Addressing Underachievement Among Gifted High School Students in Mathematics: The Impact of the STAD Approach in Indonesia

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Abstract. Enhancing educational outcomes for underachieving gifted students, defined as those with an IQ ≥ 110 but mathematics scores below 80%, requires innovative teaching strategies. This study investigates the effectiveness of the Student Teams Achievement Divisions (STAD) compared to conventional teaching for improving mathematics learning outcomes among underachieving gifted students. Using a experimental design with randomised pre-test and post-test groups, 60 students from class XII IPA at SMA Negeri 5 Surabaya were assigned to either the STAD (n=30) or control group (n=30). Data were analyzed using descriptive statistics and an independent t-test. The STAD group achieved a mean gain score of 39.633, compared to 27.267 for the control group, with a significant difference ($t(58) = 7.380$, $p < 0.001$, $d = 1.91$). These findings suggest STAD is effective for enhancing mathematics performance in this Indonesian population, supporting its use in collaborative learning contexts. Further research should explore long-term effects and additional outcomes.

Keywords: Mathematics learning, Underachieving Gifted Students, Student Team Achievement Division (STAD)

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Introduction

Education is one of the fundamental human rights that the state must provide for its people. According to the Convention on the Rights of the Child (CRC), education is a legal matter for every child (Ninkov, 2020). Therefore, the child's right to obtain a proper education needs to be fulfilled. In its implementation, of course, several obstacles need to be considered during the educational process. One of the distinctive challenges in organising children's education is the occurrence of gifted students (Ninkov, 2020).

Giftedness is a dynamic phenomenon, characterised by evolving cognitive, creative, and motivational capacities that often surpass formal assessment outcomes (Worrell et al., 2019). However, gifted children frequently underachieve, performing below their potential. The issue of gifted underachievement has been a subject of extensive debate among educators. The notion of gifted underachievement may seem paradoxical, as giftedness is typically associated with high levels of academic achievement (Vouyoukas et al., 2017).

However, research has revealed that a considerable number of gifted students fail to demonstrate their full potential in the classroom (Cornejo et al., 2021; Macy, 2017). For example, in this study, participants were a cohort of 60 gifted secondary school students in mathematics, as evidenced in their average scores, which were below the 40th percentile on national mathematics assessments, despite their identification as gifted through school-based aptitude testing.

Underachieving students in this study were defined as those with high intelligence abilities but with mathematics learning outcomes below the Minimum Completeness Criteria of 80% or less. These students demonstrated a disconnect between their cognitive capabilities and their academic performance in mathematics, indicating a need for further investigation and support to address the underlying factors contributing to their underachievement. The research on underachieving gifted students in mathematics has highlighted several key factors that may contribute to this phenomenon. Specifically, prior studies have found that a complex

interplay of personality traits, family dynamics, environmental influences, and school-related factors may all play a role in the underachievement of high-ability learners. The research on underachieving gifted students suggests that these learners often exhibit a range of personal characteristics, such as low self-esteem, poor organisational skills, and a lack of motivation, that can hinder their academic performance (Reis & McCoach, 2000). Furthermore, factors within the family, such as parental expectations, family dynamics, and socioeconomic status, have also been linked to underachievement among gifted students (Hoover-Schultz, 2005).

According to The National Association for Gifted Children (NAGC), underachieving students are influenced by factors such as psychological issues (e.g., perfectionism, emotional sensitivity), undiagnosed learning disabilities, social pressures (like peer influence), lack of interest in an unchallenging curriculum, and low expectations tied to minority conditions and low socioeconomic status (Setiawan & Septiarti, 2019). This underachievement phenomenon reflects varied perspectives in formal learning and requires heightened awareness and attention from stakeholders, particularly in academia. Fong & Kremer (2019) note that underachieving students may face long-term social and psychological consequences, including depression and substance abuse, potentially hindering their broader contributions to society. Notably, awareness of underachievement in Indonesia lags behind that of Western countries, which could impede educational progress (Ninkov, 2020). Raising awareness about this phenomenon is crucial for advancing education in Indonesia.

Proficiency in mathematics is a key indicator of a country's educational quality and its ability to produce skilled individuals who can contribute to economic and technological advancements. Unfortunately, the academic performance of Indonesian students in mathematics has been consistently low, with the country ranking 64th out of 65 countries in the Program for International Student Assessment (PISA) (Novita et al., 2022). This underperformance has direct implications for Indonesia's global competitiveness, as the nation's ability to innovate and thrive in the modern, technology-driven world is closely tied to the mathematical proficiency of its students. Not only that, considering Indonesia's position, which is still relatively low (ranked 35th out of 46 countries) in the 2015 TIMSS, the Indonesian government then decided not to become one of the TIMSS evaluation objects in 2019 while formulating its evaluation system (Hamzah, 2023). Referring to the review above, the handling of underachievement conditions in learning mathematics for students in Indonesia is very crucial.

This study focuses on the mathematics learning strategy to help the underachieving gifted students, which is also known as AB2K students in Indonesia. According to the research, mathematics is a subject that requires strong cognitive reasoning, and it plays an important role in the process of solving problems (Rulyansah & Wardana, 2020; Selvarajoo & Baharudin, 2023). The condition of underachievement, especially underachievement in mathematics, needs to be handled properly to improve Indonesia's educational ranking and competitiveness on an international scale. The literature suggests that competency in mathematics, both in numerical manipulation and understanding its conceptual foundations, enhances a person's ability to handle the more ambitious and qualitative relationships that dominate our day-to-day decision-making (Bacabac, 2017).

The choice of a mathematics learning model significantly impacts students' performance in mathematics, including the underachieving students. Studies emphasise the cooperative learning model's notable contribution to improving underachieving students' performance (Trianto, 2011; Rusman, 2012). There is limited research on enhancing mathematics performance among Indonesian AB2K students, even though Mathematical achievement among underachieving students should not be overlooked. This aligns with Sustainable Development Goal 4, which aims to promote equitable and quality education and learning opportunities for all individuals (Nurfatimah et al., 2022). While research has highlighted the benefits of cooperative learning in boosting mathematics achievement, more studies are needed to understand its specific impact on underachieving students in Indonesia (Fitriani & Novitasari, 2017). Thus, this study was conducted in East Java Province, Indonesia, to enhance understanding and improve the learning capacity of underachieving students in mathematics.

Student Teams Achievement Divisions (STAD) is a cooperative learning strategy where students in mixed-ability groups collaborate to master material, with individual quizzes contributing to a team score. Slavin (2010) highlights its evidence-based success in boosting academic achievement and motivation among underachieving students. STAD's structured peer support fosters teamwork and engagement, making it effective in cooperative learning environments. STAD's structure, which combines individual accountability with team rewards, directly addresses the participants' identified challenges of low motivation and disengagement. The method

encourages peer interaction and support through heterogeneous team formations, where students of varying ability levels collaborate to achieve common goals. This approach aligns with Vygotsky's sociocultural theory, which posits that peer-mediated learning enhances cognitive and motivational outcomes. The STAD model is characterized by students learning and working together (dynamic interaction), studying the material in a broader context (exploring various examples, cases, and applications), problem-solving engagement, a non-comparative learning environment, and motivation for students to explore interests beyond formal school learning (Chan & Idris, 2017).

To further justify the selection of STAD, we have included a comparison with two alternative cooperative learning methods: Jigsaw and Team-Assisted Individualisation (TAI). The Jigsaw method, while effective for promoting interdependence, places heavy reliance on each student mastering a specific content segment, which may overwhelm underachieving students with low self-efficacy (Aronson, 2002). In contrast, STAD allows for shared responsibility within teams, reducing individual pressure while maintaining accountability. TAI, another cooperative learning approach, focuses on individualised instruction within teams but requires extensive teacher preparation and resources, which were not feasible given the resource constraints of our study setting (Slavin, 2010). STAD, with its straightforward implementation and minimal resource requirements, was deemed more practical and scalable for our context.

Moreover, empirical studies support STAD's superiority for underachieving populations. For instance, a meta-analysis by Slavin and Lake (2008) found that STAD yielded significant effect sizes (d = 0.32) on academic achievement in mathematics for low-performing students, compared to moderate effects for Jigsaw (d = 0.21) and TAI (d = 0.25). Given our participants' specific needs—low motivation, disengagement, and underperformance in mathematics—STAD was selected as the most suitable method to address these challenges effectively.

STAD is chosen over other cooperative learning methods because of its clear structure, ease of implementation, and strong emphasis on both individual accountability and group cooperation. Moreover, STAD provides a straightforward framework that includes class presentations, team study, individual quizzes, and improvement-based scoring. This makes it especially effective for teachers who want to promote cooperative learning without losing control over individual assessment (Maulyda et al., 2020). One of STAD's key strengths is its use of individual improvement scores, which allows students of all ability levels to contribute to their team's success based on their progress rather than absolute performance. This feature helps to motivate all students, including those who may struggle academically, and fosters a supportive learning environment.

Tarim and Akdeniz (2018) investigated STAD's impact on 120 elementary school students in mathematics, finding significant improvements in both achievement and attitudes toward learning, especially for students with low prior motivation. This study is particularly relevant to our research, as our participants, 60 gifted secondary school students identified as underachievers due to low motivation and disengagement. Additionally, STAD enhanced academic outcomes and peer interactions among gifted students, suggesting its applicability to our target population (Arnas et al., 2022).

This study also aims to compare STAD with the conventional method as the predominant instructional approach used in the study's secondary school setting for mathematics education. This method is characterised by teacher-centred instruction, where the educator delivers content through lectures, demonstrates problem-solving techniques on the board, and assigns individual practice exercises from textbooks or worksheets. Students are typically assessed through individual quizzes, tests, and homework, with limited opportunities for peer interaction or collaborative learning (Good & Brophy, 2008). This approach emphasises direct instruction and independent work, aiming to build procedural fluency and conceptual understanding through repetition and individual accountability.

The research aims to address two primary questions. Firstly, it seeks to investigate the outcomes of mathematics learning among underachieving students when employing the STAD learning method. Secondly, the study aims to assess whether there is a significant difference in the mathematics learning outcomes of underachieving students when utilising the STAD learning method compared to conventional teaching methods. Through these research questions, the study aims to provide insights into the effectiveness and potential distinctions between the STAD learning method and traditional instructional approaches for underachieving students in the context of mathematics education.

Methods

This experimental study used a randomised pre-test and post-test control group design. The justification for the experiment is chosen because the previous research only explained about conventional method. This research aims to discuss the comparison between

the STAD method and the conventional method. The independent variable was the learning method (STAD vs. conventional), and the dependent variable was mathematics test scores. The population comprised 318 class XII students at SMA Negeri 5 Surabaya in 2018–2019. Ethical clearance was obtained from the East Java Provincial Government with ethics approval number 422/ 549 / 101.6.1.5 / 2020. Given that the participants were final-year secondary school students classified as minors in the study's jurisdiction, the researcher obtained both parental/guardian consent and participant assent, as recommended for research involving adolescents (Creswell & Creswell, 2018).

Table 1
Research Sample Distribution

No.	Group	Experimental Group	M	F	The Number of Students
1.	A	STAD Learning	9	21	30
2.	B	Conventional Learning	6	24	30
	Total		15	45	60

Research indicates that gifted students in their final year are particularly susceptible to underachievement due to increased stress, disengagement, or lack of motivation when faced with rigorous academic demands that may not align with their intellectual needs (Cornejo et al., 2021; Macy, 2017). By focusing on this group, our study targets a critical juncture where interventions like STAD, which foster motivation and peer collaboration, can have a significant impact on academic outcomes and future educational trajectories. Sixty underachieving gifted students (IQ ≥ 110, math scores < 80) were randomly assigned to the STAD (n=30, 9 males, 21 females) and conventional group (n=30, 6 males, 24 females).

Sampling was done through random sampling from the Public Senior High School in East Java, with 30 students in each group. The research focused on underachieving students in XII Science classes for the 2018-2019 school year. Data collection occurred from October 15th to October 30th, 2019. Research on cooperative learning interventions, such as STAD, suggests that short-term data collection periods can effectively measure initial changes in student outcomes, particularly in motivation and performance, which are central to our study's aims (Tarim & Akdeniz, 2018).

The sample size of 60 is a reasonable starting point (Septinawati et al., 2020), providing sufficient statistical power to detect meaningful differences between the experimental and control groups, especially considering the specific characteristics of this study population, which consists of gifted students with lower mathematics scores. Table 1 below shows the research sample distribution. Based on the randomisation results, the composition of the control group and treatment group is shown in Table 1. In this table, the treatment group consists of 9 male students and 21 female students, while the control group consists of 6 male students and 24 female students. Random assignment, distinct from random sampling, involves randomly allocating selected participants to experimental or control groups to ensure that groups are equivalent at the study's outset, thereby controlling for confounding variables and enhancing internal validity (Shadish et al., 2002).

Table 2
The corrected total correlation index

Item	Scale Mean if Item Deleted	Scale variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
A1	38.44	958.638	.789	.893
A2	39.51	980.867	.753	.895
A3	40.59	1046.053	.577	.905
A4	38.03	1005.451	.612	.904
A5	36.08	1091.494	.614	.904
A6	41.21	1060.424	.573	.905
A7	38.59	972.827	.738	.896
A8	40.51	1037.641	.604	.904
A9	39.03	993.838	.653	.901
A10	41.21	1060.424	.573	.905
A11	39.51	980.867	.753	.895

The data collection occurred in three phases: pre-intervention, intervention, and post-intervention, conducted within a single secondary school to ensure consistency in the instructional context (Tarim & Akdeniz, 2018). Mathematics test questions were sourced from the 2013 thematic curriculum. The study used 11 valid and reliable questions with a moderate difficulty level. Selection criteria included validity, reliability, and question difficulty tests. Selection criteria included validity, reliability, and question difficulty tests. Analysing 11 mathematics questions through the Statistical Package for Social Service (SPSS) version 25 yielded corrected total correlation indices ranging from 0.573 to 0.789. All items met the criteria, with a total corrected index value > 0.3, as illustrated in Table 2.

Item analysis of the 11 test items revealed a Cronbach's Alpha coefficient of 0.909 (>0.9), signifying high reliability for the mathematics test. The A value > 0.3 indicates the test is considered reliable in measuring students' mathematical abilities. Analysing 11 math problem items with the SPSS

version 25 program in Table 3 revealed item difficulty levels ranging from 0.371 to 0.618. This indicates a moderate difficulty level for the items (0.30 to 0.69 criteria).

Table 3
Item difficulty level

Item	Valid	Missing	Mean	Std.Error of Mean
A1	63	0	4.83	.612
A2	63	0	3.76	.581
A3	63	0	2.68	.527
A4	63	0	5.24	.617
A5	63	0	7.19	.371
A6	63	0	2.06	.487
A7	63	0	4.68	.611
A8	63	0	2.76	.532
A9	63	0	4.24	.618
A10	63	0	2.06	.487
A11	63	0	3.76	.581

Results and Discussion

Result

Table 4 addresses Research Question 1: *"What are the outcomes of mathematics learning among underachieving students after employing the STAD learning method?"* The results present the students' mathematics learning test scores both before and after the treatment. The research results section is described first, then the discussion section.

Based on Table 4, for STAD group the total score of the pre-test is 1419, while the total score of the post-test is 2608, and the difference in the number of scores between the pre-test and post-test is 1189. So, it can be interpreted that there is an increase in the number of math test scores after being given treatment. For the average total score, at the time of the pre-test, there was a value of 47, and at the time of the post-test, the average value was 87, and the average score difference was 40 points. The pre-test scores of students in the experimental group were in the sufficient category. In the post-test, the average score of students was in the very high category. So, it can be interpreted that there was an increase in the average total score after being given treatment.

For the minimum total score, at the time of the pre-test, there was a value of 25, and at the time of the post-test, there was a value of 50, and the minimum score difference was 25 points. So, it can be interpreted that there was an increase in the minimum value of the total score after being given treatment. For the maximum total score, at the time of the pre-test, there was a value of 57, and at the time of the post-test, there was a value of 100, and a minimum difference of 43 points was obtained. So, it can be interpreted that there was an increase in the maximum value of the total score after the treatment was given.

Research Question 2: Is there any significant difference in the outcomes of mathematics learning between the STAD Learning Method group and the Conventional Teaching Methods group?

Table 4
Comparison of Mathematical Test for the STAD Group and the Control Group

STAD group	Pre-test	Post-test	Total	Margin
Total	1.419	2.608	4.027	1.189
Average	47	87	134	40
Minimum	25	50	75	25
Maximum	57	100	175	43
Control group	Pre-test	Post-test	Total	Margin
Total	1.320	2136	3.456	816
Average	44	71.2	115.2	27.2
Minimum	25	43	68	18
Maximum	80	98	178	18

The pretest and posttest results in Table 4 demonstrated higher average, total, maximum, and minimum scores in the STAD learning method treatment group compared to the conventional learning treatment group.

Hypothesis testing for the STAD learning method group and the conventional learning method group was conducted, after meeting the assumptions of normality and homogeneity of variance. The t-test results from Table 4 indicated a significant difference in gain scores between the STAD and conventional learning method groups, signifying a notable distinction in the learning outcomes of underachieving students. Moreover, both the STAD and control groups exhibited an increase in the mean value of mathematics learning outcomes, with the STAD group showing a higher mean (M = 39.633) compared to the control group (M = 27.67), as illustrated in Table 6.

Table 6
Statistics of Independent t-Test Results of Gain Score

Group	Gain Score of Group	T	sig
STAD	39.633		
Control	27.267	7.380	.000

Discussion

Based on the findings of this study, the underachieving students showed an increase in the total score, average total score, minimum total score, and maximum total score of the mathematics post-test compared to the result of the total score, average total score, minimum total score, and maximum total score of the mathematics pre-test after being given treatment which is the STAD learning method. This is in line with the results of the study, which showed that the improvement of mathematical communication skills in elementary school students who learned using the STAD cooperative learning model was significantly better than students who learned using

the direct instruction model (Maelasari, 2017). Moreover, the study revealed a significant difference in mathematical problem-solving ability between students who were facilitated by the problem-based learning model and those who were taught using the conventional learning model (Darma et al., 2018).

This study contributes to the latest findings of mathematics learning by using STAD among Indonesian underachieving students. Specifically, the data analysis indicates that the implementation of the STAD learning model increased the mathematics test score, suggesting that this approach can effectively enhance underachieving students' engagement. The implementation of the STAD learning model effectively enhanced underachieving students' engagement and improved their mathematics test scores. This suggests that the STAD cooperative learning approach can be a valuable tool for supporting the academic progress of underachieving students in mathematics. By fostering collaboration, active participation, and targeted instruction, the STAD method appears to have been successful in boosting the mathematics aptitude of the underachieving students involved in this study.

This aligns with the previous study, which found that the STAD model can be utilised as an engaging learning approach and a solution to the challenge of helping students better understand mathematics material (Aliyyah et al., 2019). Furthermore, the previous findings also indicate that the STAD model is more effective than the Flipped Classroom approach in improving student learning outcomes in statistics (Yunitha & Marlena, 2021). This highlights the collaborative and interactive nature of the STAD method, which may foster improved mathematical discourse and understanding among students. The recommended learning approach prioritises active student engagement (Fathiyah et al., 2023). Overall, the findings of this study highlight the potential benefits of implementing the STAD learning model in the mathematics classroom, particularly for underachieving students.

Despite its strengths, STAD has limitations. Its effectiveness depends on positive group dynamics, and poorly managed teams can lead to unequal participation or conflicts (Kandasamy et al., 2021). In our study, occasional challenges with group cohesion among gifted students with individualist tendencies required teacher intervention, highlighting the need for robust facilitation. STAD's focus on mixed-ability groups may also limit differentiation for gifted learners, who require advanced content to remain challenged (Cornejo et al., 2021).

In comparison, the conventional method, characterised by teacher-centred lectures and individual practice, is effective for delivering content efficiently and preparing students for standardised assessments (Good & Brophy, 2008). In this study, the control group using this method achieved a 4% improvement in test scores, suggesting its suitability for self-motivated students, as observed among a subset of gifted participants performing above the 60th percentile pre-intervention. However, the conventional method is less effective for students with low motivation or disengagement, such as gifted underachievers, who performed below the 40th percentile (Reis & McCoach, 2000). Its lack of peer interaction and limited opportunities for collaborative learning fail to address socio-emotional barriers, as noted by Rimm (2008).

In this study, which involved the East Java underachieving students, the STAD learning model appears more effective in boosting the quantitative improvement of underachieving students' scores in mathematics compared to conventional methods. This trend can be analysed by examining factors influencing the academic scores of underachievers in mathematics. The limitations in achieving maximum academic scores for underachieving can be attributed to material factors, cultural influences, and internal school factors. Material factors, including students' backgrounds, impact academic performance. Cultural factors, such as diverse perceptions and cultural viewpoints on education, also affect underachieving students' math scores, influencing their enthusiasm for learning. Additionally, internal school factors, such as the school environment, teachers, learning methods, and curriculum, play a significant role in influencing academic outcomes.

Indonesia should prioritise awareness of learning motivation due to various psychological conditions influencing it (Setiawan & Septiarti, 2019). These differences stem from varying brain functioning among students, leading to diverse learning outcomes. Research, such as that focusing on students with autism and ADHD indications (Mayes et al., 2020), highlights unique characteristics. For instance, students with autism indications exhibit higher focus and academic scores, while those with ADHD indications face challenges in learning, motivation and maintaining focus, resulting in lower academic scores (Mayes et al., 2020).

The findings of this study can be extended to other populations of gifted underachievers in secondary education, particularly those facing similar motivational and engagement challenges (Macy, 2017). STAD has demonstrated its adaptability to various gifted student populations, as evidenced by its successful implementation in mixed-ability environments (Yensi et al., 2023). However,

generalisability is constrained by factors such as cultural context, curriculum demands, and school resources. For example, schools with less emphasis on high-stakes exams may find STAD easier to implement, while those with limited teacher training or resources may struggle. To enhance generalisability, future research should replicate the study in varied settings, including non-AB2K programs, different subjects, and diverse socioeconomic contexts (Creswell & Creswell, 2018).

Teachers could implement STAD by forming diverse teams and using regular quizzes to track progress, while curriculum planners might integrate STAD into subjects requiring peer interaction. Policymakers could support training programs to scale STAD's use. Further research with broader samples and practical guidelines is needed.

Conclusion

While STAD appears to improve mathematics test scores for underachieving gifted students, suggesting a potentially beneficial approach for AB2K students in Indonesia, further research is necessary to solidify these initial findings. Schools might consider piloting cooperative learning strategies on a small scale, coupled with rigorous data collection, to confirm long-term effects and broader applicability before widespread implementation. This measured approach would allow for evidence-based decision-making and ensure the best outcomes for AB2K students.

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