

## APPLICATION OF PROJECT-BASED LEARNING ASSISTED BY MICROSOFT MATHEMATICS TO IMPROVE STUDENTS' MATHEMATICAL REPRESENTATION ABILITY

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### Abstract

This study examined the effect of Project-based Learning (PjBL) assisted by Microsoft Mathematics on students' mathematical representation ability. A quasi-experimental design with a posttest-only control group was employed in two tenth-grade classes at a senior high school in Kolaka Regency. The experimental group received PjBL with Microsoft Mathematics, while the control group was taught conventionally. Data were collected through a representation test, a questionnaire, and an observation sheet, and analyzed using both descriptive and inferential statistics. Results showed that the experimental group achieved a significantly higher mean score (81.17) than the control group (60.19), with a mean difference of 20.99 points ( $p < 0.05$ ). The questionnaire findings revealed very positive student perceptions, indicating that Microsoft Mathematics was easy to use, helpful in understanding concepts, and improved problem-solving skills, while also fostering interest and independence. Observation confirmed that PjBL was implemented effectively: teachers provided clear guidance, students designed projects, collaborated, and presented outcomes through various representations using Microsoft Mathematics. These findings demonstrate that combining PjBL with technology strengthens students' mathematical representation ability and enriches learning. The study implies that technology-supported project learning can serve as an effective model for promoting meaningful, engaging, and skill-oriented mathematics education in secondary schools.

**Keywords:** Mathematical representation; Microsoft Mathematics; project-based learning; senior high school; technology-assisted learning

### Abstrak

Penelitian ini mengkaji pengaruh Project-based Learning (PjBL) berbantuan Microsoft Mathematics terhadap kemampuan representasi matematis siswa. Desain penelitian yang digunakan adalah kuasi-eksperimen dengan kelompok kontrol posttest-only pada dua kelas X di salah satu SMA di Kabupaten Kolaka. Kelompok eksperimen mendapatkan pembelajaran PjBL dengan Microsoft Mathematics, sedangkan kelompok kontrol diajar secara konvensional. Data dikumpulkan melalui tes representasi, angket, dan lembar observasi, kemudian dianalisis dengan statistik deskriptif dan inferensial. Hasil penelitian menunjukkan bahwa kelompok eksperimen memperoleh skor rata-rata yang secara signifikan lebih tinggi (81,17) dibandingkan kelompok kontrol (60,19), dengan selisih rata-rata 20,99 poin ( $p < 0,05$ ). Temuan angket menunjukkan persepsi siswa yang sangat positif, bahwa Microsoft Mathematics mudah digunakan, membantu dalam memahami konsep, meningkatkan keterampilan pemecahan masalah, sekaligus menumbuhkan minat dan kemandirian. Hasil observasi menegaskan bahwa PjBL terlaksana secara efektif: guru memberikan arahan yang jelas, siswa merancang proyek, berkolaborasi, serta mempresentasikan hasil melalui berbagai bentuk representasi dengan Microsoft Mathematics. Temuan ini menunjukkan bahwa menggabungkan PjBL dengan teknologi dapat memperkuat kemampuan representasi matematis siswa dan memperkaya pembelajaran. Penelitian ini menyiratkan bahwa pembelajaran berbasis proyek yang didukung teknologi dapat menjadi model efektif untuk mendorong pendidikan matematika yang bermakna, menarik, dan berorientasi pada keterampilan di sekolah menengah.

**Kata kunci:** Microsoft Mathematics; pembelajaran berbantuan teknologi; project-based learning; representasi matematis; sekolah menengah atas



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## INTRODUCTION

Mathematical representation ability is a skill that enables the communication, understanding, and connection of mathematical concepts through various forms of representation, including symbolic, visual (graphs and diagrams), and verbal. These skills are essential in supporting conceptual understanding and the development of problem-solving strategies (Mainali, 2020). However, many students face difficulties in using these various representations, which hinders their ability to solve math problems effectively. One of the leading causes is a weak understanding of basic mathematical concepts, coupled with less varied learning methods and a teaching focus that emphasizes procedures over conceptual understanding (Jailani et al., 2020; Jiménez-Gaona & Vivanco-Galván, 2024; Morales Jr et al., 2024). This results in students' difficulties in transforming information into various forms of representation, such as transforming story problems into mathematical models or understanding the relationship between graphs and equations ((Bagus, 2018); (Hutagaol, 2013); (Sinaga et al., 2023)). Another exacerbating factor is the lack of variety in learning media, such as diagrams and concrete props, which hinders students' understanding of mathematical concepts ((Lutfi & Khusna, 2021); (Rosyida et al., 2024b)). Therefore, a more innovative and interactive learning approach is needed to improve students' mathematical representation skills.

One approach that can be used to improve this ability is Project-based Learning (PjBL). This approach enables students to learn through exploration and problem-solving in a real-world context. Research shows that discussion-based learning, collaboration, and

the use of various mathematical representations can significantly improve students' understanding of mathematical concepts ((Andrà et al., 2024); (Mpalami & Moleko, 2022)). PjBL provides opportunities for students to develop skills in presenting mathematical ideas in various forms, such as graphs, diagrams, visual models, and symbolic equations. This approach also emphasizes problem-solving that connects mathematical theory with real-world situations, thus strengthening conceptual understanding and improving students' critical thinking skills ((Evans et al., 2018); (Nasution et al., 2021)). In addition, PjBL encourages collaboration among students, which helps them in transforming information from one form of representation to another (Barroso et al., 2016).

The application of PjBL can be more effective if supported by the use of technology, which facilitates the exploration and representation of mathematical concepts. Technology enriches the learning experience by allowing students to access various resources, visualize abstract concepts, and present project results interactively ((Megawati, 2024); (Montés et al., 2022)). Technology also increases students' active involvement in the learning process, which in turn strengthens their understanding of mathematics (Hakim et al., 2019; Rahayu et al., 2023; Tuktamyshov & Gorskaya, 2021). One of the technologies that can be used in PjBL is Microsoft Mathematics.

Microsoft Mathematics is a free and legal software that excels in supporting math learning. The interface is simple and easy to use, resembling a graphing calculator, and is capable of completing various calculations, including algebra, calculus, matrices, and 2D/3D graphics. Its advantage lies

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in its ability to present both visual and symbolic representations simultaneously, helping students understand abstract concepts more deeply. The step-by-step problem-solving feature and handwriting input support through the Math Input Panel make it easy for students to learn independently and express mathematical ideas flexibly, making it very effective in developing mathematical representation skills.

The approach offered in this study has advantages over previous research that applied PjBL to enhance students' mathematical representation skills at the elementary level using two-dimensional figures ((Hanifah et al., 2021); (Ilma & Turmudi, 2021); (Restu et al., 2020); (Hanifah et al., (2021))). At the same time, Restu et al. (2020) employed PjBL with simple fractions for grade III elementary students. Meanwhile, Ilma and Turmudi (2021) combined PjBL with GeoGebra software to teach integrals to high school students. These studies utilized PjBL with various media, including physical props and specific software such as GeoGebra, for specific topics. However, these approaches are limited to using media or tools that are only relevant to certain materials. This research proposes an innovation by integrating PjBL with Microsoft Mathematics. This software enables the visualization of mathematical concepts interactively and dynamically, allowing students to more easily understand and represent mathematical concepts with greater accuracy than conventional methods.

The main novelty of this research lies in the flexibility of Microsoft Mathematics, which can be applied to a wide range of math topics, in contrast to other software that is focused on specific materials. With features such as interactive graphics, automatic equation

solving, and 3D visualization, it provides a more engaging and practical learning experience. This approach enables students to become more independent in exploring mathematical concepts, thereby improving their reasoning and problem-solving skills. This research fills a gap in previous research by offering a more holistic learning solution that can be applied to a variety of math topics.

## **METHODS**

This study employed a quasi-experimental method with a Posttest-Only Control Group design. The research was conducted at SMAN 1 Kolaka. The population consisted of all 10th-grade students, and the sample comprised two classes of 36 students each. The sample was selected through purposive sampling based on the mathematics teacher's recommendation. The considerations for determining the sample included the similarity of students' academic characteristics and the fact that both classes were taught by the same teacher, thereby ensuring instructional consistency across groups.

Operationally, the research was implemented in three stages: preparation, implementation, and data collection. In the preparation stage, the researchers coordinated with the mathematics teacher, conducted initial observations, confirmed the sample classes, and developed the necessary learning instruments. These included lesson plans (RPP), student worksheets (LKPD), and project-based learning materials integrated with Microsoft Mathematics. All instruments underwent expert validation to ensure content and construct suitability for classroom use. Prior to implementation, the teacher received a briefing on the integration of Microsoft Mathematics into the PjBL approach.

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The implementation stage consisted of delivering the instructional treatment over four regular mathematics meetings. In the experimental group, learning was carried out using Project-Based Learning (PjBL) supported by Microsoft Mathematics. The activities involved classroom discussion, completing the LKPD, using Microsoft Mathematics to support problem solving, and presenting the results. During these meetings, the teacher provided initial instructions, facilitated the use of Microsoft Mathematics, and guided students through the completion of the project tasks. Meanwhile, the control group received conventional instruction delivered by the same teacher throughout the treatment period.

In the data collection stage, a posttest—previously validated for content and construct—was administered to both groups at the end of the instructional period to measure students' learning outcomes. Three instruments were used in the study: (1) an essay test to measure students' mathematical representation skills, (2) a closed-ended questionnaire to assess students' perceptions of Microsoft Mathematics, and (3) an observation sheet to evaluate the implementation of PjBL. Data were collected through the administration of the posttest, distribution of questionnaires, and classroom observations. The post-test data were

analyzed using descriptive statistics and an independent samples t-test to determine differences between the experimental and control groups. Prior to the t-test, normality and homogeneity tests were conducted to ensure that the assumptions of parametric analysis were met. Questionnaire data were analyzed descriptively by calculating the mean score of each indicator and interpreting the results into categorical levels of perception. Observation data were analyzed qualitatively through descriptive analysis by summarizing the fulfillment of each indicator in the observation checklist and identifying patterns related to the implementation of the PjBL model supported by Microsoft Mathematics. The qualitative findings were used to reinforce the interpretation of the quantitative results.

## RESULTS AND DISCUSSION

This study aimed to evaluate the effect of the Project-based Learning (PjBL) model supported by Microsoft Mathematics software on students' mathematical representation abilities. The data analysis included both descriptive and inferential statistical tests applied to the post-test data from two groups: the experimental group and the control group. The descriptive analysis of students' mathematical representation abilities after the intervention is presented in Table 1.

Table 1. Descriptive statistics of students' mathematical representation abilities

Group	N	Mean	Std. Deviation	Std. Error Mean
Control	36	60.1864	15.57450	2.59575
Experiment	36	81.1744	14.98172	2.49695

Table 1 presents the descriptive statistics of students' mathematical representation abilities after the intervention for both research groups. The control group, which received

conventional instruction, achieved a mean score of 60.19 with a standard deviation of 15.57. In contrast, the experimental group, which engaged in project-based learning supported by

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Microsoft Mathematics, attained a higher mean score of 81.17 with a standard deviation of 14.98. This difference in mean scores indicates a clear gap in students' mathematical representation performance between the two groups. Furthermore, the relatively similar standard deviations suggest that the range of score variation in both groups was comparable, reinforcing the likelihood that the observed difference in achievement stemmed from the instructional model employed.

The descriptive results indicate that project-based learning supported by Microsoft Mathematics is more effective in enhancing students' mathematical representation skills than conventional teaching methods. The higher average score achieved by the experimental group underscores the effectiveness of PjBL in creating a more meaningful learning experience, enabling students not only to master procedures but also to connect mathematical concepts with real-world contexts. This finding aligns with studies asserting that PjBL fosters student understanding through exploration and collaboration in solving problems that require the use of various forms of mathematical representation (Ratnasari et al., 2018).

Moreover, Microsoft Mathematics made a significant contribution to this process. The software offers features such as symbolic representation, graphing, and 3D visualization, which assist students in comprehending inter-conceptual relationships. With technological support, students are able to visualize their computations and compare different forms of representation in a short time, ultimately deepening their conceptual understanding. This study supports prior research emphasizing that integrating technology into mathematics instruction

enriches students' learning experiences and enhances their active engagement (Megawati, 2024; Montés et al., 2022).

The lower achievement observed in the control group highlights the limitations of conventional instruction, which tends to be teacher-centered and primarily focused on procedural delivery. Students in this group appeared to have fewer opportunities to independently develop their ability to represent mathematical ideas in visual or symbolic forms. This condition is consistent with the findings of Jailani et al. (2020) and Rosyida et al. (2024), which suggest that traditional approaches often fail to foster students' mastery of mathematical representation due to limited use of varied media and instructional strategies.

Table 1 indicates that combining PjBL with the support of Microsoft Mathematics has the potential to be an effective instructional strategy for developing mathematical representation skills. The substantial difference in mean scores between the experimental and control groups suggests that the impact of this approach is not merely a statistical anomaly, but rather a tangible outcome of integrating project-based pedagogy with representational technology. This reinforces the notion that innovative instructional models that position students as active participants and utilize interactive technology can lead to consistently higher achievement in mathematics learning. Subsequently, a prerequisite test for normality was conducted, and the results are presented in Table 2.

Table 2. Tests of Normality

	Kolmogorov-Smirnov <sup>a</sup>		
	Statistic	df	Sig.
Control	.145	36	.055
Experiment	.146	36	.052

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Table 2 presents the significance values from the Kolmogorov–Smirnov test for both groups: 0.055 for the control class and 0.052 for the experimental class. These findings indicate that the post-test data from both groups are normally distributed. Consequently, the assumption of normality is met, allowing for the use of appropriate parametric statistical analyses.

The normal distribution in both groups suggests that the data are suitable for parametric tests, such as the t-test, to compare group outcomes. This normality also indicates the absence of extreme outliers that could distort the interpretation of results, thereby preserving the reliability of the analysis. Furthermore, the normal distribution serves as a critical foundation for assessing the effectiveness of the implemented learning approach, particularly in comparing the impact of PjBL supported by Microsoft Mathematics with conventional instruction. Given that the data from both groups follow a normal distribution, any observed differences in subsequent analyses—such as the t-test—can be more validly attributed to the instructional treatment rather than to statistical anomalies. In this context, it strengthens the claim that the improvement in mathematical representation skills in the experimental group is a tangible result of the integration of PjBL with technology (Rabi et al., 2021).

Normality also reflects that variations in students' learning outcomes occurred naturally and were not influenced by extreme non-instructional factors. This test is crucial, especially considering that mathematical representation is a complex competency involving the ability to comprehend and express concepts in multiple forms—such as graphs, symbols, and verbal

narratives. When the learning process is facilitated by PjBL, which emphasizes active and collaborative engagement, and supported by the interactive features of Microsoft Mathematics, students are provided with greater opportunities to develop these representations in meaningful and diverse ways (Rehman et al., 2024; Siregar & Yahfizham, 2025). Subsequently, further analysis was conducted through a homogeneity test, with the results presented in Table 3.

Table 3. Tests of Homogeneity

	Levene's Test for Equality of Variances	
	F	Sig.
Equal variances assumed	.066	.799

Levene's test yielded a significance value of 0.799, as shown in Table 3, which exceeds the threshold of 0.05. This result indicates that the variances between the experimental and control groups can be considered homogeneous. This homogeneity suggests that the spread of data in both groups exhibits a relatively similar degree of variability. In this context, the distribution of scores for mathematical representation abilities is equivalent across groups, thereby allowing for statistically sound comparisons between them.

The homogeneity of variances serves as a critical foundation in inferential analysis, as it ensures that any observed differences in group means are not due to imbalances in data dispersion, but rather attributable to the treatment applied. Within the scope of this study, the homogeneity assumption confirms that both the experimental and control groups began with comparable variability in learning outcomes. With this condition met, comparisons of the

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effects of project-based learning supported by Microsoft Mathematics versus conventional instruction can be made more objectively and reliably.

Furthermore, the presence of homogeneity strengthens the validity of the findings, affirming that the improvement in mathematical representation abilities within the experimental group is indeed a result of implementing PjBL and leveraging representational technology. This condition ensures the validity of the interpretation of instructional effectiveness by ensuring no structural distur-

bances in the dataset. With balanced distributions and equivalent variances, the PjBL approach supported by Microsoft Mathematics can be identified as the primary factor contributing to the differential learning outcomes between the two groups in a fair and empirically grounded manner (Siregar & Yahfizham, 2025). Subsequently, an independent t-test was conducted to examine the statistical significance of differences in mathematical representation abilities between the groups, with the results presented in Table 4.

Table 4. Independent Samples Test

	t-test for Equality of Means						
	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
						Lower	Upper
Equal variances assumed	-5.827	70	.000	-20.98806	3.60176	-28.17154	-13.80457
Equal variances not assumed	-5.827	69.895	.000	-20.98806	3.60176	-28.17173	-13.80438

Table 4 shows a significance value (p) of 0.000 ( $p < 0.05$ ), indicating a statistically significant difference in the mean scores between the experimental and control groups. This finding suggests that the observed outcomes were not due to chance, but rather the result of the instructional treatment applied. The experimental group achieved a mean score that was 20.99 points higher than that of the control group, reinforcing the conclusion that the PjBL approach, when integrated with Microsoft Mathematics, has a substantial impact on improving students' mathematical representation abilities.

The t-test results provide empirical evidence that project-based learning supported by Microsoft Mathematics significantly enhances student achievement compared to

conventional instruction. This improvement highlights that integrating technology within a project-based learning framework enables students the opportunity to grasp mathematical concepts through more varied and interactive forms of representation. These findings also support the perspective of Montés et al. (2022), who emphasized the pivotal role of technology in increasing student engagement and deepening understanding of abstract concepts.

A key advantage of Microsoft Mathematics in this study lies in its ability to present both visual and symbolic representations simultaneously. Through features such as 2D/3D graphing, equation solving, and step-by-step solutions, students can more easily establish connections between different forms of representation (Naganjaneyulu et al., 2020); (Siregar & Yahfizham,

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2025)). As a result, students move beyond rote memorization of procedures and begin to develop representational skills that support conceptual understanding. The application of this technology has proven effective in enriching the mathematics learning experience, enhances its meaningful and contextually relevant for students.

Moreover, the findings of this study reinforce those of Ilma and Turmudi (2021), who demonstrated the effectiveness of integrating PjBL with GeoGebra in enhancing students' understanding of integral concepts. However, Microsoft Mathematics offers broader applicability, as it can be used across various mathematical topics, ranging from algebra and calculus to functions. This flexibility enables the software to support the development of mathematical representation across diverse subject matter, making it highly relevant for comprehensive implementation in the secondary school curriculum ((Rizki & Widyastuti, 2019); (Siregar & Yahfizham, 2025)).

Theoretically, these findings align with the constructivist perspective, which asserts that knowledge is actively constructed by learners through interaction with their environment and representational tools (Ingulfsen et al., 2023; Mugambi, 2018). Project-based learning (PjBL) provides real-world contexts that challenge students to think critically, design solutions, and present their work in various forms of mathematical representation. With the support of Microsoft Mathematics, this knowledge construction process becomes more structured, interactive, and oriented toward the development of higher-order thinking skills (Badjeber & Purwaningrum, 2018; Tanjung & Yahfizham, 2024).

Furthermore, the combination of the PjBL and interactive technological support such as Microsoft Mathematics addresses the limitations of conventional instructional methods. As noted by Jailani et al. (2020) and Rosyida et al. (2024), traditional instruction often emphasizes procedural routines and seldom provides opportunities for students to develop deep representational understanding. In this context, an innovative project-based and technology-supported approach serves as a more effective solution for fostering representational comprehension.

In addition to improving academic outcomes, the implementation of this model also positively influences students' motivational aspects (Wijnia et al., 2024). The broader space for exploration allows students to feel a greater sense of control and autonomy over their learning process. This condition aligns with Ryan and Deci (2020) theory of intrinsic motivation, which posits that granting autonomy and opportunities for active participation enhances student engagement, motivation, and academic performance. Overall, the findings of this study not only affirm the cognitive effectiveness of Microsoft Mathematics-supported PjBL but also highlight its contribution to the mathematics learning.

Beyond the mathematical representation tests, this study also incorporated a questionnaire to explore students' perceptions of using Microsoft Mathematics within project-based learning. These questionnaire data are essential, as they provide a more comprehensive understanding not only of learning outcomes but also of students' experiences, attitudes, and perspectives toward the instructional media used. The results of the student questionnaire analysis can be seen in Table 5.

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Table 5. Students' perceptions of Microsoft Mathematics use

Aspect	Item Statement	Mean	Category
Ease of Use	Easy-to-understand interface	3.72	Very High
	No feature-related difficulties	3.67	Very High
Learning	Supports concept understanding	3.67	Very High
Benefits	Aids problem-solving	3.75	Very High
	Increases interest in mathematics	3.69	Very High
	Promotes independent learning	3.69	Very High
Attitudes and Perceptions	Learning becomes more enjoyable	3.69	Very High
	Preferred for future use	3.75	Very High
	Worth recommending to peers	3.75	Very High
	Suggested as school learning media	3.78	Very High

Table 5 reveals that all questionnaire items received scores in the "Very High" category, with average values ranging from 3.67 to 3.78. In terms of usability, students reported that Microsoft Mathematics had an easy-to-understand interface (3.72) and that its features were relatively easy to use (3.67). Regarding perceived benefits, the highest score was recorded for the item stating that the application helps in solving mathematical problems (3.75). Other items—such as its role in aiding conceptual understanding, increasing interest, and fostering independent learning—also received very high scores. As for attitudes and general perceptions, the most favorable response was to the statement that Microsoft Mathematics should be incorporated into classroom learning media (3.78).

The questionnaire results complement the t-test findings, which demonstrated a significant improvement in the mathematical representation abilities of the experimental group. Students' overwhelmingly positive perceptions reinforce the interpretation that improved outcomes were not only evident in test scores but also supported by a more engaging and meaningful learning experience. Students' responses regarding ease of use suggest that the integration of technology did not pose a

barrier but instead facilitated conceptual understanding. This aligns with the findings of Megawati (2024) and Montés et al. (2022), who emphasized that interactive technology can enhance student participation and deepen understanding of abstract concepts. In terms of benefits, students perceived Microsoft Mathematics as helpful for both understanding concepts and solving problems more effectively. This supports the findings of Nasution et al. (2021), which affirm that PjBL strengthens the connection between theoretical knowledge and real-world application—especially when supported by representational media.

Moreover, students' expressed desire for continued use of the application in future lessons and its introduction to other students reflects a high level of acceptance of this learning innovation. Such positive attitudes are critical, as the success of any educational innovation is determined not only by its cognitive effectiveness but also by student acceptance and enthusiasm as end-users. Therefore, the questionnaire results affirm that the implementation of PjBL supported by Microsoft Mathematics is not only effective in improving academic achievement but also delivers a positive learning experience that promotes its sustainability in mathematics education.

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In addition to tests and questionnaires, this study also included classroom observations to assess the implementation of the PjBL model supported by Microsoft Mathematics. Based on observations by three researchers, all observed aspects demonstrated positive outcomes. Teachers were found to have clearly explained the learning objectives and the steps involved in the project activities, ensuring that students understood the direction of the tasks. Students actively participated in designing mathematical projects, utilized Microsoft Mathematics effectively as a supporting tool, and were able to connect mathematical concepts to real-world problems. They also presented project outcomes using various forms of representation such as graphs, tables, and mathematical symbols. Teachers consistently provided feedback on students' representations, and interactions in the form of discussions and peer collaboration were evident throughout the activity. Overall, all indicators listed in the observation checklist were fully achieved, indicating successful implementation of the designed instructional model.

The observation results reinforce the earlier findings from both the tests and the questionnaire. While the test results demonstrated a significant improvement in students' mathematical representation abilities, and the questionnaire reflected highly positive student perceptions, the classroom observations confirmed that the implementation process was also carried out effectively. The teacher's clarity in guiding project activities successfully fostered a conducive learning environment, in which students did not passively receive information but were actively engaged in designing,

investigating, and connecting mathematical concepts to real-life contexts. This aligns with the characteristics of PjBL as outlined by Nasution et al. (2021) which emphasize collaborative learning in the context of authentic problems.

The use of Microsoft Mathematics within the project activities was also observed to support students' representational skills. Students were able to visualize concepts in the form of graphs, tables, and mathematical symbols, facilitating inter-representational transformation, as highlighted by Mainali (2021). Teacher feedback on students' representations played a crucial role in ensuring accurate conceptual understanding, while peer discussions helped strengthen students' collaborative and mathematical communication skills. This is consistent with the perspective that technology-enhanced learning not only improves classroom interaction quality but also enriches students' ways of understanding mathematics ((Burrill, 2017); (Jaafar et al., 2022)).

Overall, the findings of this study hold important implications for mathematics instruction in secondary schools. The integration of PjBL with the support of Microsoft Mathematics has proven effective not only in enhancing students' cognitive achievement but also in increasing their engagement and motivation to learn. Mathematics teachers can adopt this approach to enrich the learning experience by designing activities that demand multi-modal representations, training students to connect symbolic, visual, and verbal concepts within authentic contexts. Schools and educational policymakers should also consider providing infrastructure support and professional development

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for teachers to ensure the effective implementation of mathematical software tools such as Microsoft Mathematics. In conclusion, this study demonstrates that the synergy between project-based pedagogical strategies and representational technology offers a learning model that is both relevant and adaptive to the demands of 21st-century education.

## CONCLUSION AND SUGGESTION

This study aimed to evaluate the impact of implementing Project-based Learning (PjBL) supported by Microsoft Mathematics software on the mathematical representation abilities of secondary school students. The instructional model was designed to position students as active participants in designing, solving, and representing mathematical concepts with the aid of interactive technology.

The results revealed that PjBL integrated with Microsoft Mathematics had a significant positive effect on students' mathematical representation skills. Inferential analysis showed a statistically significant difference in post-test mean scores between the experimental and control groups, with the experimental group achieving higher outcomes. This difference affirms that the innovative approach, which combines project-based learning with technology, enriches students' learning experiences and fosters deeper representational understanding.

The questionnaire data further indicated that students held highly positive perceptions toward the use of Microsoft Mathematics. They found the application user-friendly, helpful in understanding concepts and solving problems, and instrumental in increasing their interest and independence in learning. These positive responses

underscore that the success of the approach lies not only in academic achievement but also in student acceptance and enthusiasm toward educational innovation.

Additionally, classroom observations demonstrated that the implementation of PjBL was conducted effectively. Teachers provided clear guidance, students actively designed mathematical projects, utilized Microsoft Mathematics efficiently, and successfully connected concepts to real-world problems, presenting their results in various representational forms. These findings provide strong evidence that integrating PjBL with Microsoft Mathematics enhances students' representational abilities, strengthens engagement, and fosters a more collaborative and meaningful learning environment. This highlights the substantial potential of adopting similar models to support 21st-century mathematics education.

Nevertheless, this study has certain limitations. The sample was restricted to two classes in a single school, limiting the generalizability of the findings. Moreover, the research focused primarily on cognitive outcomes and student perceptions, without fully exploring affective dynamics or long-term impacts. Therefore, a recommendation for further research is the need for a learning model that integrates students' learning experiences with the use of Microsoft Mathematics, making the learning process more meaningful. This is based on the fact that students often struggle to connect abstract mathematical concepts with real-world learning experiences in the classroom. By combining students' learning experiences—whether contextual, collaborative, or problem-based with technological support such as Microsoft Mathematics or other media,

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students can more easily understand, explore, and visualize complex mathematical concepts.

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