The Influence of Initial Ability and Critical Thinking on Science Learning Outcomes through RADEC-Based Comic Media

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Abstract: This study aims to analyze the influence of initial abilities and critical thinking on learning outcomes through RADEC-based comic media for fourth grade elementary school students. The focus of the study was to determine the extent to which initial abilities and critical thinking affect student learning outcomes. The research method used was quasi-experimental with a pretest-posttest control group design. The research sample consisted of two classes, namely the experimental class using RADEC-based comic media and the control class using conventional learning methods. The research instruments included initial ability tests, critical thinking tests, and learning outcome tests. Data were analyzed using the Two-Way ANOVA statistical technique to test the effect of initial abilities and critical thinking on learning outcomes, and the Independent Samples T-Test to compare differences in learning outcomes between the experimental and control classes. The results showed that: students' initial abilities had a significant effect on learning outcomes through RADEC-based comic media; critical thinking had a significant effect on learning outcomes; the interaction between initial abilities and critical thinking did not have a significant effect on learning outcomes. The practical implications of this study are the importance of considering students' initial abilities and critical thinking in designing learning strategies, as well as the use of RADEC-based comic media as an effective learning alternative in Elementary Schools.

Keywords: Critical thinking; Early childhood skills; Elementary school; Learning outcomes; RADEC

Introduction

The Independent Curriculum emphasizes learning that not only focuses on knowledge transfer, but also the development of complete competencies that include cognitive, affective, and psychomotor aspects. In this context, the subject of science and natural sciences is key in building students' understanding of natural and social phenomena in a contextual and meaningful way. Unfortunately, national assessments show that elementary school students' science learning achievement is still low, with only around 37% of upper-grade students being able to answer questions in the intermediate reasoning category (Jegstad, 2024); (Schlatter et al., 2022). This low achievement reflects the weak mastery of concepts and the minimal active involvement of students in science and natural sciences learning. The dominant lecture and memorization approaches cause students to be passive and less motivated to think at a high level (Almoslamani, 2022; Bayona & Durán, 2024). One of the factors an important thing to consider in designing learning is identifying students' initial abilities.

The mismatch between the level of difficulty of the material and initial abilities can hinder student engagement and reduce the effectiveness of learning (Istijanto & Nathalie, 2024; Salguero-Pazos & Reyes-de-Cózar, 2023). In addition to initial abilities, strengthening critical thinking is an urgent need in basic education because it is related to 21st century skills. Students who think critically are better able to evaluate information, connect concepts, and make evidence-

based decisions (Calma & Davies, 2025; Sellars et al., 2018). Therefore, a learning approach that supports the development of these abilities is very important so that students not only know, but are also able to think and act logically. Interesting learning media such as comics have been shown to be effective in increasing motivation and understanding of science concepts.

Comics present a combination of text and visuals that help students understand abstract concepts more easily and are appropriate for various levels of early ability (Getie, 2020; Sellars et al., 2018). Research also shows that comics can increase elementary school students' interest in learning and science literacy compared to conventional textbooks (Fitria at al., 2023; Utami et al., 2024). To support the development of critical thinking through visual media such as comics, the RADEC learning approach is relevant. RADEC (Read, Answer, Discuss, Explain, and Create) encourages active involvement and high-level thinking of students through systematic learning stages (Nadia et al., 2023; Oktadila et al., 2025). Research shows that this strategy has a positive impact on elementary school students' science process skills (Fahmi et al., 2024; Solé-Llussà et al., 2022). However, most studies still examine RADEC or comic media separately.

Not many have integrated the two in the context of early ability, critical thinking, and science learning outcomes quantitatively and empirically (Arifin et al., 2025; Lin et al., 2023; Melesse et al., 2025). This gap indicates the need for further research that examines the relationship between these variables in an integrated learning design. Based on initial observations in three elementary schools (SDN 04 Sumpur, SDN 09 Sumpur, and SDN 10 Batu Tebal), it was found that students' initial abilities, critical thinking skills, and social science learning outcomes were still relatively low. The average student scores in the three schools were in the range of 28.8 to 32.2 for initial abilities, around 53 for critical thinking, and 56 to 65 for social science learning outcomes. This fact indicates an urgent need for more contextual, interesting learning that builds active student participation (Li et al., 2023; Mebert et al., 2020).

Therefore, this study aims to examine the influence of initial abilities and critical thinking skills on social science learning outcomes through RADEC-based comic media. This study is expected to provide empirical evidence of the effectiveness of this approach in improving the quality of social science learning in elementary schools. Theoretically, this study enriches the literature on innovative social science learning, and practically, it becomes the basis for adaptive, contextual, and relevant learning strategies to the demands of the 21st century.

Method

The type of research used in this study is quantitative research with the Quasi experiments method where this type of researcher cannot have full control over the assignment of subjects to the experimental and control groups. According to (Miller et al., 2020), the purpose of Quasi Experimental research is to evaluate the effect of a treatment or intervention on research subjects in conditions where randomization is not possible. In its implementation, the researcher used two classes, namely the experimental class by giving treatment using RADEC-based comic media while the control class used conventional media. Random sampling using the 1-stage Cluster Sampling technique. Based on the results of the draw, class IV SDN 09 Sumpur was obtained as the experimental class and class IV SDN 10 Batu Tebal as the control class.

The instrument used in this study used a descriptive test of 15 which was given in the form of a pretest and posttest. The test instruments given to the experimental class and the control class were the same. The data collection technique used was pretest and posttest. The steps taken to collect data are: providing initial ability test questions and pretest essay questions for critical thinking, providing posttest essay questions for critical thinking and essay tests for learning outcomes, conducting a two-way ANOVA test to analyze the effect of interaction between two independent variables, namely Initial Ability and critical thinking, on the dependent variable, namely Learning Outcomes.

Result and Discussion

Data analysis technique for hypothesis testing in this study is by using Two-Way ANOVA with General Linear Model (GLM) Univariate, which is a statistical test method used to analyze the effect of two independent variables (factors) on one dependent variable simultaneously. Decision making in Two-Way ANOVA is based on the significance value (p-value) compared to the significance level (alpha = 0.05). If the significance value <0.05, then there is a significant influence of the factor being tested on the dependent variable, while if the significance value ≥ 0.05, then there is no significant influence. In addition, if the interaction effect between the two factors is significant, it indicates that the combination of these factors affects the dependent variable together (Andersson et al., 2014; Garofalo et al., 2022; Zhu & Li, 2018). The following are the results of the hypothesis test in this study which were calculated using SPSS software version 25 can be seen in the Table 1.

Table 1. Results of Data Hypothesis Testing

Dependent variables Source	Type III sum of Squares	df	Mean sources	F	Sig.
Corrected Model	446.051a	4	1121.51	21.14	0.000
Intercept	1206.786	1	1206.78	245.61	0.000
KA	913.457	1	913.45	14.33	0.002
Bk	53.273	2	296.63	7.12	0.007
KA+BK	86.820	1	88.82	1.63	0.004
Error	191.096	11	53.03		
Total	273.250	35			
Corrected Total	6077.147	34			

R. Squared= .738 (adjusted R. Squared=.703

Furthermore, the Critical Thinking (CBT) variable also showed a significant influence on learning outcomes with an F value of 7.126 and a significance value of 0.007. These results indicate that critical thinking skills play an important role in supporting students' understanding of the science and science material delivered through the RADEC-based approach (Ariesta, 2019). Students who are able to analyze, evaluate, and reflect on information critically are better able to construct knowledge meaningfully, thus having an impact on improving learning outcomes (Kirana et al., 2025; Oktadila et al., 2025). However, the interaction between Initial Ability and Critical Thinking (CA * CBT) did not show a significant influence on learning outcomes, with an F value of 1.637 and a significance value of 0.004 (p <0.05). This indicates that although both variables contribute significantly individually, they do not strengthen or weaken each other's influence on learning outcomes (Ní Bhroin & King, 2020; Panadero & Lipnevich, 2022).

Based on the results of the two way ANOVA test in the study entitled "The Effect of Initial Ability and Critical Thinking on Science Learning Outcomes through RADEC-Based Comic Media for Grade IV Elementary School Students", significant findings were obtained on the influence of each independent variable. First, the Initial Ability (KA) variable shows a significant influence on science learning outcomes with an F value of 14,334 and a value of in other words, the influence of Initial Ability and Critical Thinking is independent and not interactive in the context of this study. Overall, the R squared value of 0.738 indicates that 73.8% of the variation in students' science learning outcomes can be explained by a combination of the variables Initial Ability, Critical Thinking, and their interactions. This indicates that the model used has high predictive power (Hair et al., 2021; Olarte et al., 2025). This finding implies that the use of RADEC-based comic media can be an effective learning strategy in facilitating improved learning outcomes, both for students with high and low initial abilities, as well as students with varying critical thinking abilities (Juliyanti & Syahfitri, 2024; Widya & Unga, 2023). Therefore, teachers are expected to consider differentiation in learning based on students' initial conditions to optimize the effectiveness of the learning media used (Adawiyah et al., 2024). These findings support the hypothesis that the use of comic media based on the RADEC model has a positive effect on improving student learning outcomes (Chan, 2023; Julianti et al., 2024; Putri et al., 2025), compared to conventional learning approaches. In the context of the study entitled "The Effect of Initial Ability and Critical Thinking on Science Learning Outcomes through RADEC-Based Comic Media in Grade IV Elementary School Students", these results strengthen the effectiveness of innovative learning media that are not only visually appealing, but also support students' active cognitive and affective involvement in the learning process (Haleem et al., 2022; Indriyani et al., 2024). Thus, RADEC-based comic media has been proven to be able to create a more meaningful learning environment and have an impact on student learning outcomes (Arini et al., 2024).

Conclusion

Based on the results of the research that has been conducted and the analysis of the data that has been presented, the following conclusions can be drawn: The initial abilities of students have a significant influence on learning outcomes through RADEC-based comic media. Students with high initial abilities tend to achieve better learning outcomes compared to students with low initial abilities. This shows that initial abilities play an important role as a foundation in the learning process, especially when using RADEC-based comic media. Critical Thinking also has a significant influence on learning outcomes through RADEC-based comic media. Students who have a high interest in learning tend to be more motivated and active in the learning process, so they are able to achieve more optimal learning outcomes. High Critical Thinking encourages students to be more involved in learning projects and develop a deeper understanding of the material being taught. There is no significant interaction between initial abilities and critical thinking on learning outcomes

through RADEC-based comic media. This means that the influence of initial abilities on learning outcomes does not depend on the level of critical thinking, and vice versa. These two factors work independently in influencing learning outcomes. Thus, RADEC-based comic media has proven to be effective as an innovative alternative in science learning that not only emphasizes learning outcomes, but also encourages increased critical thinking skills in students.

Author Contributions
All authors contributed to the writing of this article. Each author made significant contributions including data collection, analysis, and drafting of the article; R. J., R. A., M., D. All authors were involved in providing new ideas, input, and complementary words to complete this article.

Conflict of Interest
The authors have declared that there is no conflict of interest regarding the publication of this paper. This statement ensures transparency and integrity of the publication process, confirming that the findings are presented impartially and without external influence.

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