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The Role of Collaborative Wiki and KWL Framework in Advancing Cognitive Development and Learning Motivation in Elementary Schools

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Abstrak
The integration of technology in elementary education is vital to support students' cognitive development and motivation. Despite its potential, effective synergy between collaborative digital tools and reflective learning strategies remains underexplored in classroom practice. This study investigates the effects of integrating collaborative wikis and the Know–Want–Learn (KWL) framework on cognitive development and learning motivation among fifth-grade students in Jember, Indonesia. Using a quasi-experimental design with a mixed-method approach, the study involved 120 students assigned to experimental and control groups. Data were collected via pre- and post-tests, motivation questionnaires based on the ARCS model, classroom observations, and interviews. ANCOVA results revealed a significant increase in cognitive scores in the experimental group ($F(1,117) = 28.59$, $p < 0.001$), with motivational improvements noted across all four ARCS components. These findings demonstrate that the integration of wikis and KWL promotes reflective, collaborative, and engaging learning. The study contributes to the development of context-sensitive pedagogical models, particularly valuable for under-resourced primary education settings.
Keywords: KWL Strategy, Cognitive Development, Learning Motivation, Elementary Education, Collaborative Wiki

INTRODUCTION

The transformation of education in the 21st century encourages a paradigm shift from content-oriented learning to competency-based learning that emphasizes cognitive development, motivation, and high-level thinking skills. Basic education as a foundation for long-term development plays a central role in fostering critical thinking skills and intrinsic learning motivation that are prerequisites for academic success at further levels ((Adiputra & Heryadi, 2021). In this context, innovative learning strategies that integrate constructivist approaches with digital technologies are becoming increasingly important to encourage student engagement in active, collaborative and meaningful learning processes (UNESCO, 2022).

Collaborative wikis as web-based digital media have been widely used in education to facilitate collaborative writing activities, idea exchange, and project-based collaboration. This platform allows students to contribute to building knowledge openly and reflectively, which in turn has a positive impact on cognitive development and social skills (Kuo et al., 2022). In studies in elementary education, wikis have been shown to increase active participation, students' sense of responsibility for the learning process, and facilitate the creative expression of ideas. (Farhan et al., 2024; Hasanah et al., 2022). However, this media will be more effective if supported by a systematic learning strategy, one of which is the KWL (Know–Want to Know–Learned) strategy, which stimulates the activation of prior knowledge, learning motivation, and metacognitive reflection. (Fitriana et al., 2021).

The KWL strategy has been widely adopted in learning to improve students' conceptual understanding and critical thinking skills, especially in elementary education. KWL allows students to develop a more focused thinking framework through independent exploration and group discussion. Research by (Erawan, 2023) shows that the implementation of KWL strategy in English subject can significantly improve learning outcomes and student engagement. However, in practice, most of the implementation of KWL is still done conventionally through printed media or oral discussions, without the integration of digital technology that can expand the space for collaboration and learning documentation.

A significant gap found in the current literature is the limited number of studies that integrate collaborative wikis and KWL strategies as a single pedagogical approach at the elementary school level. Most studies separate the study of learning technology and cognitive strategies separately. Wikis are mostly studied in the context of secondary or higher education. (Erawan, 2023), while the KWL strategy is still used analogously and has not been optimally combined with digital platforms to support documented and collaborative reflective learning. This gap is important to fill because the integration of the two approaches has great potential in fostering deeper conceptual understanding while increasing learning motivation at the elementary level.(Sari et al., 2023)

Elementary education is an important foundation in building cognitive abilities and learning motivation of students, which will determine their success at the next level of education. In the era of globalization and advances in information technology, the need for innovative and adaptive learning strategies is increasingly urgent. One approach that has received attention is the integration of wiki-based collaborative learning and the Know-Want-Learn (KWL) framework, which is believed to be able to accommodate the needs of cognitive development while increasing the learning motivation of elementary school students.(Maharani et al., 2023)

Previous research status generally supports the use of wikis and KWL strategies separately. For example, research (Ulumi et al., 2023) confirms the effectiveness of digital media in improving the quality of learning in elementary schools, while (Nugraha, 2024) emphasizes the importance of reflective strategies in building students' knowledge. However, there are not many studies that explicitly build synergy between the two and analyze their impact simultaneously on two important variables: cognitive development and learning motivation. Thus, the position of this study is to expand the contribution of previous studies with an integrative and contextual approach..

The novelty of this study lies in the integrative design between collaborative wiki as a digital media and KWL strategy as a reflective pedagogical framework in the context of elementary school thematic learning. This integration not only targets learning outcomes, but also focuses on the dynamics of students' thinking processes, discussions, and reflections that can be traced digitally. This approach supports the principle of social constructivism, where students construct meaning through social interaction and meaningful use of technology (Jonassen, 1999; Siemens, 2005). Therefore, this study not only contributes to the development of technology-based learning theory, but also offers a practical model for teachers in designing learning that is relevant to the digital era..

The purpose of this study is to investigate the role of collaborative wiki integration and KWL strategies in advancing the cognitive development and learning motivation of elementary school students. This study examines how the two approaches are implemented in classroom practice, and to what extent they impact students' learning engagement, reflection quality, and cognitive achievement. This study is expected to provide empirical contributions to the development of collaborative, reflective, and technology-based learning practices, while enriching academic discourse on contextual and applicable digital learning strategies at the elementary level.

METHODS

This study used a quantitative approach with a quasi-experimental design of the non-equivalent control group design, which is considered appropriate for testing the effectiveness of an intervention in field conditions that do not allow for full randomization (Fraenkel et al., 2019). This design was chosen because it provides flexibility in grouping students based on the natural conditions of the class without manipulating the random distribution, but still allows for comparison between the treatment and control groups. The study was conducted in one of the public elementary schools in Jember Regency, East Java, with a duration of three months, starting from early February to the end of April 2025. The intervention in the form of thematic learning with the integration of collaborative wiki and KWL

strategies was carried out in the experimental group, while the control group received conventional learning.

The population in this study were all fifth grade students from the school, with a sample of 120 students divided into two parallel classes, each with 60 students for the experimental and control groups. The purposive sampling technique was used to determine classes that had homogeneous characteristics in terms of age, basic academic achievement, and previous technology-based learning experiences. The researcher was directly involved in every stage of the learning implementation as an active observer, assisted by two class teachers who functioned as key informants, as well as one assistant teacher who had received training in the use of wikis and the KWL framework. Data collection activities were carried out while still paying attention to research ethics, including approval from the school and parents of students..

Data collection was carried out using three main techniques: (1) cognitive tests based on HOTS (Higher-Order Thinking Skills) questions which were developed and validated based on the national curriculum, (2) learning motivation questionnaires using a Likert scale which had been modified from the ARCS motivation instrument. (Budiyono, 2016), and (3) participant observation to capture the dynamics of wiki and KWL use in the student learning process. In addition, semi-structured interviews were conducted with class teachers and students as a triangulation of qualitative data to strengthen the interpretation of the intervention results. The instrument was tested first to ensure content validity and internal reliability using item-total correlation techniques and Cronbach's alpha coefficient. (Sugiyono, 2014).

The data obtained were analyzed using inferential statistics, especially ANCOVA (Analysis of Covariance), to test the difference in post-test scores between the experimental and control groups by controlling the pre-test variables, using the latest version of SPSS software. Motivation data were analyzed through descriptive statistics and independent t-test differences. For qualitative data from interviews and observations, thematic analysis was carried out by referring to (Sarmanu, 2017), which includes the stages: data familiarization, initial coding, theme search, theme review, and narrative interpretation. The validity of the findings is strengthened through method triangulation, peer debriefing, and member checking, to ensure the credibility and validity of the research results. (Creswell, 2014). With this procedure, this research is expected to produce a strong and scientifically accountable interpretation.

RESULTS AND DISCUSSION

Results

. This study involved 120 fifth grade students from an elementary school in Jember Regency, who were divided into two groups: 60 students in the experimental group who received collaborative wiki-based learning and KWL strategies, and 60 students in the control group who received conventional learning. The demographic characteristics of the participants were relatively homogeneous, with an age range of 10–11 years, and there were no significant differences in the pre-test scores of cognitive abilities or initial levels of learning motivation.

1. Cognitive Development Test Results

Analysis of cognitive ability tests was conducted through pre-test and post-test using HOTS-based questions. The following is the average score obtained by both groups.:

Table 1 Analysis of cognitive ability tests

Group	Pre-test Score (Mean ± SD)	Pre-test Score (Mean ± SD)	Δ (Gain)
Experiment	58.23 ± 7.41	82.67 ± 6.89	**+24.44**
Control	57.90 ± 7.55	69.02 ± 8.12	+11.12

Table 1 presents a comparative analysis of cognitive ability test scores between the experimental and control groups before and after the intervention. The experimental group showed a marked improvement, with pre-test scores averaging 58.23 (SD ± 7.41) and post-test scores reaching 82.67 (SD ± 6.89), yielding a gain score (Δ) of +24.44. In contrast, the control group exhibited a more

modest increase from a mean pre-test score of 57.90 (SD ± 7.55) to a post-test score of 69.02 (SD ± 8.12), with a gain score of +11.12. These results indicate that both groups experienced cognitive gains over time; however, the magnitude of improvement in the experimental group was significantly higher.

This substantial gain in the experimental group suggests the effectiveness of the intervention administered, likely attributed to its alignment with cognitive engagement principles and active learning strategies. The relatively smaller gain observed in the control group could be reflective of conventional instructional methods that may not adequately stimulate higher-order thinking processes. The data support the hypothesis that the intervention introduced in the experimental group not only enhanced cognitive performance but also provided a more structured and impactful learning experience, as evidenced by the lower standard deviation in post-test scores, indicating more consistent learning outcomes among participants.

Table 2. Results of Analysis on Post-test Scores of Students' Cognitive Abilities

Source of Variation	df	Mean Square	F	Sig. (p)	Information
Pre-test (Covariate)	1	1302.47	42.87	< 0.001	Significant influence of pre-test
Groups	1	869.13	28.59	< 0.001	Significant differences between groups
Error	117	30.40	–	–	–
Total	**120**	–	–	–	–

Table 2 presents the results of an ANCOVA (Analysis of Covariance) conducted to examine the differences in post-test scores of students' cognitive abilities between the experimental and control groups, while statistically controlling for the influence of pre-test scores. The analysis reveals that the covariate, pre-test scores, has a significant effect on the post-test results, as indicated by an F-value of 42.87 and a p-value < 0.001. This finding underscores the importance of considering initial cognitive ability levels when evaluating the effectiveness of an intervention, as these baseline differences can significantly impact learning outcomes.

Furthermore, the effect of group membership (experimental vs. control) on post-test scores was also statistically significant, with an F-value of 28.59 and a p-value < 0.001. This result provides strong evidence of a significant difference in cognitive achievement between the two groups after the intervention, even after adjusting for initial differences in pre-test scores. The relatively low mean square error (30.40) suggests a good model fit and reinforces the robustness of the findings. Overall, these results validate the effectiveness of the intervention in enhancing students' cognitive abilities and highlight the added value of using ANCOVA to control for pre-existing disparities in experimental educational research.

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2. Learning Motivation Questionnaire Results

The learning motivation questionnaire used a Likert scale of 1–5 developed from the ARCS model (Keller, 2010), with a Cronbach's Alpha reliability = 0.87. The average score of students' learning motivation before and after treatment is shown in the following table.:

Table 3 Learning Motivation Questionnaire Results

Motivational Aspects	Group	Pre Score (Mean ± SD)	Post Score (Mean ± SD)	Δ (Gain)
Attention	Eksperimen	3.21 ± 0.54	4.35 ± 0.51	+1.14
Relevance	Eksperimen	3.18 ± 0.48	4.26 ± 0.49	+1.08
Self Confidence	Experiment	3.15 ± 0.56	4.22 ± 0.47	+1.07
Satisfaction	Experiment	3.12 ± 0.50	4.30 ± 0.53	+1.18
Total Score	Experiment	12.66 ± 1.71	17.13 ± 1.82	**+4.47**
Total Score	Kontrol	12.70 ± 1.66	14.02 ± 1.55	+1.32

The data on motivational aspects demonstrate a significant improvement in all four measured dimensions—attention, relevance, self-confidence, and satisfaction—among students in the experimental group following the intervention. Mean scores in attention increased from 3.21 (SD ± 0.54) to 4.35 (SD ± 0.51), while relevance rose from 3.18 to 4.26 (Δ = +1.08), self-confidence from 3.15 to 4.22 (Δ = +1.07), and satisfaction from 3.12 to 4.30 (Δ = +1.18). These gains collectively resulted in a total motivation score increase of +4.47, from a pre-score of 12.66 (SD ± 1.71) to a post-score of 17.13 (SD ± 1.82). In contrast, the control group only exhibited a modest gain of +1.32 in total motivation score, suggesting that the instructional intervention applied in the experimental group had a pronounced and positive effect on student motivation across multiple dimensions.

These findings suggest that the intervention not only supported cognitive growth but also enhanced intrinsic motivational factors, which are critical for sustained engagement and deep learning. The consistent gains across all subscales indicate a holistic improvement in students' learning disposition, aligning with the ARCS motivation model (Attention, Relevance, Confidence, Satisfaction). The ability of the intervention to meaningfully increase students' perceived relevance and satisfaction implies that the learning experiences were personally meaningful and emotionally rewarding. As motivation is a strong predictor of academic persistence and achievement, these results provide compelling evidence of the intervention's broader pedagogical value in promoting both affective and cognitive learning outcomes.

4. Interview Results and Documents

The interviews with class teachers highlighted that the use of wikis enabled greater student expression, especially in articulating ideas and co-constructing project content. These observations align with Vygotsky's (1978) socio-constructivist theory, wherein tools like wikis mediate collaborative meaning-making. Teachers reported enhanced engagement, with students more actively participating in digital discussions, providing peer feedback, and demonstrating increased confidence in expressing ideas — a shift also evidenced in the increased structural and content depth observed in students' wiki contributions.

The motivational effect was further reinforced through the KWL framework. Observation data indicated that the "Want to Know" phase fostered curiosity and guided inquiry, supporting the activation of prior knowledge and self-regulated learning. This is consistent with Keller's ARCS model, particularly in stimulating "Attention" and "Relevance." The qualitative findings corroborate the quantitative gains in student cognitive and motivational outcomes, suggesting that the integration of collaborative digital platforms with reflective frameworks can produce pedagogically meaningful shifts in learner behavior and performance

Interview Results (Teachers' Perspectives)

Table 4 The qualitative data gathered through semi-structured interviews with classroom teachers highlighted several key findings regarding the implementation of collaborative wikis and the KWL framework:

Theme	Verbatim/Quotation	Interpretation
Increased Student Participation	"Students were more active in discussions and often initiated conversations with peers about the topic."	The collaborative nature of the wiki platform encouraged students to engage in peer interaction and group dialogue.
Enhanced Peer Response Culture	"They started responding to their friends' writings and providing feedback, even those who used to be shy."	This indicates improved peer feedback literacy and social engagement among students.
Confidence in Digital Expression	"Some students who were usually quiet became braver in expressing their ideas in the digital forums."	The digital environment provided a safe space for less confident students to contribute.

Discussion :

This study successfully answered the problem formulation regarding whether the integration of collaborative wiki and KWL strategy can improve the cognitive development and learning motivation of elementary school students. The findings from ANCOVA showed that the experimental group had a significant increase in post-test scores compared to the control group ($F(1,117)=28.59$, $p<0.001$), while the analysis of learning motivation confirmed a significant increase in the scale in the experimental group. These results clearly answer the first research question, namely: "Does the intervention improve cognition and motivation?" - the answer is yes, the intervention is proven to be effective.

Furthermore, the process of obtaining these findings is based on a quasi-experimental method involving pre- and post-tests, motivation questionnaires, and observations and interviews. Data were tested using ANCOVA and t-tests, supported by qualitative findings in the form of narrative responses from teachers and documentation of student activities. This combination of quantitative and qualitative methods strengthens the reliability of the findings, and confirms that changes in learning outcomes are not merely coincidental, but a direct result of integrated pedagogical interventions..

Interpretation of cognitive data shows that collaborative wikis encourage students' analytical and synthetic thinking. This is in line with social constructivism theory. (Langford, 2005), which emphasizes the need for social interaction and reflection in knowledge building. Interaction in wikis facilitates thought dialogue and argumentation, while KWL strategies structure the cognitive process from beginning to final reflection. Study by Liu et al. (2022) also noted that digital integration and similar metacognition were able to improve HOTS scores in elementary school students, in line with the results of this study..

In terms of motivation, the increase in openness in terms of attention and learning satisfaction illustrates that wiki-KWL creates a stimulating and curious learning environment. This finding supports the ARCS theory. (Song & Kao, 2023) and reinforced by the results of a meta-analysis which found that interactive technology can strengthen students' intrinsic motivation. (Li et al., 2024). Thus, providing a digital discussion space through a wiki, guided by the KWL framework, triggers students' ongoing emotional and motivational engagement..

This discussion further relates the findings to the identified literature gap. Previously, most studies have discussed wiki or KWL separately. This study fills the methodological gap of the literature review, namely the integration of both components in one pedagogical model. The findings show that the synergy between collaborative technology and reflective cognitive strategies is not only powerful in improving individual aspects (cognition or motivation), but also strengthens classroom interactions collectively, contributing to the research gap raised..

Theoretically, this study offers modifications to the constructivism and ARCS theories. On the one hand, wiki-KWL reaffirms that meaningful learning requires reflective and dialogical structures, as (Alam, 2023) On the other hand, it adds a new dimension to learning motivation by including the digital collaboration factor as an intrinsic motivational variable — suggesting that digital learning environments can trigger more durable and contextual motivation..

The practical benefits of this study are very relevant. Teachers can apply wiki-KWL as a thematic learning strategy to improve conceptual understanding, high-level thinking skills, and students' enthusiasm for learning. Policy makers can also use this model as a reference in digital competency-oriented curricula. This implication is in line with the need for digital literacy mandated by UNESCO (2023) in basic education. Finally, this study forms a foundation for the development of a theory of digital technology-based learning and reflection. It was found that wiki-KWL is not just a learning medium but a pedagogical ecosystem that integrates reflection, collaboration, and documentation of the thinking process digitally. Further research needs to expand this model to other subjects, longer duration, and analysis of long-term impacts on students' affective-social aspects..

Collaborative wiki implementations have been shown to theoretically support the computer-supported collaborative learning (CSCL) model, which emphasizes social interaction as the basis for knowledge construction. (Stafford et al., 2014) Findings from teacher interviews—such as “Students were more active in discussions and often initiated conversations with peers about the topic”—reinforce these psycho-social impacts. According to Hsu (2019), collaborative dialogues that emerge in wiki platforms increase student participation and engagement, which in turn leads to improvements in writing quality and critical thinking skills.(Liu et al., 2022) This is in line with the interpretation of the theme “Increased

Student Participation", showing that wikis are not just collaborative writing tools, but also facilitative media for peer-to-peer interaction in elementary classes..

In line with Demirbilek's research (2015), The use of wikis as a peer feedback platform supports the development of a more mature peer response culture. The teacher's quote "They started responding to their friends' writings and providing feedback, even those who used to be shy" reflects an increase in students' feedback literacy. This is consistent with the results of peer feedback studies that "peer feedback effectively compliments teacher feedback for quality writing". Interpretation of the table shows that wikis open up social access for shy students to provide input, an important aspect in building academic literacy and reflective responsibility. The use of wikis is also seen as a 'safe space' for students who lack verbal confidence, as shown in the quote "Some students who were usually quiet became braver in expressing their ideas in the digital forums." Wheeleer et al.'s (2009) study shows that wikis give students a sense of "permission" to experiment with ideas as a writer's identity without the direct pressure of a physical public. The interpretation of the theme "Confidence in Digital Expression" is in line with the idea that digital environments can reduce student anxiety and encourage active engagement, especially in shy elementary school age groups.

Overall, these qualitative findings reinforce the theoretical construct of CSCL and peer feedback practices in modern educational literature. Wiki as a digital platform is not just a collaboration tool, but also a catalyst for increased participation, a culture of peer response, and bolder expression of ideas. This suggests that the integration of wiki and metacognitive strategies such as KWL (although the focus in this table is on the wiki aspect) has the potential to create a holistic, supportive, and meaningful learning environment at the elementary school level..

CONCLUSION

This study has shown that the integration of collaborative wiki and KWL strategy significantly contributes to improving the cognitive development and learning motivation of elementary school students. Quantitative data analyzed through ANCOVA indicated that the experimental group experienced a higher increase in learning outcomes than the control group after being controlled by the pre-test score. In addition, the questionnaire results showed an increase in all aspects of learning motivation, especially attention and satisfaction. These results confirm the effectiveness of the approach that combines collaborative digital media and reflective strategies in elementary-level contextual learning. Theoretically, these findings strengthen the framework of social constructivism (Amna Saleem et al., 2021; Mayer, 2004) and connectivism (Alam, 2023), where the learning process is not only rooted in individual experiences but is also influenced by social interactions facilitated by technology. The KWL strategy guides students to activate prior knowledge and build understanding through reflection, while the collaborative wiki provides a dialogue space that strengthens the construction of shared meaning. The synergy of both creates a learning environment that stimulates high-level thinking processes as well as students' emotional and motivational involvement.(Sulistyawati et al., 2024).

Furthermore, the results of this study not only fill the methodological gap in previous studies that tend to separate the use of technology and cognitive strategies, but also contribute to the development of digital learning models that are relevant to the demands of 21st century learning. Therefore, the proposed wiki-KWL model can be a strategic alternative in designing collaborative, reflective, and sustainable learning at the elementary education level, especially in contexts that experience limited resources but want to optimize the potential of simple technology.

Recommendations

Based on these findings, it is recommended that elementary school teachers begin to adopt an integrative approach between collaborative digital platforms such as wikis and reflective learning frameworks such as KWL in their teaching practices. To ensure effective implementation, teacher training needs to focus on developing skills in designing purposeful wiki activities and guiding students in developing systematic thinking frameworks. In addition, schools can develop micro-technology-based policies that enable simple yet strategic use of digital platforms in elementary classrooms.

Further research is recommended to expand the scope of learning topics and age levels, and to test the long-term impact on other dimensions such as social collaboration and digital skills. In addition, modifications to the wiki-KWL model based on locality and student learning culture can be a focus of

exploration to create a more contextual and sustainable learning approach. Thus, this model can contribute more broadly to technology-based pedagogical transformation in the basic education system, both at the national and global levels..

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