competitive and fun learning atmosphere. In addition, the integration of gamification in learning models such as Problem-Based Learning has also been proven to be able to significantly improve students' mathematical literacy (Fajriati et al., 2024). This shows that the gamification approach has great potential in supporting the development of numeracy literacy competencies.

In addition to Kahoot, the Wordwall platform is also one of the effective digital learning media in increasing student engagement and learning outcomes. Wordwall provides different types of interactive activities that allow students to learn through engaging educational games. Research shows that the use of Wordwall can increase students' motivation to learn and understand concepts, especially in mathematics and literacy learning (Rahmawati et al., 2024). In addition, Wordwall has also been proven effective in improving students' numeracy skills through a problem-based learning approach (Agusdianita et al., 2023). The use of Wordwall as a digital learning and assessment medium also supports the development of more adaptive and technology-based learning.

Although Wordwall and Kahoot have been extensively studied separately, studies integrating the two platforms into a single learning ecosystem are still very limited. Most research tends to focus on the effectiveness of a single platform without exploring the potential synergies between digital platforms. In fact, the integration of various technologies in one learning ecosystem can increase the effectiveness of learning in a more comprehensive and sustainable manner (Romero & Ventura, 2024). The development of a digital ecosystem allows for more structured, adaptive learning, and is able to utilize data to improve the quality of learning processes and outcomes.

In the context of digital learning, student engagement is a key factor that influences learning success. Student engagement includes cognitive, emotional, and behavioral aspects that are interrelated in the learning process. Research shows that the use of gamification-based learning media can significantly increase student engagement, which ultimately impacts improved learning outcomes (Di Blasi et al., 2023). Therefore, the development of a digital learning ecosystem needs to consider student involvement as an important variable in improving numeracy literacy competencies.

Based on the literature review, it can be concluded that digital technology, especially Wordwall and Kahoot, has great potential in improving the numeracy literacy competence of elementary school students. However, there is still a research gap related to the integration of the two platforms in a comprehensive and systematic digital ecosystem. In addition, the relationship between technology integration, student engagement, and learning outcomes has not been studied in depth.

Therefore, this research has a strategic position in filling this gap by developing a digital ecosystem based on a combination of Wordwall and Kahoot to accelerate the numeracy literacy competencies of elementary school students.

This research is expected to make a theoretical contribution to the development of gamification-based digital learning models as well as practical contributions in improving the quality of learning that is interactive, adaptive, and relevant to the demands of the digital era.

METHODOLOGY

This study uses a quantitative approach with a quasi-experimental design, especially a nonequivalent control group design, which aims to test the effectiveness of the development of a digital ecosystem based on the combination of Wordwall and Kahoot on improving the literacy-numeracy competence of elementary school students. This approach was chosen because it allowed researchers to compare learning outcomes between the experimental group and the control group without full randomization, while still maintaining adequate internal validity in the context of educational research (Creswell & Creswell, 2021). The population in this study is all grade V elementary school students in one of the public schools in Indonesia, with sampling techniques using non-probability sampling purposive sampling. The sample consisted of 60 students who were divided into two groups, namely 30 students as the experimental group and 30 students as the control group. The selection of samples was based on the equality of academic characteristics and readiness to use digital technology to ensure comparability between groups (Sugiyono, 2022).

Data collection techniques are carried out through tests, questionnaires, and observations. Test instruments are used to measure students' literacy-numeracy competencies based on indicators that refer to the PISA framework (OECD, 2022), while questionnaires are used to measure the level of student involvement during digital learning. The questionnaire instrument was developed from the student engagement scale that has been validated in previous research (Fredricks et al., 2022). Observations were carried out to obtain supporting qualitative data related to learning activities. The validity test of the instrument was carried out through the validity of the content with expert judgment and the validity of the construct using Pearson correlation analysis, while the reliability was tested using the Cronbach's Alpha coefficient with the criterion of ≥ 0.70 (Hair et al., 2021).

The research procedure is carried out in stages, starting from the planning stage which includes literature study, instrument preparation, and instrument trial. The implementation stage included giving pretests to both groups, implementing Wordwall and Kahoot-based learning in the experimental group and conventional learning in the control group, then ending with a posttest. The final stage includes data processing and analysis. Data analysis techniques used descriptive and inferential statistics, including normality tests, homogeneity tests, t-tests (independent sample t-tests), and regression analysis to test the relationship between student engagement and learning outcomes. Data analysis was carried out with the help of SPSS software version 26 and Microsoft Excel to ensure the accuracy and efficiency of data processing (Field, 2021).

RESEARCH RESULT

Improving Students' Literacy-Numeracy Competency

The results of the analysis showed a significant increase in literacy-numeracy competence in the experimental group that used a digital ecosystem based on Wordwall and Kahoot compared to the control group. The average scores of the pretest and posttest are presented in Table 1.

Table 1. Comparison of Pretest and Posttest Scores

Groups	Rata-rata Pretest	Posttest rate-rate	Increase (%)
Eksperimen	62,4	80,6	18,2%
Controls	63,1	70,2	7,1%

The results of the independent sample t-test showed a significance value (Sig. = 0.000 < 0.05), which indicated a significant difference between the two groups. This shows that the use of a combination of Wordwall and Kahoot is more effective in improving numeracy literacy than conventional methods.

Student Engagement in Learning

Analysis of student engagement questionnaires showed that the experimental group had a higher level of engagement than the control group. The average engagement score is presented in Table 2.

Table 2. Student Engagement Score

Aspects of Engagement	Eksperimen	Controls
Cognitive	4,21	3,45
Emotional	4,35	3,50
Behavior	4,40	3,60
Total Average	4,32	3,52

The data showed that students in the experimental group were more active, enthusiastic, and involved in the learning process, especially in behavioral and emotional aspects.

The Relationship of Engagement to Learning Outcomes

The results of the regression analysis showed a positive relationship between student involvement and literacy-numeracy learning outcomes. A determination coefficient value (R^2) of 0.64 indicates that 64% of the variation in learning outcomes is influenced by the level of student involvement.

Table 3. Regression Analysis Results

Variabel	Coeficin (β)	Sig.
Student Engagement	0,80	0,000

This shows that the higher the student involvement, the higher the learning outcomes achieved.

Digital Ecosystem Effectiveness (Wordwall + Kahoot)

The results of the observation show that the integration of Wordwall and Kahoot creates more interactive and varied learning. Wordwall plays a role in practicing concepts independently and exploramically, while Kahoot serves as a competition-based evaluation that increases student motivation. The combination of the two results in a more comprehensive learning experience than using a single platform.

Comparison with Previous Research

The findings of this study show an increase of 18.2%, which is higher than previous studies that generally reported an increase in the range of 10–15% on the use of a single digital platform (e.g. Wordwall or Kahoot separately). This difference indicates that the integration of two platforms in one learning ecosystem provides a stronger synergistic effect than a single use. In addition, this study also confirms that student involvement plays an important variable that has not been studied simultaneously in previous research.

Key Research Findings

Based on the overall results of the research, it can be concluded that the use of a digital ecosystem based on the combination of Wordwall and Kahoot is significantly able to improve the literacy-numeracy competence of elementary school students. In addition, student engagement in digital learning was shown to increase markedly in the experimental group compared to the control group. Further analysis also showed a positive and significant relationship between student engagement levels and learning outcomes achieved. The integration of the two digital platforms results in higher learning effectiveness compared to the use of one platform separately, thus showing a synergistic effect in supporting a more interactive and meaningful learning process.

DISCUSSION

This study shows three main findings. First, the use of a digital ecosystem based on Wordwall and Kahoot has proven to be more effective than conventional learning in improving the literacy-numeracy competencies of elementary school students. This can be seen from the increase in the score of the experimental group from 62.4 to 80.6, while the control group only increased from 63.1 to 70.2. Substantively, the difference in increase between groups shows that digital interventions not only result in improvements, but also greater improvements than usual learning. Second, student engagement in the experimental group was higher across all dimensions – cognitive, emotional, and behavioral. Third, student involvement has a strong positive relationship with learning outcomes, shown by the regression coefficient $\beta = 0.80$ and the determination coefficient $R^2 = 0.64$. Thus, the effectiveness of the intervention is not only seen in the score of learning outcomes, but also in the accompanying psychopedagogical process, namely the increase in student engagement during learning.

These findings support the hypothesis that interactive and gamification-based digital learning is able to improve learning outcomes. Statistically, the results of the independent sample t-test with $\text{Sig.} = 0.000 < 0.05$ showed that the difference in posttest results between the experimental and control groups did not occur by chance. Nevertheless, it should be noted methodologically that the numbers "18.2%" and "7.1%" in the table seem to be more accurately read as a difference in points rather than relative percentages. If calculated as a percentage increase from the initial score, then the experimental group increased by about 29.2%, while the control group was about 11.3%. This note is important so that

the interpretation of the data becomes more precise and does not create ambiguity in the reporting of results.

Theoretically, the results of this research can be explained through Self-Determination Theory (SDT). SDT explained that the quality of learning motivation increases when the learning environment supports three basic psychological needs, namely competence, autonomy, and connectedness. Environments that provide clear feedback, opportunities to choose, and enjoyable learning experiences tend to encourage more autonomous motivation, which in turn has an effect on engagement, perseverance, and performance. In the context of this study, Wordwall provides a space for independent and exploratory practice, while Kahoot provides quick feedback, challenges, and social-competitive experiences. The combination of the two is very likely to meet the needs of students' competence, autonomy, and connectedness in a more balanced manner than conventional learning. Ryan and Deci emphasized that autonomous motivation is related to better interest, vitality, confidence, performance, creativity, and persistence. Recent meta-analyses also show that gamification tends to increase intrinsic motivation as well as perceptions of autonomy and connectedness, although the impact on the perception of competence can vary.

From the perspective of student engagement theory, the results of this research are also very consistent. Fredricks, Blumenfeld, and Paris argue that student engagement is a multidimensional construct that includes behavioral engagement, emotional engagement, and cognitive engagement. These three dimensions do not stand alone, but strengthen each other in shaping the quality of the learning experience. The findings of this study show a similar pattern: the experimental group scored higher on behavioral, emotional, and cognitive aspects. This means that students are not only more active outwardly, but also more enthusiastic and more mentally involved in processing the material. In a large meta-analysis involving 137 studies and 158,510 participants, student engagement was shown to be positively correlated with academic achievement ($r = 0.33$) and subjective well-being. Thus, the regression findings in this study – that engagement explains 64% of the variation in learning outcomes – are not isolated results, but are in line with international evidence patterns.

The important meaning of these findings is that student involvement is not just a companion variable, but one of the main mechanisms that bridge the use of digital media with improved learning outcomes. Within this framework, Wordwall and Kahoot act not only as technical aids, but as learning environment designs capable of moving students from passive positions to active participants. When students feel challenged, get quick feedback, and see real learning progress, they are more likely to focus, maintain effort, and process information more deeply. Therefore, the positive relationship between engagement and learning outcomes in this study has a strong practical meaning: learning interventions are more effective when they are designed to foster engagement, not just deliver material.

The effectiveness of the combination of Wordwall + Kahoot can also be explained by the pedagogical functions of the two which complement each other.

Wordwalls tend to be powerful as a medium for practice, reinforcement of concepts, and flexible repetition. Students can practice more individually, test comprehension, and gain manipulative-digital experiences that suit the learning needs of the elementary school phase. Recent evidence suggests that the use of Wordwall in primary school math learning is associated with increased interest and learning outcomes; for example, the study of Yuniastuti et al. reported an increase in scores from 65.4 to 84.2, and another study also emphasized the effectiveness of Wordwall in improving mathematics learning outcomes in elementary school.

In contrast, Kahoot is powerful as a means of formative evaluation, rapid monitoring of comprehension, and a motivational driver through game elements such as scores, music, and leaderboards. Systematic studies and cutting-edge research show that Kahoot can increase active participation, motivation, and engagement through direct feedback and gamification mechanisms. However, there is also a note that Kahoot does not always automatically generate deep learning if used only as a quick quiz with no conceptual follow-up. Therefore, when Kahoot is combined with Wordwall, the weaknesses of one platform can be covered by the advantages of the other: Wordwall supports deepening and practice of concepts, while Kahoot strengthens attention, formative evaluation, and enthusiasm for learning. This theoretically explains why a two-platform ecosystem can produce greater synergistic effects than the use of a single platform.

The findings of this study are also relevant to the broader gamification literature. Diaz and Estoque-Loñez's meta-analysis shows that gamification in general has a positive and significant effect on learning outcomes; even in their review, Kahoot was cited as the gamification platform with the most effect among the apps analyzed. On the other hand, a systematic review by Ruiz, Sanchez, and Figueredo shows that gamification has the potential to increase school engagement, although the quality of implementation and instructional design largely determines the end result. So, the improvement in the experimental group in this study can be interpreted not only as a success in the use of technology, but also as a success in appropriate gamification-based instructional design.

If it is associated with the concepts of literacy and numeracy, the results of this study also make sense. The PIRLS framework emphasizes that reading literacy is not just the technical ability to read, but the ability to understand and use information for various purposes. Meanwhile, TIMSS places mathematical abilities in the cognitive domains of knowing, applying, and reasoning. This means that literacy-numeracy requires more than memorization; Students must actively understand, apply, and reason. Digital ecosystems such as Wordwall and Kahoot have the potential to help with this process because they provide repetitive exercises, more engaging context, and quick responses to errors. In a purposeful digital environment, students can practice more often connecting information, choosing strategies, and checking the accuracy of answers – all of which are at the heart of literacy and numeracy development.

Compared to previous studies that generally reported an increase of around 10–15% on the use of a single platform, the results of this study showing a higher increase can be read as an indication that the combination of platforms provides added value. The logical explanation is the differentiation of learning functions: Wordwall strengthens the exploration and practice phases, while Kahoot strengthens the evaluation phase, strengthens attention, and competitive motivation. In other words, students don't just learn through one type of experience, but through a more complete sequence of experiences: understanding, trying, repeating, evaluating, and then being motivated to improve performance. This kind of structure is closer to the principles of active learning and formative assessment than one-way learning. Meta-analytical evidence on K–12 formative assessments also showed that formative assessments had a positive effect on academic achievement, with Hedges' overall effect $g = 0.25$ out of 258 effect sizes across 118 studies.

Nevertheless, the findings of this study still need to be read critically. There are several factors that may support the success of the intervention. First, the novelty effect of digital media can increase students' attention and enthusiasm at the beginning of use. Second, the characteristics of elementary school students who tend to like visual, interactive, and competitive activities make platforms like Wordwall and Kahoot more suitable for development. Third, the quality of teacher implementation is likely to be a determining factor; The same platform can have a different impact if instruction, class management, or question quality are different. Fourth, quick feedback and a competitive atmosphere can increase short-term focus, especially on evaluative activities. However, the literature also reminds that the effects of gamification are not always stable in the long term; Motivation can decrease if students start to get bored or if the elements of play are more dominant than the substance of learning. In addition, some studies show mixed results depending on the design, context, and quality of pedagogical integration.

Factors that may contradict or limit the effects of the intervention also need to be considered. Not all students respond to the competition in the same way; For some students, the leaderboard can be motivating, but for others, it can lead to stress, anxiety, or a feeling of being left behind. The availability of devices, network stability, and digital literacy of teachers and students can also affect the quality of the learning experience. In addition, if Wordwall or Kahoot activities place too much emphasis on answering speed, there is a risk that students will focus on win-wins, rather than deep reasoning. This may explain why some literature still assesses gamification to be effective for engagement, but not necessarily automatically optimal for deep learning without advanced conceptual reinforcement.

From a methodological perspective, this research has several limitations that should be openly acknowledged. First, the information presented did not show sample size, detailed initial equivalence examination of the group, nor statistical effect measures such as Cohen's d . As a result, the power of practical inference from the t -test results cannot be fully assessed. Second, the measurement of student engagement seems to rely heavily on questionnaires, so

it is still possible to be influenced by social perception bias. Third, the design of the control pretest-posttest is indeed robust, but without delayed posttest data, it is not certain whether the improvement lasts in the medium or long term. Fourth, the variables of teachers, the quality of the questions, the frequency of platform use, and the condition of the infrastructure have not been explained as the controlling variables. Fifth, there is an ambiguity in the label "increase (%)" which numerically more closely resembles a point difference. This kind of technical weakness is important to fix so that research reports are more precise and replicative.

Based on these limitations, further research should be directed to several things. First, use a larger and more diverse sample to make the generalization of results stronger. Second, add effect measures, test complete statistical assumptions, and consistent gain analysis, such as normalized gain or relative percentage gain. Third, combining quantitative data with classroom observations, interviews, or learning analytics so that engagement is not only measured from student perception. Fourth, examine the long-term effects to see if the increase in learning outcomes and motivation persists after the novelty element decreases. Fifth, compare several implementation scenarios: Wordwall alone, Kahoot alone, and a combination of both. With such a design, the claim of "synergistic effect" can be tested more robustly. Sixth, subsequent research can also test whether engagement acts as a mediator between the use of digital platforms and learning outcomes, not just as a direct predictor.

Overall, this research makes an important contribution to the development of basic education, especially in the intersections of digital learning, gamification, literacy-numeracy, and student engagement. Its theoretical contribution lies in the affirmation that the effectiveness of digital media cannot be understood only from the technological side, but must be explained through motivational mechanisms and student involvement. Its practical contribution is to provide a basis for elementary teachers to design learning that is not only engaging, but also has a real impact on learning outcomes. Meanwhile, its methodological contribution lies in efforts to link digital interventions with process variables, namely engagement, which has often been treated as just an additional variable. Thus, this study expands the understanding that increasing literacy-numeracy through digital technology will be more meaningful if the technology is designed as an interactive, structured, and student-centered learning ecosystem.

CONCLUSIONS AND RECOMMENDATIONS

Based on the results of the study, it can be concluded that the use of a digital ecosystem based on the combination of Wordwall and Kahoot is significantly more effective in improving the literacy-numeracy competence of elementary school students than conventional learning. The improvement in learning outcomes in the experimental group was higher than in the control group, and was supported by the results of statistical tests that showed significant differences. In addition, this digital-based learning has also been proven to be able to increase student involvement in cognitive, emotional, and behavioral

aspects. Other findings suggest a strong positive relationship between student engagement and learning outcomes, so engagement plays an important role as a factor influencing learning success.

Conceptually, this effectiveness shows that the integration of Wordwall and Kahoot produces a synergistic effect, where the two complement each other in supporting the learning process—Wordwall as a medium for practice and reinforcement of concepts, and Kahoot as a means of interactive evaluation that increases student motivation and participation. Therefore, teachers are advised to utilize these two platforms in an integrated manner in learning, with systematic planning and oriented to understanding concepts, not just game activities. Schools also need to provide support in the form of technology facilities, internet access, and training for teachers so that the implementation of digital learning can run optimally and sustainably.

Furthermore, for the next researcher, it is recommended to develop a research with a wider scope, both in terms of sample size and context variation, as well as examine the long-term effectiveness of the use of digital media on learning outcomes. Follow-up research can also explore the role of student engagement as a mediating variable in more depth, as well as compare the use of platforms separately and in combination to reinforce findings about synergistic effects. Thus, the results of this research not only make a practical contribution to classroom learning, but also become the basis for the development of more innovative and evidence-based digital learning models.

ADVANCED RESEARCH

Based on the findings of this study, there are opportunities for the development of advanced research that is more complex and contributes to strengthening the theory and practice of digital learning. First, the next research can test a more comprehensive mediation and moderation model by placing student engagement as a mediating variable between the use of the digital ecosystem (Wordwall + Kahoot) and literacy-numeracy learning outcomes. In addition, moderation variables such as intrinsic motivation, self-efficacy, or students' level of digital literacy can also be included to find out what conditions strengthen or weaken the effectiveness of the intervention. This approach can be analyzed using Structural Equation Modeling (SEM) or Partial Least Squares (PLS) so that the relationships between variables can be explained more holistically.

Second, follow-up research needs to examine the long-term effectiveness (longitudinal study) of the use of digital platforms. This research is still limited to short-term measurements (pretest-posttest), so it cannot explain the sustainability of learning impacts. Longitudinal studies with periodic measurements (e.g. 3 months, 6 months, or 1 year) will provide an idea of whether the increase in literacy-numeracy and student engagement is stable, increasing, or decreasing over time. This is important to test whether the effect that appears is a real impact of learning or just a novelty effect.

Third, subsequent research can develop a more robust experimental design through randomized controlled trials (RCTs) or quasi-experiments with stricter controls, as well as expand the number and characteristics of samples. The study can also compare several treatment conditions, such as the use of Wordwall alone, Kahoot alone, a combination of both, and integration with other platforms. With this multi-condition comparative design, researchers can more specifically identify the contributions of each platform and empirically test the presence of synergistic effects in the digital learning ecosystem.

Fourth, it is necessary to explore more deeply the cognitive processes and learning experiences of students through a mixed methods approach. Quantitative data can be combined with interviews, classroom observations, or learning analytics analysis to understand how students interact with the platform, the learning strategies used, and the obstacles they face. This approach will provide a richer understanding of the mechanisms by which technology affects learning, not only in terms of outcomes, but also in terms of process.

Fifth, advanced research can also examine the integration of this digital ecosystem with other learning approaches, such as Problem-Based Learning (PBL), STEM, or Differentiated Instruction, to see if its effectiveness increases when combined with specific pedagogical strategies. In addition, the development of an adaptive learning-based learning model that adjusts the difficulty level of the questions to students' abilities is also a potential research direction in the digital education era.

Overall, this advanced research agenda is expected not only to strengthen the validity of the findings, but also to produce a more comprehensive, adaptive, and evidence-based digital learning model in improving students' literacy-numeracy. With a more multidimensional approach and a stronger methodology, future research can make a more significant contribution to the development of educational science, particularly in the integration of technology and learning in primary schools.

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