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Effect of Student-Centered Teaching Approach on Academic Performance in Mathematics at the Secondary School Level

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ABSTRACT

Objective: The study's primary purpose is to investigate the effect of a Student-Centered Teaching Approach on Student's Academic Performance in Mathematics at the Secondary Level. **Method**: The study was carried out using the quasi-experiment method. In this study, convenient sampling was used to select secondary schools and select students for intervention. This study used a few instrumentations, such as a mathematics test, which was used for pre-and posttests. **Results**: The analysis data in the posttest reveal an increase in mean, mode, and median scores after implementing a student-centered approach toward the experimental group. This study proves that the effectiveness of a student-centered teaching approach positively impacts students' academic performance in mathematics. The rejection of the null hypothesis suggests that the student-centered approach led to a statistically significant improvement in students' scores compared to the teacher-centered approach. **Novelty:** This contributes valuable insights to educational practices, advocating for adopting student-centered methods in mathematics instruction. This study proved the effectiveness of the Student-Centered Teaching Approach on students's Academic Performance in Mathematics at the Secondary Level.

INTRODUCTION

Mathematics is paramount in the education system and is the basis of many scientific and business fields. The core objective of Mathematics education is to equip students with essential computational skills and foster logical reasoning and problem-solving competencies (Bakker et al., 2021). However, Mathematics often poses challenges for many students, which may result in low academic achievement (Sneck et al., 2019). The teaching approach is crucial to students' understanding and academic achievement. Traditional teaching methods, often described as teacher-centered, focus on direct instruction where teachers are the primary source of knowledge (Sutaphan & Yuenyong, 2019; Richit & Tomkelski, 2020). Though effective in specific contexts, such methods might not encourage critical thinking or foster a deep understanding of Mathematics in students. Many education experts have suggested a shift towards student-centered teaching approaches to enhance students' engagement and academic performance. Student-centered learning focuses on students' needs, abilities, interests, and learning styles and involves them as active participants in the learning process (Richit & Tomkelski, 2020; Sutaphan & Yuenyong, 2019). However, more research is needed to investigate the effectiveness of student-centered teaching approaches on academic performance in mathematics, specifically in the context of Bangladesh.

This study aims to fill this gap by focusing on the effects of the student-centered teaching approach on students' academic performance in Mathematics at the secondary level in Khulna, Bangladesh. It is hypothesized that the use of a student-centered

Teaching approaches can positively impact students' academic achievement in Mathematics.

Student-centered teaching approaches in mathematics have positively impacted students' academic performance at the secondary level. These approaches focus on centralizing student mathematical thinking and reasoning, promoting student engagement, and improving math achievement (Thanheiser & Melhuish, 2023; Xu & Huang, 2022; Denton, 2021). Studies have shown that student-centered instruction can improve math skills, including creative problem-solving, analysis, reflection, and persistence. Additionally, student-centered teaching methods are more effective for students of low socioeconomic status. In contrast, racial differences in the efficacy of student-centered instruction have been observed, with black students benefiting less than white students (Khalil & Yousuf, 2020). Modular approaches in student-centered instruction have also been found to enhance academic achievement in mathematics at the secondary level. Overall, student-centered teaching approaches can improve students' academic performance in mathematics at the secondary level.

In a student-centered approach, students work together in groups and assist each other. It is important to note that this approach means teachers continue giving lectures partially. Instead, it encourages a gradual and thoughtful shift towards student involvement. Students found the student-centered learning process, especially case discussions, enjoyable (Zhang et al., 2023; Capone, 2022; Sørensen et al., 2023). They believed that the case discussions enhanced their understanding, promoted practical group work, and encouraged using various resources for self-directed learning. Overall, students found student-centered learning exciting and engaging.

The student-centered teaching approach focused on using peer assistance to learn the tasks in a sports education curriculum unit. Another study by Wallhead (2004) supports this idea. The study looked at the progress of six students in terms of their content knowledge. The findings indicated that these students actively participated and followed the content of peer-assisted learning tasks effectively. The peer teaching method effectively enhanced their knowledge in primary content areas. However, it showed a different effectiveness in developing their understanding of more advanced content. The students need help elaborating content because they need help demonstrating, diagnosing errors, and modifying tasks effectively. To empower students in the classroom, teachers must be actively involved to prevent students from becoming passive learners. Simply lecturing can lead to passivity. Teachers can employ the peer-assisted method to ensure students acquire knowledge. By incorporating activities tailored to meet students' needs, meaningful learning can occur. This is crucial in today's education, emphasizing the importance of teachers focusing on students' needs, abilities, and interests while considering how children learn.

The student-centered approach focuses on continuous assessment. Teaching informational systems development using a collaborative mentoring style was more effective than traditional lectures (Balwant & Doon, 2021; Baig, 2023; Zamiri & Esmaeili, 2024). They used small workgroups, personal portfolios, and student-driven experiences, showing that students in collaborative classrooms achieved higher grades. Despite being less easily measurable, students gained important skills, including collaborative teamwork and taking responsibility for their learning.

Teachers should actively involve students in class activities to engage them in a student-centered approach. One effective way is to ask open-ended questions that encourage participation. Another strategy is to design instruction around specific

problems, fostering student interaction and allowing them to share their solutions. This approach enhances problem-solving skills and does not compromise performance on standardized tests. Research indicates that students become more adept at applying mathematical knowledge to new problems when they create their solution methods.

According to Douglas A. Grouws and Kristin J. Cebulla in their research handbook on enhancing student achievement in mathematics, students in typical Japanese classrooms spend around 40% of their instructional time practicing routine procedures, 15% applying these procedures in new situations, and 45% inventing new procedures and analyzing new situations. Research highlights the importance of providing students with opportunities to practice established methods and invent new ones. Several studies indicate that students develop a deeper conceptual understanding of the relationships between different mathematical ideas when they discover and create mathematical concepts and procedures. Student-centered approaches ensure active engagement and lead to increased motivation for the students. The students are more actively participating in their learning activity, improving the learning outcome of mathematics (Wei & Singh, 2024). This study found that student-centric methods can improve active learning and enhance mathematic ability performances (Nieves et al., 2024). This method allows learners to cope with complex mathematical problems (Norhanis et al., 2024). Klein et al. (2024) found that the student-centered teaching method enhances student engagement and reduces anxiety in mathematics learning. A study by Niyitegeka (2023) evaluated that student-centered teaching approaches positively impacted academic performance in mathematics, enhancing students' understanding, motivation, and engagement.

Study in junior high school science to explore the impact of prediction and explanation activities and student-centered discussions. Using an applied constructivist approach, students predicted and explained outcomes and participated in student-centered discussions, while those in the conventional approach did not have these activities (Chang, 1993). This study seeks to address these gaps by examining the effectiveness of student-centered teaching methods on Mathematics performance among secondary students in Khulna, Bangladesh. Doing so aims to contribute valuable insights to the body of research on Mathematics education in developing contexts and the ongoing discourse on teaching methodologies.

RESEARCH METHOD

Research Design

A quasi-experimental design was selected for this study as it allows for group comparison while not fully adhering to the strict random assignment of actual experiments. Quasi-experiments include assignments, but not random assignments of participants to groups (Creswell, 2012). Researchers select quasi-experimental research designs in mathematics education to control external variables and test students' problem-solving abilities. They also select quasi-experimental research designs to determine causal relationships between treatment and outcome variables when accurate experimental designs are not feasible or ethical (Rogers & Revesz, 2019). Specifically, this research used a pretest/posttest control group design. This design involves comparing within the group taught through student-centered methods.

Study Area

The study was conducted in Khulna, Bangladesh's third-largest city. This metropolitan

area provides a rich mix of urban and semi-urban schools, allowing for a diverse sample of secondary students studying Mathematics.

Sample

The sample consisted of 32 secondary school students studying Mathematics. They were the experimental group to which a student-centered teaching approach was applied. A sample is a small amount that shows what the rest is or should be like. It can also be a representative part or a single item from a larger whole or group.

Diagram of Research Process

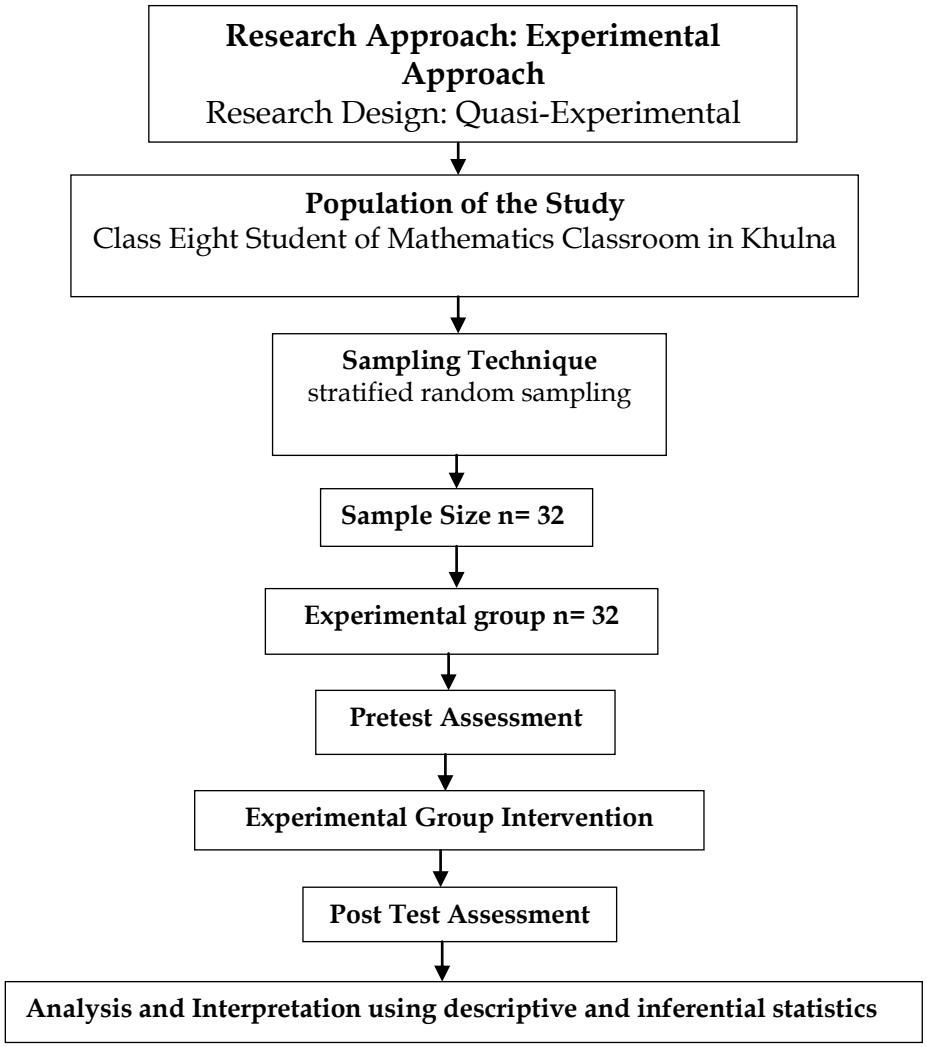

Figure 1. Diagram of research process.

Sampling Technique

Sampling is a technique of selecting individual members or a subset of the population to make statistical inferences from them and estimate the characteristics of the whole population. In this study, convenient sampling was used to select secondary schools and select students for intervention. Convenient sampling is a sampling technique in which persons are chosen who are easily accessible and can be contacted in a short amount of time (Creswell, 2012). In experimental research, setting up controlled conditions, manipulating variables, and collecting data can be resource-intensive.

Convenience sampling allows researchers to conduct experiments more efficiently by selecting readily available participants.

Data Collection Tools

The researcher developed a self-directed research tool. Using a Creative question (CQ), the researcher assessed students' cognitive domain ability. The research tool is used to collect data on student's academic performance at two different times. The CQs were framed under three components by careful consideration of Bloom's Taxonomy. A pretest and posttest are administered before and at the end of the intervention to assess student's academic performance. Bloom's Taxonomy is a hierarchical classification of the different levels of thinking and should be applied when creating course objectives. Course objectives are brief statements that describe what students are expected to learn by the end of the course (Namoun & Alshanqiti, 2021; Hardiansyah & Mulyadi, 2022; Hew et al., 2020).

RESULTS AND DISCUSSION

Results

The chapter includes data analysis and Interpretation of the results. The primary data were collected from a total of 32 respondents. This chapter summarized, synthesized, and discussed the analysis of obtained information after the pretest, posttest, and questionnaire that had been conducted on 32 secondary students. The data were coded and analyzed with appropriate statistical analysis using SPSS version 25. The statistical tests performed in this study included descriptive statistics and inferential analysis.
To measure the achievement of students after using a student-centered teaching approach.

Table 1. Difference of increase between the pretest and posttest of item 1.

	Marks of Item 1.1	Marks of Item 2.1
N	32.000	32.000
Mean	1.438	1.891
Std. Deviation	0.487	0.210
Range	1.000	0.500

Table 1, based on a sample size of 32, reveals a notable positive change in responses to Item 1 between the pretest and posttest assessments. The increase in mean scores from 1.438 in the pretest to 1.891 in the posttest indicates improvement, suggesting a positive shift in participants' understanding or performance related to Item 1. Additionally, reducing the standard deviation from 0.487 in the pretest to 0.210 in the posttest implies increased response consistency, highlighting a convergence of participant scores.

Table 2. Difference of increase between the pretest and posttest of item 2.

	Marks of Item 1.2	Marks of Item 2.2
N	32.000	32.000
Mean	2.391	3.656
Std. Deviation	1.424	0.653
Range	4.000	2.000

Table 2 shows a substantial positive change in responses to Item 2 from the pretest to the posttest assessments based on a sample size of 32. The mean score has increased significantly, rising from 2.391 in the pretest to 3.656 in the posttest, indicating a notable improvement in participants' understanding or performance related to item 2. Furthermore, the standard deviation has decreased from 1.424 in the pretest to 0.653 in the posttest.

Table 3. Difference of increase between the pretest and posttest of item 3.

	Marks of Item 1.3	**Marks of Item 2.3**
N	32.000	32.000
Mean	2.219	3.422
Std. Deviation	1.913	0.853
Range	4.000	2.000

Table 3, with a sample size of 32, shows a substantial positive change in responses to item 3 from the pretest to the posttest assessments. The mean score has increased significantly, from 2.219 in the pretest to 3.422 in the posttest, suggesting a marked improvement in participants' understanding or performance related to item 3. Additionally, the standard deviation has decreased from 1.913 in the pretest to 0.853 in the posttest.

Table 4. shows the difference in the increase between pretest and posttest.

N	**Pre-Total 32**	**Post Total 32**
Mean	6.047	8.969
Std. Deviation	3.361	0.915
Range	8.500	2.000

Table 4, involving a sample of 32 students, illustrates a substantial positive shift in student achievement resulting from the implementation of a student-centered teaching approach. The mean score has notably increased from 6.047 in the pretest to 8.969 in the posttest, indicating a significant improvement in students' overall understanding and performance. This increase underscores the efficacy of the student-centered teaching method in fostering enhanced learning outcomes. Moreover, the decrease in standard deviation from 3.361 in the pretest to 0.915 in the posttest signifies a reduction in the variability of student scores, reflecting a more consistent level of achievement across the group.

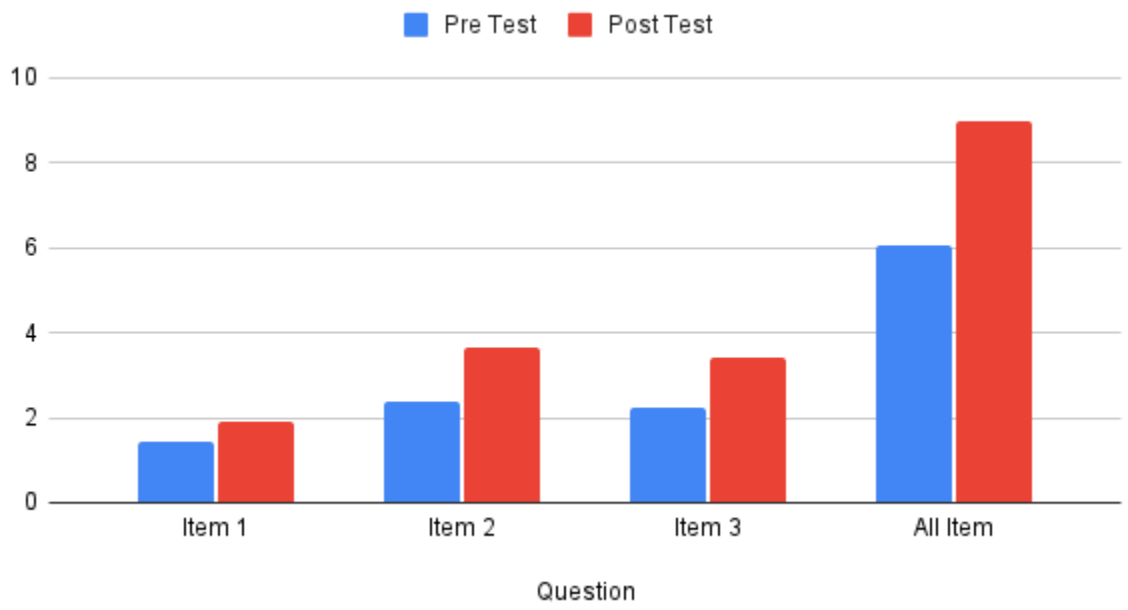

Figure 2. Mean of pretest and posttest.

Figure 2 presents the comparative means for various items in pretest and posttest conditions. The data is organized into three sets: items 1.1 and 2.1, items 1.2 and 2.2, and items 1.3 and 2.3, each with corresponding means for both conditions. For items 1.1 and 2.1, the mean in the pretest condition is 1.438; in the posttest condition, it increases to 1.891. Similarly, for items 1.2 and 2.2, the pretest mean is 2.391, which rises to 3.656 in the posttest—items 1.3 and 2.3 exhibit a pretest mean of 2.219, escalating to 3.422 in the posttest condition. Moreover, the overall trend is captured by the pretest and posttest mean values, indicating a noticeable increase from 6.047 in the pretest to 8.969 in the posttest. This suggests a positive shift in the measured variable across the studied items.

This result suggests that, on the mean, scores from the pretest to the posttest for each item and for the overall mean increase. Thus, it is proven that students achieve better results after using a student-centered teaching approach. To discover the effectiveness of a student-centered teaching approach in Mathematics on students' academic performance. Null Hypothesis (H^0): There is no significant difference in students' performance in mathematics between the student-centered teaching approach and the teacher-centered approach. Alternative Hypothesis (H^1): There is a significant difference in students' performance in mathematics between the student-centered teaching approach and the teacher-centered approach. A paired samples t-test was performed to evaluate whether there was a difference in students' mathematics performance between the student-centered teaching approach and the teacher-centered approach.

Table 5. The result of the paired samples is the statistics of the pretest and posttest.

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Pre-Total	6.047	32.000	3.361	0.594
	Post Total	8.969	32.000	0.915	0.161

Table 5 shows that the pretest score was (M=6.047; SD=3.361), and the posttest score after the intervention was (M=68.830; SD=0.915).

Table 6. Paired sample correlations of pretest and posttest.

		N	Correlation	Sig.
Pair 1	Pre-Total & Post Total	32.000	0.664	0.000

Table 6 shows the correlations between pretest and posttest. The correlation coefficient shows no significant difference in students' mathematics performance between the student-centered teaching approach and the teacher-centered approach [r (32) = 0.664, p = 0.000].

Table 7. Results of paired samples t-test.

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95.000% Confidence Interval of the Difference Lower	Upper			
Pair 1	Pre-Total - Post Total	-2.921	2.837	0.501	-3.944	-1.898	-5.826	31.000	0.000

The results indicated a significant difference between the teacher-centered approach (M=6.047, SD= 3.361) and the student-centered teaching approach (M=8.969, SD= .9153). t(31) = -5826), p =0.000. The t-value is -582, and the degrees of freedom (df) are 31. The negative sign indicates that the mean performance scores of the student-centered approach are significantly higher than those of the teacher-centered approach. The p-value is extremely small (close to zero), indicating that the observed difference in mean scores is doubtful to occur by random chance. Therefore, the result is considered statistically significant. The result shows that the p-value is <0.050, which means the null hypothesis cannot be accepted at a 5% significance level. Thus, there is a statistically significant difference between the mean mark of the pre-and posttest. So, there is a difference in students' performance in mathematics between the student-centered teaching approach and the teacher-centered approach. This result suggests that the student-centered teaching approach positively impacted students' academic performance in mathematics. The rejection of the null hypothesis suggests that the student-centered approach led to a statistically significant improvement in students' scores compared to the teacher-centered approach. This contributes valuable insights to educational practices, advocating for adopting student-centered methods in mathematics instruction. However, it is essential to consider additional factors, such as long-term effects and student engagement, to provide a comprehensive understanding of the implications for educational policy and practice.

Discussion

From the study, the student-centered approach to teaching yields superior academic performance compared to the teacher-centered approach. The previous chapter delineates a substantial and statistically significant difference in outcomes when students engage with these distinct pedagogical strategies. While acknowledging the potential influence of other contributing factors, the study's limitations prevent an exhaustive examination or assessment of these variables. Despite potential confounding factors, the data robustly supports the efficacy of student-centered teaching. This

underscores the need for further research to explore the nuanced interplay of additional variables and their impact on educational outcomes. The findings advocate for a paradigm shift towards student-centric methodologies, emphasizing their positive correlation with heightened academic achievement.

This study had two objectives: 'to measure the achievement of students after using a student-centered teaching approach' and 'to discover the effectiveness of a student-centered teaching approach in Mathematics on students' academic performance. The average score has grown substantially, progressing from 6.047 in the pretest to 8.969 in the posttest. This notable increase indicates a significant enhancement in students' comprehension and performance. It underscores the effectiveness of the student-centered teaching approach in promoting improved learning outcomes. Furthermore, the decline in standard deviation from 3.361 in the pretest to 0.915 in the posttest indicates a reduction in the variability of student scores, highlighting a more uniform level of achievement within the group. The results indicate that switching to a student-focused teaching method has boosted student achievement, improving overall performance and more consistent learning outcomes. This supports the idea that this teaching style enhances educational results for students. In our study, the obtained p-value is 0.000, which is less than the significance level of 0.050. Therefore, we reject the null hypothesis, leading us to conclude that there is a significant difference in students' performance in mathematics between the student-centered teaching approach and the teacher-centered approach. These results conclude that using a student-centered approach has positively influenced students' math performance. Rejecting the null hypothesis means there is a significant improvement in scores with the student-centered method compared to the teacher-centered one. These findings offer critical educational insights, promoting using student-centered approaches in math teaching. However, it is crucial to consider factors like long-term effects and student engagement to grasp the implications of educational policies and practices fully. The effectiveness of a student-centered teaching approach in improving students' academic performance in mathematics is a critical question that educators and researchers continuously seek to address. The hypothesis results, which indicate a statistically significant improvement in students' scores with adopting a student-centered approach compared to a teacher-centered approach, offer valuable insights into this inquiry.

A student-centered teaching approach emphasizes active learning, collaboration, and individualized learning experiences. Students are encouraged to actively participate in their learning actively, fostering a deeper understanding of mathematical concepts and promoting critical thinking skills. Therefore, rejecting the null hypothesis aligns with the theoretical underpinnings of student-centered approaches, affirming that such methods contribute to improved academic performance in mathematics. The findings contribute to the ongoing discourse on educational practices by advocating for the widespread adoption of student-centered methods in mathematics instruction. This recommendation is grounded in empirical evidence, adding credibility to the argument for educational reforms prioritizing student engagement, interaction, and a more personalized learning experience. Educators and policymakers can draw upon these results to justify and implement pedagogical shifts that move away from traditional, teacher-centered models toward instructional strategies that better align with students' needs and learning styles.

However, while the hypothesis results provide a compelling case for the effectiveness of a student-centered teaching approach, it is essential to acknowledge the

complexity of educational contexts and the need for a nuanced understanding of the implications for policy and practice. The research question extends beyond immediate test scores, prompting a consideration of long-term effects. For instance, do students retain the knowledge and skills acquired through student-centered methods over time? Understanding the sustainability of the observed improvements is crucial for making informed decisions about instructional strategies. Emphasizing that to enhance student performance, educators should adopt activity-stimulating and student-centered approaches, such as the demonstration method, as opposed to relying solely on conventional methods like lectures (Malinao et al., 2023; Amber et al., 2022; Maikano et al., 2022). Highlights the various advantages of the demonstration teaching method. Firstly, it contributes to time efficiency and material conservation.

Additionally, it serves as an attention-grabbing and potent motivator during lesson delivery. The method allows students to receive immediate feedback through their own produced outcomes, offering a tangible connection to the course of study. Moreover, it provides a real-life context for learning as students acquire practical skills using tools and materials. When executed by skilled teachers, the demonstration method becomes a motivational tool and effectively demonstrates the correct procedures. Overall, the study underscores the significant positive impact of the demonstration method on students' academic performance, validating its efficacy as an engaging and effective teaching approach.

This study aimed to explore the effect of a student-centered teaching approach on students' academic performance. The results indicated an enhancement in the scores of prospective secondary mathematics teachers on the student-centered teaching approach, signifying that the provided instruction contributed to an improvement in their attitudes towards the student-centered teaching approach. This discovery is encouraging; prospective teachers may lean towards teacher-directed instruction and seek guidance in student-centered learning environments due to their familiarity with the teacher-directed approach. Conversely, other studies propose that given the option, participants prefer a constructivist-based teaching approach over the traditional lecture-based method (Özer, 2023; Hu et al., 2023; Dejene & Song, 2020; Onanuga et al., 2021; Bell, 2019).

More than merely discussing the importance of a constructivist environment is required; it is crucial to ensure the actual implementation of the approach. The microteaching experience, coupled with subsequent class discussions, played a vital role in helping prospective teachers internalize the structure of the student-centered approach to teaching. Despite having a positive perception of constructivism, teachers may need help integrating the student-centered approach into their teaching methods and implementing reform processes by prospective secondary mathematics teachers in classrooms. Consequently, from the present study, we can infer that exposure to the student-centered approach during the course and engaging in microteaching aligned with this approach assisted participants in meeting various expectations associated with this teaching approach.

CONCLUSION

Fundamental Finding: Education is transmitting or gaining knowledge, fostering reasoning and judgment abilities, and preparing oneself or others intellectually for the future. The success of this process heavily relies on the method employed, influencing the degree to which the educational objectives are met. Engaging in a student-centered

approach catalyzes capturing and sustaining students' attention. Prioritizing and addressing individual learning needs results in a higher quality of education. **Implication:** Effectively managing students' expectations is crucial for fostering academic development. The study's anticipated impact is to inspire mathematics teachers and educational researchers to delve deeper into this realm, aiming to refine teaching approaches for contemporary students. **Limitation:** Embracing the shift toward a student-centered approach empowers students to participate actively in the learning process, collaborate as a team, and utilize diverse resources to solve problems. Notably, this approach nurtures students' independence in analysis, synthesis, and evaluation, making them accountable for their learning. The significance lies in students' ability to independently resolve challenges without solely relying on teachers. **Future Research**: This comprehensive educational model enhances academic skills and cultivates a sense of responsibility and autonomy in students. It is a matter of study to conduct in the future Andover.

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