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Enhancing Elementary School Students' Creative Thinking and Engagement through the ARIAS Learning Model Assisted by Wordwall

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ABSTRACT

This study examined the effectiveness of the ARIAS learning model (Assurance, Relevance, Interest, Assessment, and Satisfaction) assisted by Wordwall in improving elementary students' creative thinking and engagement in mathematics learning, particularly on equivalent fractions. The study employed a quantitative quasi-experimental design with a nonequivalent control group. The participants consisted of 42 fourth-grade students from two public elementary schools in the Diponegoro cluster, Sumbang District, Banyumas Regency, with 21 students in the experimental class and 21 students in the control class. Data were collected through essay tests, observation sheets, and student engagement questionnaires. The results showed that students taught using the ARIAS model assisted by Wordwall achieved higher creative thinking scores ($M = 86.48$, $SD = 8.02$) than students in the control class ($M = 74.00$, $SD = 5.33$), with a significant difference ($p < .001$). Student engagement was also significantly higher in the experimental class ($M = 88.57$, $SD = 5.86$) compared to the control class ($M = 69.81$, $SD = 5.89$). These findings indicate that the ARIAS learning model assisted by Wordwall effectively enhances both creative thinking and student engagement in elementary mathematics learning.

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SUBJECT

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1. Introduction

Current mathematics education expects students not only to master procedures but also to reason, communicate, and generate ideas flexibly. In elementary classrooms, these expectations are closely related to the broader 21st-century agenda that emphasizes creativity, problem solving, collaboration, and meaningful participation in learning [1]. Yet mathematics instruction in many schools still remains teacher-directed and procedural, which can narrow students' opportunities to explore alternative strategies and limit their active participation in class. Research on school engagement and active learning consistently shows that students learn more deeply when they are behaviorally, emotionally, and cognitively involved in classroom activity [2].

In the thesis on which this article is based, similar conditions were identified among fourth-grade students in the Diponegoro cluster, Sumbang District, Banyumas Regency. On the topic of equivalent fractions, students tended to rely on routine procedures, had difficulty producing varied or original responses, and were not consistently engaged during learning activities. This issue matters because creative thinking helps learners produce multiple strategies, elaborate ideas, and evaluate their own reasoning in mathematics, while student engagement reflects the extent to which learners pay attention, participate, collaborate, persist, and value the learning task.

To address this problem, this study focuses on the ARIAS learning model assisted by Wordwall. ARIAS emphasizes assurance, relevance, interest, assessment, and satisfaction. [3]. As an instructional framework, it is intended to strengthen students' confidence, connect content with lived experience, sustain attention, provide formative feedback, and build a sense of accomplishment. Wordwall, meanwhile, offers game-like interactive activities that may make mathematical practice and feedback more immediate, concrete, and engaging. This combination is pedagogically relevant because equivalent fractions require conceptual understanding, visual representation, and repeated comparison tasks that benefit from interactive and contextual learning experiences [4].

The present study contributes to the literature in three ways. First, previous classroom studies have often examined either ARIAS or Wordwall separately, or they have concentrated on a single outcome such as achievement, motivation, or conceptual understanding. Second, studies of technology-supported engagement frequently focus on secondary or higher education, whereas evidence from elementary mathematics remains more limited. Third, relatively few studies have investigated creative thinking and engagement together, even though cognitive and affective processes are intertwined during mathematics learning. Accordingly, this article asks: (1) Does the ARIAS learning model assisted by Wordwall affect elementary students' creative thinking? (2) Does it affect student engagement? and What is the relationship between creative thinking and student engagement within the experimental class?

The theoretical basis of this study is social constructivism. From a Vygotskian perspective, learning develops through social interaction, scaffolding, and meaning-making within culturally mediated activities [5], [6]. In mathematics classrooms, this implies that students benefit when concepts are discussed, represented, compared, and connected to familiar situations. Equivalent fractions, for example, are better understood when students manipulate representations, explain why two fractions are equal, and compare multiple solution paths. Thus, learning environments that combine discussion, concrete tasks, and interactive tools can support both understanding and participation [7].

The ARIAS model can be interpreted as a motivationally oriented classroom design. Assurance encourages students to believe that they can participate and succeed. Relevance links mathematical ideas to everyday contexts so that tasks feel meaningful. Interest keeps attention focused through variation, challenge, and curiosity. Assessment provides opportunities for checking understanding and receiving feedback. Satisfaction reinforces learning through recognition, accomplishment, and reflection. Although ARIAS is an adaptation widely used in Indonesian classroom practice, its logic aligns closely with broader motivation and engagement theories, particularly work on confidence, relevance, active learning, and feedback. The ARIAS model represent a motivational instruktional desin derived from ARCS model [8]

Wordwall strengthens the operational side of this model. As a digital learning tool, it provides quiz-based and game-like activities that can be used for review, practice, formative assessment, and collaborative discussion. Educational technology and gamification research suggests that digital tools can improve participation and motivation when they are aligned with pedagogy rather than used as isolated add-ons [9]. In this study, Wordwall was therefore positioned not as an independent intervention, but as a medium that particularly supported the interest and assessment components of ARIAS.

Creative thinking in mathematics refers to the capacity to generate multiple responses, approach problems from different perspectives, produce original ideas, elaborate strategies, and evaluate the reasonableness of solutions [10], [11]. Student engagement, meanwhile, is multidimensional and includes behavioral participation, emotional involvement, cognitive investment, and in many recent frameworks, social or agentic participation [12]. These constructs are theoretically related: classrooms that support attention, autonomy, and interaction may create conditions in which students are more willing to test ideas, revise their reasoning, and persist in challenging tasks. At the same time, the relationship is not always linear, especially when different instruments capture performance and engagement in different ways [13]. This is why the present study treats the correlation analysis as exploratory rather than definitive.

2. Methodology

This study employed a quantitative approach using a quasi-experimental nonequivalent control group design. The experimental class received instruction through the ARIAS learning model assisted by Wordwall, whereas the control class was taught using conventional media-supported instruction. Pretest and posttest scores were administered to measure students' learning outcomes after the intervention. The participants consisted of 42 fourth-grade students from two public elementary schools in the Diponegoro Cluster, Sumbang District, Banyumas Regency. The experimental class included 21 students from SD Negeri Silado, while the control class consisted of 21 students from SD Negeri Karanggayam. Participants were selected using cluster purposive sampling based on school readiness, feasibility, and the comparability of the participating classes. Since the classes were drawn from different schools, the study did not randomly assign participants; therefore, causal interpretations should be made cautiously. Data were collected using three instruments. First, an essay test was administered to assess students' creative thinking skills, including fluency, flexibility, originality, elaboration, and evaluation. Second, classroom observations were conducted to evaluate student engagement, including attention, active participation, collaboration, discipline, and learning motivation. Third, documentation was used to support implementation records. Prior to data collection, all instruments were reviewed and validated by experts. Data analysis included descriptive statistics, normality and homogeneity tests, and independent-samples *t*-tests. In the revised article, the independent-samples *t*-test was identified as the primary inferential analysis for comparing posttest scores between groups. Regression and correlation analyses reported in the original thesis were retained only as supplementary evidence and interpreted with caution.

3. Results and Discussion

3.1 Results

Both classes started from broadly comparable levels of creative thinking. The mean pretest score was 65.19 in the experimental class and 65.56 in the control class. After the intervention, the experimental class reached a posttest mean of 86.48, whereas the control class reached 74.00. The posttest standard deviation was 8.023 in the experimental class and 5.328 in the control class, indicating some dispersion in both groups but a clearly higher average in the class taught with ARIAS assisted by Wordwall.

Table 1. Descriptive Statistics of Creative Thinking.

Group	Pretest Mean	Posttest Mean	Posttest SD	Posttest Range
Experimental	65.19	86.48	8.023	75-100
Control	65.56	74.00	5.328	65-84

Student engagement showed an even larger descriptive gap. The experimental class obtained a mean engagement score of 88.57 (SD = 5.861), while the control class obtained 69.81 (SD = 5.890). The minimum and maximum scores further indicate that the experimental class showed consistently strong involvement across students.

Table 2. Descriptive Statistics of Student Engagement.

Group	Mean	SD	Minimum	Maximum
Experimental	88.57	5.861	80	100
Control	69.81	5.890	60	78

The prerequisite tests reported in the thesis indicated that the data met the assumptions for parametric analysis. For homogeneity, the significance value for creative-thinking posttest scores was .052 and for student engagement was .866. The independent-samples t-test then showed statistically significant differences between the experimental and control groups for both outcomes ($p < .001$ for creative thinking and $p < .001$ for student engagement). To strengthen interpretation of practical importance, effect sizes were calculated from the thesis descriptive statistics. The effect was large for creative thinking (Cohen's $d = 1.83$) and very large for student engagement (Cohen's $d = 3.19$).

The thesis also reported supplementary regression analyses showing significant positive coefficients for creative thinking ($b = 0.411$, $p = .003$) and student engagement ($b = 0.546$, $p = .001$). Because the main research design is quasi-experimental with group comparison, these regression findings are treated here as supporting rather than primary evidence.

Within the experimental class, Pearson correlation analysis indicated a statistically significant moderate negative correlation between creative-thinking and engagement scores ($r = -.515$, $p = .017$). This result means that higher observed engagement was not accompanied by proportionally higher test scores for all students in that class. The pattern should therefore be interpreted as an empirical association within this small sample, not as evidence that engagement is detrimental to creative thinking.

3.2 Discussion

The first major finding is that students who learned through ARIAS assisted by Wordwall achieved higher creative-thinking scores than students in the comparison class. This result is consistent with scholarship suggesting that mathematical creativity grows when learners are encouraged to explore multiple strategies, connect ideas to meaningful contexts, and engage with tasks that are open enough to invite explanation and variation [14]. In the present study, the assurance and relevance phases likely helped students enter the lesson with more confidence and clearer purpose, while interactive Wordwall activities made fraction tasks more accessible and less monotonous. These conditions plausibly supported fluency, flexibility, and elaboration in problem solving.

The second major finding is the strong difference in student engagement. This aligns with a substantial body of research showing that educational technology can promote participation when it is integrated into clear pedagogical structures and not treated merely as entertainment. In ARIAS, Wordwall was embedded within instruction as a tool for practice, checking understanding, and sustaining curiosity. Such use may explain why engagement increased not only in terms of attention but also in participation, collaboration, and motivation. The very large effect size should still be viewed carefully, however, because engagement was measured through observation and classroom dynamics may differ across schools and teachers.

The third finding the significant negative correlation between creative thinking and engagement inside the experimental class deserves careful interpretation. Reviewer comments appropriately noted that this result is counterintuitive. Several explanations are plausible. First, the two variables were measured differently: creative thinking came from a written essay test, whereas engagement came from observation during learning. Students who were visibly active and enthusiastic may not always have translated that participation into the highest written test scores. Second, with only 21 students, a few contrasting cases can influence the correlation coefficient substantially. Third, the intervention may have supported both outcomes at the group level while still producing uneven individual trajectories. For these reasons, the correlation should not be interpreted as disproving the value of engagement; instead, it signals the need for larger studies using aligned and repeated measures.

More broadly, the revised findings support the view that cognitive and affective dimensions of mathematics learning should be addressed together. On equivalent fractions, students need opportunities to manipulate ideas, compare representations, and justify why different forms can express the same quantity. They also need a classroom climate that makes them willing to participate, make mistakes, and try again. ARIAS assisted by Wordwall appears promising because it combines motivational design with interactive practice. This study therefore extends prior work by showing that the combination can be useful not only for achievement or motivation alone, but also for creative thinking and classroom engagement in elementary mathematics.

Even so, the study has important limitations. The sample was small, the groups were not randomized, and the classes were drawn from different schools. Instrument validation in the thesis was described as expert review, but reliability details were limited in the article draft. In addition, the study focused on one topic—equivalent fractions—so generalization to other mathematics content should be made with caution. Future research would benefit from larger samples, stronger controls for school-level differences, clearer psychometric reporting, and repeated measures that capture both performance and engagement across time.

The findings of this study provide strong evidence that the ARIAS learning model assisted by Wordwall significantly enhances students' creative thinking. This result aligns with previous studies emphasizing that creativity develops through active engagement, exploration, and meaningful problem-solving environments [15], [16], [17], [18], [19]. The integration of assurance and relevance in ARIAS likely contributed to students' confidence and contextual understanding, which are essential for generating diverse ideas.

Another important issue supporting this finding is the role of interactive media in reducing cognitive barriers. Wordwall transforms abstract fraction concepts into visual and engaging tasks, allowing students to experiment with ideas more freely. This supports constructivist learning theory, where knowledge is actively built through interaction [20], [21], [22].

Furthermore, the significant increase in student engagement confirms that combining pedagogical structure with technology is more effective than using technology alone. Previous studies highlight that engagement improves when students are emotionally and cognitively involved in meaningful tasks [23], [24], [25]. In this study, Wordwall was not used as an isolated tool but embedded within ARIAS phases, particularly in interest and assessment stages.

The very large effect size observed in engagement suggests that gamification played a substantial role. However, this finding should be interpreted cautiously. Engagement was measured through observation, which may be influenced by classroom context, teacher interaction, and student dynamics [26], [27].

An additional important issue is the alignment between instructional design and student characteristics. Elementary students tend to respond positively to interactive and game-based learning environments. Therefore, the success of this intervention may also be influenced by developmental factors, where students are naturally inclined toward playful learning experiences [28], [29]

From a broader perspective, this study highlights the importance of integrating cognitive and affective dimensions in mathematics learning. Effective instruction should not only improve test performance but also foster engagement and motivation [30], [31], [32]

Finally, this study contributes to the literature by demonstrating that combining a motivational model (ARIAS) with interactive technology (Wordwall) can produce meaningful improvements in elementary mathematics learning. However, future research should involve larger samples, longitudinal designs, and more robust measurement tools to strengthen generalizability.

4. Conclusion

This revised article suggests that the ARIAS learning model assisted by Wordwall is a promising approach for elementary mathematics learning. Compared with the control class, the experimental class obtained substantially higher scores in creative thinking and student engagement, with statistically significant group differences and large practical effects. These findings are consistent with the view that learning environments combining confidence building, contextualization, attention support, formative assessment, and interactive media can strengthen both the cognitive and affective dimensions of learning.

At the same time, the study should not be read as proving universal effectiveness. Because the design was quasi-experimental and involved a small sample from two different schools, the findings are better understood as strong supportive evidence rather than definitive causal proof. The significant negative correlation between creative thinking and engagement in the experimental class also indicates that the relationship between these constructs is more complex than a simple positive linear pattern. Theoretically, the study contributes to mathematics education research by showing how a motivation-oriented model and a digital interactive medium can be combined within fraction learning. Practically, it offers teachers a structured and adaptable alternative for designing lessons that are more active, meaningful, and enjoyable.

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