

The Effectiveness of Project-Based Learning Integrated with Canva and Mathematical Aptitude on Whole Number Learning in Elementary School Students

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Abstract: Mathematics learning in elementary schools continues to face challenges, particularly in arithmetic operations with whole numbers, which require strong conceptual understanding and accuracy, while classroom instruction remains predominantly teacher-centered and underutilizes digital media. This study aimed to examine the effects of learning strategies, mathematical aptitude, and their interaction on students' learning outcomes in whole number arithmetic up to 100,000. A quantitative approach was employed using a 2×2 factorial experimental design involving 86 fifth-grade students. The independent variable was the learning strategy, consisting of Canva-assisted Project-Based Learning (PjBL) and Canva-assisted expository learning, while mathematical aptitude (high and low) functioned as a moderating variable. Data were collected using a mathematics learning achievement test and a mathematical aptitude questionnaire, and analyzed using two-way ANOVA. The results revealed that Canva-assisted PjBL produced significantly higher learning outcomes than Canva-assisted expository learning, mathematical aptitude had a significant effect on learning outcomes, and there was a significant interaction between learning strategy and mathematical aptitude. Notably, Canva-assisted PjBL was more effective in supporting students with lower mathematical aptitude. These findings indicate that integrating Canva into Project-Based Learning enhances students' learning outcomes and promotes more inclusive and effective mathematics instruction, confirming its relevance for 21st-century elementary education.

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Introduction

Mathematics learning in elementary schools (SD) aims to equip students with basic skills in solving problems systematically and applicatively (Handayani et al., 2021) as stated in the 2013 Curriculum, which emphasizes conceptual understanding and the application of procedures in real contexts. Mathematics learning is also aimed at developing logical, critical, and creative thinking skills, as well as a tenacious and self-confident attitude (Isrok'atun, 2020). However, mathematics learning outcomes in Indonesia are still low as shown by the

UNESCO report (2022) and international surveys such as *TIMSS* and *PISA*, where Indonesia ranked 72nd out of 79 countries with a score of 379, far below the OECD average of 489 (OECD, 2019).

One of the materials that remains a challenge is arithmetic operations for whole numbers up to 100,000, which are considered abstract and difficult for students to understand (Rora Rizky Wandini et al., 2017). This difficulty is often triggered by expository learning that focuses on delivering material without actively involving students (Dayufunmath, 2012; Dwi Septiani et al., 2023). As an alternative, the *Project-Based Learning* (PjBL) approach offers active learning through real-life problem-solving projects and has been shown to improve understanding of mathematical concepts (Kusuma et al., 2025; Chan & Koh, 2022). The integration of technology such as Canva is considered capable of strengthening the implementation of PjBL because it can help visualize concepts and increase student motivation (Mustofa & Hidayatullah, 2020; Asminar Siregar & Masganti Sitorus, 2021).

Furthermore, mathematical aptitude also influences student learning outcomes, where students' natural abilities play a role in the speed of understanding the material (Junia et al., 2023). Previous research has shown that technology-assisted PjBL can increase student engagement but has not comprehensively examined the interaction between PjBL, Canva technology, and mathematical aptitude (Prasetyo & Wulandari, 2024; Suhendra & Suryani, 2024; Astuti & Harini, 2024; Ardiansyah & Dwi, 2024; Taufiq & Kristiana, 2024). Therefore, this study combines these three elements to analyze the influence of Canva-assisted PjBL and mathematical aptitude and their interaction on the learning outcomes of fifth-grade elementary school students in arithmetic operations with whole numbers. This study also explores how differences in student characteristics and access to technology affect learning effectiveness, while filling *the research gap* regarding the application of Canva in PjBL on the topic of whole numbers. Thus, this research is expected to provide new insights regarding the use of technology and the importance of considering mathematical talent in designing more inclusive, effective, and relevant learning for future education.

Research Method

This study employed a quantitative approach using a quasi-experimental design, as the researcher did not randomly assign participants to groups. The research design applied was the Nonequivalent Control Group Design, which involved two groups: an experimental group and a control group.

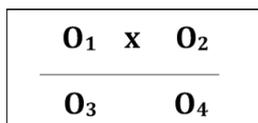


Figure 1 Nonequivalent Control Group Design Information:

- O_1 = Experimental group before being given treatment (pretest)
- O_2 = Experimental group after being given treatment (posttest)
- O_3 = Control group before being given treatment (pretest)
- O_4 = Control group after being given treatment (posttest)
- X = Treatment (Project-Based Learning (PjBL) learning assisted by Canva)

The experimental group received instruction through Canva-assisted Project-Based Learning (PjBL), while the control group was taught using a Canva-assisted expository learning strategy. This design allowed for a comparison of students' learning outcomes

before and after the instructional treatment in both groups to examine the effectiveness of the learning strategies.

In addition, this study implemented a 2×2 factorial experimental design to analyze the effects of the independent variables and their interaction. The first independent variable was the learning strategy, consisting of Canva-assisted PjBL and Canva-assisted expository learning. The second variable was mathematical aptitude, which functioned as a moderating variable and was classified into two levels: high mathematical aptitude and low mathematical aptitude. This factorial design enabled the analysis of the main effects of each variable as well as their interaction on students' learning outcomes.

The research procedure began with preliminary observations to identify students' initial conditions related to their understanding of whole number arithmetic operations. Subsequently, research subjects were assigned to the experimental and control groups. Students in both groups were then administered a mathematical aptitude test to classify them into high- and low-aptitude categories. Afterward, a pretest was administered to both groups to measure students' initial learning outcomes prior to the implementation of the instructional treatment.

The instructional treatment was then conducted according to the research design. The experimental group participated in Project-Based Learning activities supported by Canva, while the control group received Canva-assisted expository instruction. Upon completion of the learning sessions, a posttest was administered to both groups to assess changes in students' learning outcomes. The differences between pretest and posttest scores were used to determine the effectiveness of Canva-assisted PjBL in improving students' learning outcomes.

The research subjects consisted of all fifth-grade students at Ngampung Public Elementary School, Jombang, during the 2025/2026 academic year, totaling 86 students. The participants were drawn from four parallel classes with relatively homogeneous characteristics. A total of 46 students were assigned to the experimental group, while 40 students were assigned to the control group.

The research instruments included a mathematics learning achievement test and a mathematical aptitude test. The learning achievement test was administered in the form of written pretests and posttests to measure students' conceptual understanding, problem-solving ability, and accuracy in performing whole number arithmetic operations. The mathematical aptitude test was used to assess students' logical reasoning, analytical skills, abstraction ability, and speed in solving mathematical problems.

Data analysis was conducted in several stages. Prior to hypothesis testing, assumption tests were performed, including tests of normality and homogeneity, to ensure that the data met the requirements for parametric statistical analysis. After these assumptions were satisfied, hypothesis testing was carried out using Two-Way Analysis of Variance (ANOVA) to examine the effects of learning strategies, mathematical aptitude, and their interaction on students' learning outcomes. The results of this analysis served as the basis for drawing conclusions regarding the effectiveness of Canva-assisted Project-Based Learning.

Result

Before conducting a two-way ANOVA test, this study first carried out prerequisite tests which included the Normality test and the homogeneity test to ensure that the data met the required statistical assumptions; the Normality test was used to see whether the distribution of student learning outcomes followed a normal distribution as a requirement for parametric

statistical analysis, while the homogeneity test aimed to ensure equality of variance between groups so that the comparison in the ANOVA was not biased and truly reflected the influence of learning strategies and students' mathematical talents; these two tests were important so that the results obtained were valid and accountable, especially because this study analyzed the interaction between *the Project-Based Learning (PjBL) learning strategy* assisted by Canva and the expository strategy assisted by Canva with students' mathematical talents in influencing the learning outcomes of arithmetic operations of whole numbers up to 100,000 in fifth grade elementary school students, so that the fulfillment of prerequisite assumptions ensured that the two-way ANOVA could be applied appropriately and conclusions regarding the effectiveness of each learning strategy could be drawn validly.

The Tests of Homogeneity of Variances table presented below contains the results of Levene's Test, which was used to test the homogeneity of variance of student learning outcome data on the material of arithmetic operations of whole numbers. This test was conducted on fifth-grade elementary school students to ensure that the variance between data groups was relatively equal, so that any differences in learning outcome scores could be attributed to the influence of learning strategies and mathematical aptitude levels, rather than to unequal data distribution. These results serve as an important basis in determining the validity of the ANOVA analysis and provide confidence that comparisons between groups can be made fairly and accurately.

Table 1 Results of Homogeneity of Variance Analysis with Levene's Test

		Levene Statistic	df1	df2	Sig.
HASIL BELAJAR MATERI OPERASI HITUNG BILANGAN CACAH	Based on Mean	1.112	1	84	.295
	Based on Median	1.060	1	84	.306
	Based on Median and with adjusted df	1.060	1	82.945	.306
	Based on trimmed mean	1.217	1	84	.273

Based on the results of *Levene's Test* for the homogeneity of variance test, a significance value of 0.295 (based on *the mean*), 0.306 (based on *the median*), 0.306 (based on *the median* with degrees of freedom adjusted), and 0.273 (based on *the trimmed mean*) was obtained, all of which were greater than $\alpha = 0.05$, so that the variance between groups was declared homogeneous; this condition indicates that the differences in learning outcome scores in the Canva-assisted *PjBL strategy* and the Canva-assisted expository strategy, both in high and low mathematically gifted students, can be compared fairly because the data variance is equivalent, and ensures that the differences in learning outcomes that arise reflect the influence of learning strategies and mathematical talent, not due to inequality of variance, so that the two-way ANOVA analysis can be carried out appropriately and its interpretation is valid, while confirming that all groups are in equal initial conditions so that each effect found truly describes the interaction between learning strategies and mathematical talent on learning outcomes of arithmetic operations of whole numbers up to 100,000 in fifth grade elementary school students.

The following table presents the results of the normality test for student learning outcomes using the One-Sample Kolmogorov-Smirnov Test. This test is applied to unstandardized residuals to assess whether the data distribution follows a normal distribution pattern. Data normality is one of the basic assumptions that must be met before conducting an ANOVA analysis, as fulfilling this assumption ensures that comparisons between groups can be made legitimately and that the results can be interpreted validly. In other words, through this test, researchers can ensure that any differences in student learning outcomes reflect the real influence of learning strategies and mathematical aptitude variables, not the result of deviations in the data distribution.

Table 2. Results of the One-Sample Kolmogorov-Smirnov Normality Test for Student Learning Outcomes

One-Sample Kolmogorov-Smirnov Test

		Unstandardized Residual	
N		86	
Normal Parameters ^{a, b}	Mean	.0000000	
	Std. Deviation	6.68857021	
Most Extreme Differences	Absolute	.084	
	Positive	.082	
	Negative	-.084	
Test Statistic		.084	
Asymp. Sig. (2-tailed) ^c		.198	
Monte Carlo Sig. (2-tailed) ^d	Sig.	.143	
	99% Confidence Interval	Lower Bound	.134
		Upper Bound	.152

a. Test distribution is Normal.

b. Calculated from data.

c. Lilliefors Significance Correction.

d. Lilliefors' method based on 10000 Monte Carlo samples with starting seed 754262874.

Based on the results of the *One-Sample Kolmogorov-Smirnov Test* conducted on *unstandardized residual* data of fifth grade students' learning outcomes on the material of arithmetic operations of whole numbers up to 100,000, from 86 samples obtained an average residual of 0.000 with a standard deviation of 6.689 and an absolute maximum difference value of 0.084 (positive 0.082 and negative -0.084), while the significance value of *Asymp. Sig. (2-tailed)* is 0.198 and the value of the *Monte Carlo method* is 0.143, both of which are greater than $\alpha = 0.05$, so that the residuals are declared normally distributed; with the fulfillment of this Normality assumption, a two-way ANOVA analysis can be carried out validly because differences in learning outcomes are not influenced by deviations in data distribution, so that the influence of the *Project-Based Learning (PjBL)* strategy assisted by

Canva and the expository strategy assisted by Canva and its interaction with mathematical talent can be analyzed precisely and the results interpreted validly.

The differences in average student learning outcomes based on learning methods and mathematical aptitude levels are illustrated in Figure 4.4. This visual presentation makes previously numerical data easier to understand and more engaging. The graph helps demonstrate trends and patterns of differences between groups, making it easier for readers to understand the impact of Canva-assisted learning strategies and the role of mathematical aptitude on student learning outcomes. Therefore, this image strengthens understanding and clarifies the results of the research analysis.

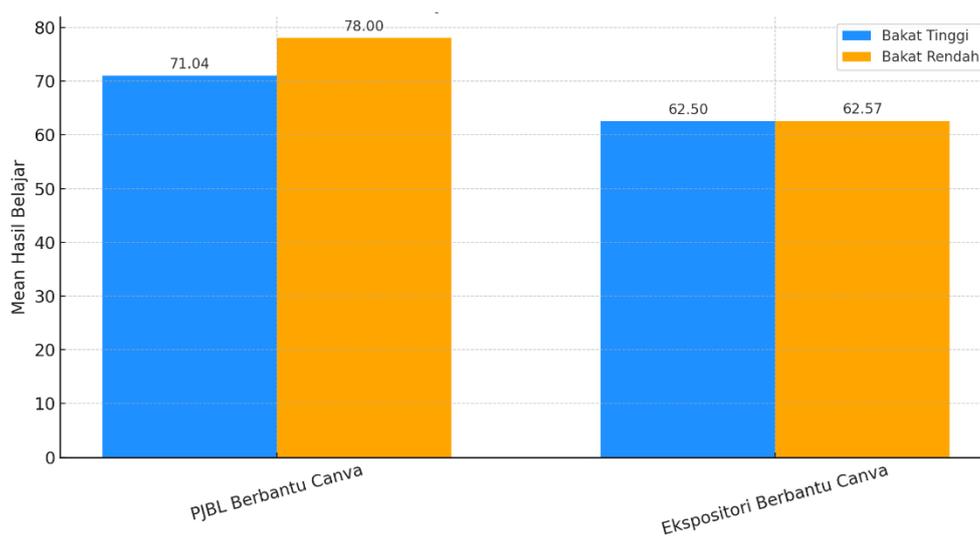


Figure 2. Learning outcomes based on mathematical methods and talents

The graph shows a comparison of the average learning outcomes of fifth grade students on the material of arithmetic operations of whole numbers up to 100,000 based on Canva-assisted learning strategies and mathematical aptitude levels, with two strategies being compared, namely Canva-assisted *Project-Based Learning (PjBL)* and Canva-assisted expository strategies; the average learning outcomes in *PjBL* reached 71.04 for highly gifted students and 78.00 for low-gifted students, while Canva-assisted expository strategies produced an average of 62.50 for highly gifted students and 62.57 for low-gifted students, so it appears that Canva-assisted *PjBL* provides higher results than expository because the project-based approach encourages creativity, collaboration, and conceptual understanding through visual media, while more teacher-centered expository strategies tend to produce lower and relatively balanced scores; Interestingly, low-talented students in *PjBL* actually scored higher than high-talented students, indicating that the combination of project learning and digital media such as Canva can empower students with low math abilities through visual and contextual activities, while the Canva-assisted expository strategy did not show significant differences between talent levels, so that overall the graph confirms that Canva-assisted *PjBL* is a more effective and inclusive approach because it improves learning outcomes while reducing gaps between talent groups.

Table 3. ANOVA Results
Tests of Between-Subjects Effects

Dependent Variable: HASIL BELAJAR MATERI OPERASI HITUNG BILANGAN CACAH

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	3303.263 ^a	3	1101.088	60.972	<,001
Intercept	336915.622	1	336915.622	18656.489	<,001
METODE	2576.563	1	2576.563	142.676	<,001
BAKAT_MATEMATIKA	221.593	1	221.593	12.271	<,001
METODE * BAKAT_MATEMATIKA	213.267	1	213.267	11.810	<,001
Error	1480.830	82	18.059		
Total	409826.000	86			
Corrected Total	4784.093	85			

a. R Squared = .690 (Adjusted R Squared = .679)

Based on the results of the analysis using a two-way *ANOVA* test, it was found that *Canva*-assisted learning strategies and mathematical aptitude had a significant influence on student learning outcomes in the material of whole number arithmetic operations, indicated by the difference in learning outcomes between students who followed the *Canva*-assisted *PjBL* strategy and the *Canva*-assisted expository strategy with a value of $F = 142.676$ and $\text{Sig.} = 0.000 < 0.05$ so that H_{01} was rejected and H_{a1} was accepted, which means that *Canva*-assisted *PjBL* is more effective because it involves students actively and creatively; in addition, mathematical aptitude also had a significant influence with a value of $F = 12.271$ and $\text{Sig.} = 0.001 < 0.05$ so that H_{02} was rejected and H_{a2} was accepted, indicating that highly talented students tend to get better results; furthermore, a significant interaction was found between learning strategies and mathematical aptitude with a value of $F = 11.810$ and $\text{Sig.} = 0.001 < 0.05$ so that H_{03} is rejected and H_{a3} is accepted, which means that the effectiveness of *Canva*-assisted and expository *PjBL* differs at each talent level, where *Canva*-assisted *PjBL* is generally more beneficial, especially for low-talented students because the project-based approach facilitates concrete, collaborative, and engaging learning experiences.

To clarify the relationship between learning strategies and mathematical aptitude on student learning outcomes, the following graph is presented to demonstrate the interaction pattern between the two. This graph shows that student learning outcomes on arithmetic operations with whole numbers are influenced by the combination of learning methods and mathematical aptitude levels. This visualization is important to reinforce the results of the statistical analysis, as it clearly illustrates that learning effectiveness depends not only on the method used but also on the students' basic mathematical abilities.

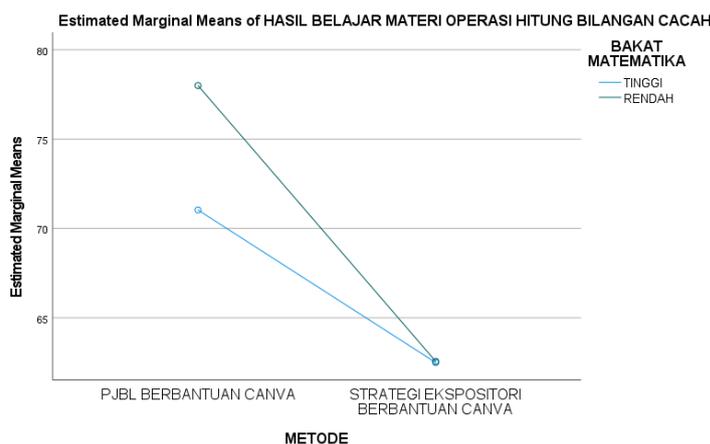


Figure 3. 2of Learning Methods and Mathematical Aptitude on Learning Outcomes

Figure 3. shows the results of the *Estimated Marginal Means analysis* which illustrates the differences in learning outcomes of the material on arithmetic operations of whole numbers based on the learning method (Canva-assisted *PjBL* and Canva-assisted expository strategy) and students' mathematical aptitude (high and low), where highly gifted students who participated in Canva-assisted *PjBL* obtained the highest average learning outcomes of close to 80, while the highly gifted group who learned through Canva-assisted expository strategy experienced a decrease to around 65, and a similar pattern was seen in low-gifted students although the difference was smaller, with Canva-assisted *PjBL* producing an average of around 70 and Canva-assisted expository strategy decreasing to around 65; The intersecting lines on the graph indicate an interaction between learning methods and mathematical aptitude, which shows that the effectiveness of the method is not only determined by the strategy used but also by the level of student aptitude, so that Canva-assisted *PjBL* is more suitable for highly talented students while low-talented students require more targeted assistance, and overall these results confirm that *PjBL* with the support of digital media such as Canva is more effective in increasing engagement, conceptual understanding, and motivation compared to expository strategies that are lecture-based.

Discussion

The results of the hypothesis test in this study indicate that the learning strategy has a significant effect on the learning outcomes of the material on arithmetic operations of whole numbers up to 100,000; statistically found $F = 142.676$ with $\text{Sig.} = 0.000 (<0.05)$, so the hypothesis that there is no influence of the method on learning outcomes is rejected. This finding emphasizes that the difference in instructional approaches - namely the Canva-assisted *PJBL* learning strategy versus the Canva-assisted expository strategy - is not just a difference in teaching style but produces real differences in students' academic achievement. In the context of applications in 5th grade elementary school, the results of this analysis indicate that when students are involved in meaningful projects that require planning, collaboration, and a concrete end product, they tend to build stronger procedural and conceptual understanding compared to when the material is presented expository even though both use visual media such as Canva.

Theoretically, the superior results of *PjBL* can be interpreted through the framework of social constructivism and active learning theory: knowledge is built through the experience of interacting with authentic tasks, not just through passive acceptance of teacher narratives.

PjBL encourages higher-order cognitive processes analysis, synthesis, and reflection that are essential for understanding large number operations, and this is consistent with recent meta-analytic findings showing positive effects of PjBL on academic achievement and thinking skills (L. Zhang & Ma, 2023). The meta-analysis reported significant improvements in learning outcomes when a project-based approach is implemented effectively, particularly in the domains of reasoning and problem-solving, which are relevant to the demands of whole number operations.

Furthermore, the support of visual media in this case, Canva strengthens the cognitive mechanisms that make PjBL effective. Dual Coding and multimedia principles demonstrate that presenting information in dual formats (verbal + visual) improves comprehension and retention and reduces cognitive load on working memory, thereby helping students internalize abstract numerical concepts. Recent studies on mathematical visualization confirm that well-designed visual interventions improve conceptual understanding and problem-solving skills, so the combination of PjBL and Canva which allows students to produce and represent solutions visually has strong theoretical and empirical foundations.

These results are also in line with a number of recent empirical studies demonstrating the positive effects of PjBL on mathematics learning at the elementary and secondary school levels. Several studies (e.g., reviews and cross-context research) report that PjBL improves students' cognitive and affective outcomes, including problem-solving competencies and 21st-century skills such as collaboration and creativity all of which support the learning of large number operations in elementary school (Matveeva & al., 2023; W. Zhang, 2024). Meta-analytic findings indicate medium to large effects for relevant aspects of computational thinking, collaboration skills, and problem-solving when PjBL is implemented appropriately across the elementary and secondary school age range.

However, it's important to note that the literature isn't entirely consistent: some studies find that the effectiveness of PjBL depends on the quality of the project design, teacher preparedness, intervention duration, and curriculum context. Examples of studies that don't show significant advantages of PjBL suggest that if projects are poorly facilitated or evaluations focus on non-cognitive outcomes, academic achievement gains may be insignificant (García-Rodríguez & al., 2021). These differences help explain why PjBL appears less effective in some studies moderating factors such as media integration, teacher training, and alignment of learning objectives play a significant role in determining outcomes. In this study, the use of Canva as a visual scaffold and the project design focused on whole number operations likely mitigated some of the previously reported weaknesses of PjBL, resulting in significant effects.

Comparing the findings of this study with those of other studies also highlights the role of digital media (such as Canva) as a visual learning enhancer. Studies on visualization and external representation in mathematics education show that visual tools help students reduce numerical misconceptions and make the connection between procedures and concepts more tangible. The use of user-friendly design platforms like Canva makes it easy for teachers and students to produce relevant visual materials, infographics, and interactive numerical representations for operations with large numbers (Matveeva & al., 2023; Schoenherr, 2024). Therefore, the finding that Canva-assisted PjBL outperforms Canva-assisted expository learning is consistent with evidence that active visualization and student participation in creating their own representations enhance conceptual understanding.

From an educational practice perspective, these findings have immediate implications: elementary school teachers are encouraged to design Project-Based Learning (PjBL) units that focus on authentic numerical problems (e.g., projects on measuring scale, managing a simple school budget, or creating number representation posters) and utilize Canva to help students represent their calculations. This not only enhances procedural understanding but also builds mathematical communication skills when students present their project results. School policy support and teacher training on effective project design and the use of visual platforms will increase the probability of consistent success in Project-Based Learning (PjBL) implementation, consistent with recommendations from PjBL implementation research that emphasizes professional development support for teachers.

Methodologically, this study also emphasizes the importance of considering the interaction between method and student characteristics (e.g., mathematical aptitude, pre-ability) when evaluating intervention effectiveness. Meta-analytic studies and literature reviews indicate that moderator variables (age, subject, duration, intervention quality) influence the effect size of PjBL; therefore, analyses that consider interactions, such as the two-way ANOVA used in this study, provide a richer picture of when and for whom PjBL is effective. Methodological recommendations for further studies include longitudinal measurement (follow-up), measurement of classroom processes (observation of implementation fidelity), and analysis of mediator variables such as motivation or self-efficacy that may explain the mechanisms of change (Zhang, 2024).

The empirical findings of this study support theoretical claims and previous empirical evidence: Canva-assisted PjBL resulted in higher average learning outcomes than Canva-assisted expository strategies, and this effect was statistically significant ($F = 142.676$; $Sig. = 0.000$). This finding is consistent with meta-analyses showing positive effects of PjBL on achievement and thinking skills, while also confirming the important role of visual media in fostering the internalization of abstract mathematical concepts. Furthermore, these results confirm that when PjBL is designed with appropriate visual scaffolding (e.g., Canva), students of all ability levels can benefit a point also highlighted by studies in elementary school contexts that found improvements in mathematical understanding through media-supported PjBL (Zhang & Ma, 2023).

Finally, this study presents practical suggestions and future research directions: first, teacher training on meaningful project design and the use of Canva should be part of professional development programs; second, further research should investigate the minimum duration of PjBL interventions and the project design features (e.g., task authenticity, assessment rubrics, and visual scaffolding) that contribute most to learning gains; and third, feasibility testing of the scale that examines the impact of school context (resources, student-teacher ratio) is needed to ensure the generalizability of the findings. By following in the footsteps of previous research and integrating the findings of this study, more inclusive, contextual, and evidence-based mathematics learning practices can be realized at the elementary school level.

The test results show that mathematical aptitude has a significant influence on student learning outcomes, with an F value of 12.271 and $Sig. = 0.001$ (<0.05). This means that students with high mathematical aptitude consistently achieve better learning outcomes than students with low aptitude. This finding supports the initial assumption that students' internal characteristics, particularly potential in the mathematical domain, play an important role in achieving learning outcomes.

Theoretically, the influence of mathematical aptitude can be explained through the *aptitude-treatment interaction* (ATI) framework and the theory of academic intelligence, which emphasizes that students with higher initial abilities (aptitude) will respond more effectively to learning methods and assistive media (treatment). For example, research by Fernández-Méndez et al., 2020, showed that visuospatial and motor skills were closely related to mathematics achievement in children aged 6–8 years, confirming that early cognitive factors correlate with mathematics outcomes. Furthermore, research by Kliziene et al., 2022, found that diagnostic cognitive abilities were significantly related to mathematics achievement in elementary school students, confirming that internal potential does influence learning outcomes. Thus, high mathematical aptitude likely reflects better cognitive readiness such as logical reasoning, conceptual flexibility, and procedural fluency which facilitates students' understanding of arithmetic operations with whole numbers up to 100,000.

Comparing with previous research, several studies support this finding. For example, (Siregar et al., 2021) in a study in Mizoram found a strong positive correlation between mathematical aptitude and academic achievement in mathematics, which is in line with the finding that high aptitude is associated with better outcomes. Furthermore, systematic research by Large-Scale Assessments in Education (2023) shows that prior numeracy is an important predictor of later numeracy (Getenet & Beswick, 2023), thus relevant to the study's findings. On the other hand, some research indicates that even high aptitude, if learning methods or classroom conditions are less supportive, learning outcomes are not always optimal. For example, a study by (Abuzo, 2023) found that aptitude does not automatically guarantee high performance if students experience math anxiety or a less supportive learning culture. These differences suggest that learning environment factors and instructional methods also moderate the influence of mathematical aptitude on learning outcomes.

Furthermore, the integration of Vygotsky's theory of the zone of proximal development (ZPD) suggests that students with high mathematical aptitude may be within a wider ZPD, requiring slightly less scaffolding than students with low aptitude. In the context of your study using Canva and two learning strategies highly aptitude students likely utilized visual media and project assignments more quickly to build understanding. Conversely, low aptitude students may require more structured strategies, stronger scaffolding support, or methods that explicitly reinforce basic concepts before moving on to large number operations.

The theoretical implication of your findings is that instructional design models must consider the interaction between learning methods, assistive media, and student characteristics (such as mathematical aptitude). This means that selecting the best learning method in general is not sufficient; it must be tailored to the student's internal potential so that the method and media can be optimally utilized. Therefore, learning and instructional theories must expand their frameworks to include student aptitude or cognitive potential as moderators. This is in line with literature that emphasizes the importance of learning differentiation and instructional adaptation based on students' initial abilities.

From a practical perspective, your research suggests that elementary school teachers should identify students' mathematical aptitude early for example, through numerical ability tests or number fluency diagnostics as part of their learning preparation. By identifying students with high and low aptitude, teachers can choose or adapt appropriate learning strategies: high aptitude students can be given more complex challenges or in-depth projects, while low aptitude students can be given stronger scaffolding, additional practice, and

intensive visual media (such as Canva) to build foundational understanding. This approach helps create inclusive learning that is responsive to individual differences.

Methodologically, this study serves as a reminder that mathematical aptitude variables should be included in mathematics learning research designs either as independent variables, moderators, or controls to ensure more accurate and contextual evaluations of learning methods. Future researchers are advised to use designs that consider the interaction between learning methods, media, and student predispositions, and to conduct moderation or mediation analyses, rather than just main effects. This is consistent with recommendations from meta-analytic literature that many predictive factors of mathematics achievement have not been extensively tested as moderators (Large-Scale Assessments in Education, 2023).

The findings of this study indicate that: **(1)** high mathematical aptitude is associated with higher learning outcomes in the material of arithmetic operations of whole numbers up to 100,000 in fifth grade elementary school students; **(2)** low aptitude students can still be helped through appropriate methods and media (although not specifically highlighted in this hypothesis); and **(3)** the importance of considering student characteristics when designing learning. These results reinforce the view that mathematics education in elementary schools must pay attention to aspects of individualization and differentiation so that all students can achieve optimal results.

Thus, this research makes an important contribution to the development of mathematics learning theory and practice namely, that mathematical aptitude is a significant factor influencing learning outcomes, but its impact depends on appropriate instructional design and supporting media. Further recommendations include longitudinal research to determine how mathematical aptitude interacts with methods and media over the long term, as well as experiments comparing how students with different aptitudes respond to variations in instructional methods and visual media.

The results of the study indicate a significant interaction between learning strategies and mathematical aptitude on students' mathematics learning outcomes. Statistical analysis showed an F value of 11.810 with a significance level of $0.001 < 0.05$, meaning the null hypothesis was rejected. This finding indicates that the effectiveness of learning strategies, particularly Canva-assisted PjBL and the Expository model, differs across student groups depending on their level of mathematical aptitude. In other words, the success of learning strategies cannot be seen uniformly but needs to be tailored to individual student characteristics.

Theoretically, these findings align with the constructivist principles proposed by Piaget and Vygotsky, which emphasize the importance of hands-on experience in building conceptual understanding. Project-Based Learning (PjBL) enables students to actively engage in the learning process through real-life projects, so that knowledge is not merely passively received but independently constructed. Through this approach, students can connect theory with practice, strengthen conceptual understanding, and develop critical thinking skills relevant to real-world contexts.

Furthermore, the theory of multiple intelligences introduced by Gardner (1983) supports the effectiveness of PjBL. According to Gardner, every student possesses various types of intelligence, including logical-mathematical, visual-spatial, and interpersonal intelligence. Project-based learning models, especially those supported by interactive media like Canva, can accommodate this diversity of intelligence. Students with low mathematical aptitude can still grasp concepts through visual representations, group collaboration, and

engaging learning experiences, while students with high aptitude can challenge themselves with more complex projects.

Previous research supports these findings. (Himmi et al., 2025) showed that the implementation of PjBL in mathematics education significantly improved students' mathematical representation skills. This confirms that active involvement in real-life projects can deepen the understanding of mathematical concepts, especially for students who initially experienced difficulties. Furthermore, (Fitrah, 2025) found that PjBL creates a positive learning environment and supports students' intrinsic motivation, thereby improving overall learning outcomes.

However, not all studies provide consistent results. (Zhang & Ma, 2023) reported that the effectiveness of PjBL can vary depending on the implementation context, including teacher preparedness, resource quality, and student characteristics. These differences indicate that PjBL is not a single solution that can be applied universally. Inappropriate implementation or the absence of adequate media support can reduce its effectiveness, especially for students who require more intensive guidance.

The differences in these research findings emphasize the importance of adapting learning strategies to actual classroom conditions. For example, for students with low mathematical aptitude, visual media and experiential projects can be effective tools to facilitate conceptual understanding. Meanwhile, for students with high aptitude, more structured expository methods can provide sufficient intellectual challenge. Therefore, learning strategies need to be designed flexibly and responsive to varying student abilities.

The theoretical implication of these findings is that individual student factors, such as mathematical aptitude, should be a primary consideration when designing learning strategies. Learning models that adapt to individual student needs will be more effective in improving learning outcomes and higher-order thinking skills. This concept reinforces the theory of instructional differentiation, which emphasizes the importance of adapting materials and methods to student characteristics.

Practically, these findings provide guidance for teachers in selecting appropriate learning strategies. The Canva-assisted PjBL method can be specifically applied to students with low mathematical aptitude because it can increase motivation, engagement, and conceptual understanding through real-life projects. Meanwhile, students with high aptitude can utilize the Expository model to hone their analytical and synthesis skills. This differentiated approach allows each student to receive a learning experience tailored to their potential.

From a methodological perspective, this study emphasizes the importance of considering moderating variables, such as mathematical aptitude, in educational research design. Evaluating the effectiveness of learning strategies without considering individual factors can result in inaccurate interpretations. By including moderating variables, researchers can identify significant interactions and provide more targeted recommendations for educational practice.

Furthermore, the use of interactive learning media such as Canva also contributes significantly to the success of Project-Based Learning (PjBL). This media allows for more concrete and engaging visualizations of abstract mathematical concepts, enabling students of all ability levels to understand the material more easily. Interactive media also supports group collaboration, communication, and creativity, which are essential components of project-based learning.

Overall, these findings suggest that learning strategies responsive to students' talents and characteristics can significantly improve mathematics learning outcomes. An approach that integrates PjBL, interactive media, and instructional differentiation provides a more meaningful and comprehensive learning experience. This not only enhances conceptual understanding but also fosters students' critical, creative, and collaborative thinking skills.

Thus, this research makes an important contribution to the development of adaptive, effective, and student-centered mathematics education. Teachers can utilize these findings to design more personalized and targeted learning experiences, thereby not only improving mathematics learning outcomes but also building a broader foundation of competencies for each student.

Conclusion

The results of the analysis show that there is a significant difference in learning outcomes between students who follow the Project-Based Learning (PjBL) strategy assisted by Canva and students who follow the Expository strategy assisted by Canva, with a value of $F = 142.676$ and $\text{Sig.} = 0.000 < 0.05$, so that H_{01} is rejected and H_{a1} is accepted, which confirms that the learning strategy has a significant effect on the learning outcomes of Arithmetic Operations of Whole Numbers up to 100,000, and PjBL assisted by Canva is proven to be more effective. In addition, mathematical talent also has a significant effect on learning outcomes, as indicated by the value of $F = 12.271$ and $\text{Sig.} = 0.001 < 0.05$, so that H_{02} is rejected and H_{a2} is accepted, which indicates that students with high mathematical talent tend to obtain better learning outcomes. Furthermore, there is a significant interaction between learning strategies and mathematical talent with a value of $F = 11.810$ and $\text{Sig.} = 0.001 < 0.05$, so H_{03} is rejected and H_{a3} is accepted, which means that the effectiveness of the strategy is greatly influenced by the level of mathematical aptitude, where Canva-assisted PjBL has a more positive impact, especially for students with low mathematical aptitude.

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