Performance assessment tasks in mathematics learning: gender-based analysis of vocational students' performance

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Abstract

This study investigates the impact of performance assessment tasks on mathematics learning outcomes, with particular attention to potential differences based on student gender. Employing a quasi-experimental design with non-equivalent control groups, 80 vocational pharmacy students in Bandung were divided evenly into experimental and control groups. The study aimed to evaluate whether performance assessment tasks improve mathematical knowledge, problem-solving strategies, communication skills, and attitudes toward mathematics, and whether effectiveness differs by gender. Data were collected through tests and questionnaires, then analyzed using descriptive and inferential statistics. Results showed that while the experimental group's scores improved compared to the control group, the difference was not statistically significant for either male or female students. The most notable finding was a strong association between attitudes toward mathematics and learning outcomes, particularly among female students (r=0.878, p<0.001). These results suggest that performance assessment tasks show promise as a learning strategy, though their effectiveness requires further validation. The findings highlight the critical importance of fostering positive student attitudes in mathematics instruction to enhance performance. Study limitations include the small sample size and short intervention period. The study underscores the need to design learning approaches that balance cognitive and affective aspects, particularly in vocational education contexts.

Keywords: attitude towards mathematics learning, gender differences, mathematical learning, performance assessment, quasi-experimental

INTRODUCTION

Improving the quality of mathematics learning has become a significant focus on various education policies, considering the low academic achievement of students in this field. Based on data from the OECD (2023), Indonesian students aged 15 years old obtained an average score of 366 points in mathematics assessments, far below the OECD average of 472 points. This condition shows a serious achievement gap, although some students from underprivileged backgrounds still show academic resilience (Volante & Klinger, 2022). This phenomenon highlights the importance of adopting a more contextual approach to learning and evaluation, enabling mathematics to be perceived as enjoyable and contributing to optimal learning outcomes (Masruroh et al., 2020; Oktapiana et al., 2024; Royan & Supriatna, 2024).

This context emphasizes that the concept of student performance in mathematics learning does not only refer to the achievement of final grades, but is also the result of a combination of various internal and external factors of students. These achievements reflect conceptual understanding and mastery of the material, as well as reflect the challenges faced during the learning process (Ningrum et al., 2022). Various studies show that student performance is influenced by socioeconomic status, class attendance, and parental involvement (Maurisacaetal., 2024). On the other hand, factors such as students' attitudes towards math, the quality of teaching, and the learning environment also play an essential role in determining learning success (Labo, 2023; Mazana et al., 2020a). Therefore, proper learning evaluation, such as performance assessment tasks, is becoming increasingly relevant to study and implement.

Efforts to improve student performance in mathematics learning require an evaluation strategy that not only assesses the final results, but also pays attention to the processes and skills involved in learning (Arroyo-Barrigüete et al., 2023). One of the approaches that is considered adequate is performance assessment. The application of performance assessment was able to significantly improve mathematics learning outcomes, with an average gain of 70.7%. This assessment measures aspects of knowledge, skills, and attitudes in an integrated manner, thus encouraging active participation, deeper conceptual understanding, and increased student confidence (Mazana et al., 2020a; Putri et al., 2022) The findings reinforce the argument that comprehensive and contextual evaluations can help address the challenges students face during the learning process, as outlined in previous studies (Pokhrel, 2023). The application of performance assessment tasks, which are performance-based tasks that demand the application of knowledge in an authentic context, is a more meaningful alternative to evaluation (Meylani, 2024; Petalla & Doromal, 2021; Saher et al., 2022). The application of performance assessment tasks, which are performance-based tasks that require the application of knowledge and skills directly, can provide a more comprehensive picture of students' abilities than relying solely on standardized tests. This method allows the assessment of not only the final results, but also the processes and strategies that students use in completing the task, thus in creasing the accuracy in measuring mathematical achievement (Arroyo-Barrigüete et al., 2023). Different from conventional tests that only measure cognitive abilities in a limited way (Saher et al., 2022), this assessment emphasizes processes, strategies, and final products that reflect students' holistic understanding of math material.

Literature review shows that the use of performance assessment tasks in mathematics learning is gain ingattention as an alternative to holistice valuation. Performance assessment can improve students' meta cognitive abilities, but it has not directly linked these results to other dimensions of learning performance such as attitudes and mathematical communication (Mertasari et al., 2023). On the other hand, the implementation of performance assessment significantly improves mathematics learning outcomes, although its effectiveness is still highly dependent on task design, student characteristics, and duration of implementation (Putri et al., 2022). Meanwhile, it is underlined that attitudes towards mathematics are a crucial factor in students' academic achievement, but this variable is rarely integrated in the overall measurement of student performance (Mazana et al., 2020b)

These studies show that there is a space that is still rarely studied, namely the integration of performance assessment with learning attitude and gender factors as essential variables in the context of evaluating mathematics learning outcomes. There has been limited research on how performance assessments reflect student performance as a whole, particularly in Vocational High Schools (SMK) with distinctive student characteristics and learning demands.

The present study is designed to investigate how performance assessment tasks influence mathematics learning, with particular attention to gender-related variations and the link between students'

attitudes toward mathematics and their academic outcomes. The research focuses on assessing the role of performance-based tasks in strengthening students' mastery of mathematical concepts and skills, as reflected in the comparison of pretest and posttest scores as indicators of learning achievement. It also explores how students' attitudes toward mathematics contribute to their learning results, while identifying potential differences in achievement between male and female learners within the framework of performance assessment implementation (Bowman et al, 2022; Liu, 2023; Mertasari et al., 2023; Räsänen et al., 2021).

Based on this focus, this research is expected to contribute to expanding understanding of the implementation of performance assessment tasks in mathematics classrooms through the presentation of empirical evidence regarding the effectiveness of performance assessment tasks in encouraging improved student performance. This research also provides space to understand the affective side of students that is often overlooked in learning evaluation. In this way, the study not only strengthens the theoretical and practical foundations of performance assessment in the mathematics classroom, but also offers new insights that are closer to real needs. The results of the research are expected to help teachers design learning and assessment strategies that are more contextual, flexible, and sensitive to the diversity of students, including gender differences.

METHODS

This study employed a quantitative quasi-experimental approach with a non-equivalent control group design, a methodology widely used in educational research when random assignment is not feasible (Abraham & Supriati, 2022; Yaniawati & Indrawan, 2024). The design aimed to investigate the impact of performance assessment tasks on mathematics learning outcomes, with particular attention to gender differences and the relationship between student attitudes and academic performance.

This research was carried out in one of the Vocational High Schools (SMK) with a Pharmacy expertise program in the city of Bandung. This school was chosen because mathematics learning still uses a conventional approach, where teachers are more dominant in class interactions. At the same time, students tend to be passive and only give feedback on the practice questions given. The research population includes all students in the pharmacy specialty program at the school. From that population, as many as 80 students were assigned as samples through purposive sampling techniques. The sample was then divided into two groups, namely an experimental class with 40 students (16 males and 24 females), and a control class with 40 students (18 males and 22 females). The gender composition between these two classes.

Is relatively balanced, so it is expected that it will not affect the objectivity of there search results. This study was conducted in a vocational high school with a pharmacy expertise program located in Bandung. The research focused on students' mathematics learning performance when taught using performance assessment tasks, with particular attention to gender differences. The scope of the study is limited to vocational students in one school context, and the findings may not be generalized to other educational levels or subject areas. The study also did not measure long-term retention or affective changes beyond the research period.

The variable in this study is student performance, which reflects students' achievements in mathematics learning and includes four main dimensions, namely mathematical knowledge, the use of solving strategies, mathematical communication, and attitudes towards mathematics learning. Mathematical knowledge includes students' understanding of concepts, principles, and terminology; The

use of a solution strategy refers to the ability to choose and apply the right approach in solving problems; mathematical communication reflects the ability to convey ideas or solutions orally, in writing, or visually; Meanwhile, attitudes towards learning mathematics include learning motivation, confidence, and perseverance in thinking (Arthur et al., 2022; Yaniawati et al., 2020).

The data of this study was obtained through tests and questionnaires. The test was used to measure student performance in the experimental and control groups. The test instrument consists of a number of questions that have been quantitatively analyzed, including validity, reliability, difficulty index, and differentiation. The validity value of the question is in the range of 0.54 to 0.77, which is included in the medium to high category. The reliability of the question showed two items in the low category, one medium, one high, and one very high. The differentiating power ranged from 0.233 to 0.74, while the difficulty index was in the range of 0.597 to 0.844, indicating a difficulty level that varied from medium to easy. Meanwhile, data on students' attitudes towards mathematics learning were collected through questionnaires specially designed to measure relevant affective aspects.

The research prosedure were conducted over four weeks. The implementation consisted of four main stages: (1) administering a pretest to both experimental and control groups, (2) conducting the learning intervention, in which the experimental group was taught using performance assessment tasks while the control group received conventional instruction, (3) administering a posttest to measure students; mathematics performance, and (4) distributing attitude questionnaires.

Data were collected in a paper-based format under the supervision of the classroom teacher and the researcher. The pretest was conducted in the first week, followed by three weeks of instruction, and the posttest was administered in the final week. The attitude questionnaire was distributed immediately after the posttest to both male and female students. All responses were verified by the researcher to ensure completeness and accuracy before statistical analysis.

The results from the pretest and posttest assessments were separated based on gender. Both descriptive and inferential statistics were used in analyzing the collected data. Before the hypothesis was tested, prerequisite examinations were carried out, such as testing normality with the Shapiro-Wilk test (appropriate for sample sizes below 50) and checking variance homogeneity through Levene's test (Ghasemi & Burley, 2019). The findings related to posttest scores for both experimental and control groups, categorized by gender, are presented in Table1.

Table1. Normality and Homogeneity Test Results in Post-test Data

Group	Shapiro–Wilk Test (Sig.)	Normality Conclusion	Levene'sTest (Sig.)	Homogeneity Conclusion
Experiment(male)	0,058	Normal	0,095	Homogeneous
Controls(male)	0,127	Normal	–	–
Experiment(female)	0,373	Normal	0,016	Not homogeneous
Controls(female)	0,029	Abnormal	–	–

After completing the prerequisite tests, the inferential statistical analysis in this research was conducted through several stages. First, thestudy assessedthe effectiveness of performance assessment tasks for each gender by applying the Paired Sample t-test, which compared pretest and posttest scores for all participants, as well as for male and female subgroups. Next, academic performance between genders was compared: the Independent Sample t-test was used for male students, while the Mann-Whitney U test was selected for female students because their data did not meet normality as sumptions. Finally, there lation ship between students' attitudes toward mathematics and their learning outcomes

was examined with the Pearson Product Moment Correlation, which evaluated both the strength and direction of association between the variables. All statistical analyses were performed using a significance level of α = 0.05.

RESULTS AND DISCUSSION

Descriptive Analysis of Pretest and Postest Data

The data used in this section are data from pre-test and post-test that have been grouped by gender. On average, the standard deviation (SD) and the number of students (N) are presented in table 2.

Table 2. Pre-test and Post-test Scores by Gender

Statistics	Eksperimen (male)		Control (male)		Experiment (female)		Controls (female)	
	Pretest	Posttest	Pretest	Posttest	Pretest	Posttest	Pretest	Posttest
Mean	64,06	77,38	59,00	66,67	56,92	71,88	56,591	69,86
SD	19,529	16,812	17,442	22,210	15,786	14,807	19,424	20,920
N	16	16	18	18	24	24	22	22

Table 2 shows that all groups increased their average scores from pre-test to post-test. The experimental groups, for both male and female students, displayed greater score improvements than their control counterparts. The largest gain was observed in the female experimental group, which improved by 14.96 points. Previous studies suggest this may be related to cognitive tendencies, as female students often utilize right-brain functions associated with creativity and imagination, potentially supporting better outcomes (Erawati, 2020). Furthermore, analysis of standard deviation indicated that score variability decreased in both male and female experimental groups after the intervention, suggesting that learning gains were distributed more evenly. In contrast, the control groups for both genders exhibited greater variability in post-test results. These findings imply that performance assessment tasks may contribute to not only raising achievement but also fostering more equitable results. This aligns with the OECD (2023) report noting on going gender disparities in mathematics literacy, where female students often score lower on traditional assessments. Never the less, it is important to emphasize that achievement in mathematics is influenced more by individual effort and persistence than by gender alone (Jiang, 2021).

Analysis of differences in academic performance by gender

Results of the Independent Samplet-test to compare the post-test scores of male students between the experimental and control groups presented in table 3.

Table 3. Independent t Test Results

Group	t	df	Sig.(2-tailed)
Experiment vs control (male)	1,569	32	0,126

The results of the independent sample t-test in male students showed that there was nostatistically significant difference between the post-test scores of the experimental and control groups demonstrated from the values p = 0.126 > 0.05 while to compare the post-test scores of female students in the experimental and control classes using the Mann-Whitney test, the results are presented in table 4.

Table 4. Mann Test Results–Whitney U Test

Group	Mann–Whitney U	Z	Asymp. Sig. (2–tailed)
Experiment vs Control (female)	259,500	-0,099	0,921

A very small Z-value (-0.099) and a very high significance value (0.921) indicate that the score distribution between the two groups is almost the same. The results of the analysis showed that the implementation of the performance assessment task had a positive impact on both male and female students, but no significant differences were found between the two. Thus, the effectiveness of treatment is not influenced by gender, but rather by how the treatment is designed and carried out (Lesperanceetal, 2022). On the other hand, the interaction between teachers and students is quite influential, teachers interact with male students more often than female students, this makes male students tend tobe more motivated so that their performanceis better in mathematics (Mashuri & Yawan, 2023). Thus, differences in academic performance are more influenced by interaction factors and support provided in the learning process, not based solely on gender.

Analysis of the Relationship between Attitude and Learning Outcomes

Pearson's correlation analysis was conducted to determine the strength and direction of the relationship between attitudes towards learning and student learning outcomes, taking into account gender factors. This analysis was performed separately for male and female students to identify differences in relationship patterns based on gender presented in table 5.

Table 5. Pearson Corellation Test Results in Experimental Classes

Gender	Correlation coefficient (r)	Sig.(P-value)	N
Male Gender	0,847	<0,001	16
Female Gender	0,878	<0,001	24

The results of the analysis showed that the relationship between attitude and learning outcomes in female students (r=0.878, p<0.001) was stronger than that of male students. These findings indicate that female students have a more consistent tendency to change positive attitudes into the achievement of good learning outcomes, so learning strategies that focus on attitude formation will be very effective for female students. The association between stronger attitudes and learning outcomes in female students was influenced by higher self-regulated learning compared to male students, but higher math anxiety in female students (Priharvian et al., 2024). However, a number of studies have stated that certain personality traits also play a role in supporting mathematics learning outcomes, traits that reflect discipline and perseverance are often shown by male students who are generally more confident and active in learning,while female students who tend to have a friendly and cooperative character are usually expressed with lower mathematical achievement (Mashuri & Yawan, 2023).

Effectiveness of Performance Assessment Tasks in mathematics learning

Descriptively, the experimental group showed a greater increase in learning outcome scores compared to the control group. However, the results of statistical tests show that the difference is not statistically significant. These findings indicate that performance assessment tasks have the potential to improve mathematics learning outcomes, but their effectiveness can be influenced by various factors, such as the quality of implementation, duration of treatment, and student characteristics.

These results are different from the findings of Putri, Jamali, and Muchyidin (2022), who reported that the use of performance assessments significantly improved mathematics learning outcomes. One of the distinguishing factors that may explain this difference is the design of the assessment tasks used. In the study by Putri et al., the assessment was designed within a structured and integrated learning cycle that spanned several weeks. In contrast, this study's implementation duration was limited and not fully tailored to the needs of vocational school students.

In addition, it is essential to note that the effectiveness of performance assessment does not only depend on the academic results directly, but also on the thinking process and involvement of students. Previous research has confirmed that performance assessment can encourage the development of students' metacognitive abilities in mathematics learning (Mertasari et al. 2023). Although the study did not specifically highlight the gender dimensionor learning attitudes, these findings support the assumption that performance assessments can have a positive impact on the quality of the learning process, not just on final scores.

Another factor that plays a role is students' attitudes towards learning mathematics. This study found a robust correlation between attitudes and learning outcomes, particularly among female students. The findings are in line with the results of previous studies, which show that attitude is an essential predictor of success in learning mathematics (Mazana et al., 2020b). Therefore, performance assessment tasks can be more effective if they are designed not only to measure cognitive outcomes, but also to pay attention to the affective aspects and individual characteristics of students.

Thus, although the improvement obtained is not statistically significant, these findings still make an essential contribution that performance assessment tasks have promising pedagogical potential, especially if designed contextually and taking into account psycho pedagogical factors such as learning attitudes and gender differences.

Gender implications in mathematics learning

A particularly noteworthy finding in this study is the absence of significant differencesin the effectiveness of performance assessment tasks between male and female students. This finding aligns with research indicating that variations in mathematical performance cannot be attributed exclusively to gender. Men and women can compete with each other in variousaspects of mathematics. On the other hand, the way of thinking and cognitive focus between men and women can affect mathematical performance (Kadarisma et al., 2019). Other studies show that female students have a higher interest in learning mathematics than male students. In addition, female students also tend to perform better than male students when applying cognitive strategies to learn mathematics.This indicates that women are not only more.

interested but also more effective in employing math learning strategies (Subrahmanyam, 2021). Consequently, the learning strategy should incorporate the development of a positive attitude towards mathematics, including the application of performance assessment tasks. Thus, performance assessment tasks can be used as an alternative assessment instrument that can accommodate learning diversity without paying attention to gender. However, attention is still needed to individual characteristics of students and adjustments to learning methods that can optimize the potential of each student, resulting in excellent mathematical performance.

CONCLUSION

This study shows that performance assessment tasks have the potential to help mathematics learning to be more equitable and sensitive to student differences, in cluding gender aspects. More than just academic results, attitudes towards mathematics play a significant role in learning success, so teachers need to design strategies that can foster positive attitudes in the classroom. Although these findings provide a new direction, limitations on the number of participants, duration of interventions, and out-of-class factors make the results not yet widely generalized. The main contribution of this study is the emphasis that mathematics learning in vocational schools should not only emphasize cognitive abilities, but also form supportive learning attitudes. Further research is hoped that more extensive and in-depth research is still needed to understand how performance assessments can genuinely have a sustainable impact on students' academic achievement.

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