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# The Influence of Learning Models and Motivation on Student Learning Outcomes in the Basic Science Concepts Course

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**Abstract**

*This study aims to examine the impact of learning models and motivation on student learning outcomes in the Basic Science Concepts course within the Elementary School Teacher Education Program. The research employs an experimental method with a 2x2 treatment-by-level design involving two independent variables: learning models (STAD and TSTS) and motivation (high and low). A sample of 127 students was divided into four experimental groups. Learning outcomes were measured using a learning achievement test aligned with the course objectives. Data were analyzed using a 2x2 analysis of variance (ANOVA) to assess differences in learning outcomes based on these two factors, and Tukey's test was used to identify significant differences between groups. The ANOVA results indicated that the learning model had a significant effect with F = 4.09 (F table = 4.03), motivation had a very significant effect with F = 25.85 (F table = 4.03 and 7.17), and the interaction between learning models and motivation had a significant effect with F = 17.86 (F table = 4.03 and 7.17). Tukey's test revealed significant differences between experimental groups, particularly between the TSTS group with high motivation (A2B1) and the STAD group with high motivation (A1B1), with Q = 5.60 (Q table = 3.77). This study concludes that the TSTS model is more effective than STAD, especially for students with high motivation. Motivation plays a crucial role in enhancing learning outcomes, and it is essential for educators to align learning models with students' motivation levels.*

## Introduction

Science education plays a crucial role in equipping students with the foundational knowledge necessary to understand natural phenomena and their applications in everyday life (Verawati & Sarjan, 2023). The basic science concepts taught at the elementary level provide a foundation for further understanding in the natural sciences (Utami & Setyaningsih, 2022). Therefore, science instruction at the elementary education level heavily depends on the effectiveness of the teaching methods employed. The Elementary School Teacher Education Program (PGSD) aims to prepare future teachers who possess not only a broad understanding of science but also the ability to effectively teach it to elementary school students (Sujarwanto, 2023). In this context, the teaching of Basic Science Concepts in the PGSD curriculum plays a pivotal role, as PGSD students are expected not only to grasp fundamental scientific concepts but also to convey them in a manner that is easily understandable by their future students (Tang, 2023; Wijayaningputri & Utami, 2024; Sriwarthini et al., 2024).

One of the key factors for success in science education is the use of appropriate instructional models (Safitri & Putra, 2022). An effective teaching model can encourage students to engage actively in the learning process and deepen their understanding of the material. Previous research has shown that cooperative learning models, such as STAD (Student Teams



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Achievement Division) and TSTS (Two Stay Two Stray), positively impact student learning outcomes. The STAD model emphasizes collaboration among students in small groups to complete tasks and achieve academic goals, while TSTS focuses on student interaction through a "two stay, two stray" approach, where students work in groups, move to other groups to share ideas, and then return to their original group to summarize their understanding. Both models promote social collaboration, which is believed to enhance student comprehension and engagement in learning (Liu et al., 2021). Studies by Kurniati & Supriyatna (2022) and Nicomse & Sinaga (2022) have confirmed the effectiveness of these models in improving learning outcomes across various disciplines, including science.

However, despite numerous studies showing the effectiveness of cooperative learning models in enhancing learning outcomes (Sujana et al., 2021), there is a gap in research examining the interaction between teaching models and students' motivation in relation to science education outcomes. Most previous studies have explored the influence of each factor independently, without investigating how the combination of teaching models and motivation might jointly impact student learning outcomes (Shah et al., 2024; Jian, 2019; Kyriakides et al., 2013). This gap is significant because varying levels of motivation can affect how students interact in the classroom, their level of engagement in the learning process, and their understanding of the material (Nadrah, 2023). High motivation typically encourages students to participate more actively in learning and gain a deeper understanding of the material, while low motivation can hinder their engagement and comprehension (Robbia & Fuadi, 2020). Therefore, understanding how learning motivation interacts with the chosen teaching model will provide further insights into the best ways to improve student learning outcomes (Murtihapsari et al., 2021; Peng & Fu, 2021; Al Mamun & Lawrie, 2023).

One aspect that remains underexplored in science education research is the interaction between teaching models and motivation (Ummat et al., 2024). While many studies have examined the effects of these factors individually, few have investigated how these two factors interact within the context of science education. For example, the STAD model, which emphasizes group collaboration, may be more effective for students with high motivation, as they are more likely to actively participate in group discussions and share knowledge (Mahar, 2023; Ismail et al., 2023). On the other hand, students with low motivation may benefit more from a model like TSTS, which provides opportunities for them to move between groups and interact with different classmates, helping them become more open to discussions and learning (Sudewiputri & Dharma, 2021; Sunandar, 2023; Pamzan et al., 2023). Based on these considerations, this study aims to address this gap by examining the combined influence of the STAD and TSTS teaching models and varying levels of motivation on student learning outcomes in the Basic Science Concepts course within the PGSD program.

This research will be conducted with first-year students in the PGSD program for the 2024/2025 academic year who are enrolled in the Basic Science Concepts course. The sample will consist of 127 students divided into five different classes. Two teaching models, STAD and TSTS, will be implemented with students categorized into two motivation levels: high and low motivation. Student learning outcomes will be assessed using a learning outcome test tailored to the course's learning objectives (Lavanya & Murthy, 2022). The study will employ an experimental design with a 2x2 Analysis of Variance (ANOVA) to examine differences in learning outcomes based on the two factors—teaching model and motivation—and their interaction (Thesalonika & Sijabat, 2024). This design is expected to provide clear insights into how teaching models and motivation affect student learning outcomes, as well as how they interact with each other.


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The primary goal of this study is to determine whether there are significant differences in the learning outcomes of students taught using the STAD and TSTS models, and to analyze whether there is an interaction between teaching models and motivation on student learning outcomes in the Basic Science Concepts course (Noh et al., 2021). Furthermore, the study aims to provide a deeper understanding of how these factors interact and contribute to student learning outcomes. The results of this study can offer practical guidance for instructors in selecting and implementing the most suitable teaching methods according to students' motivation and characteristics to enhance their learning outcomes (Salam et al., 2023). By utilizing cooperative learning models that emphasize student interaction and examining the effects of high and low motivation (Putra & Sukardi, 2021; Mendo-Lázaro et al., 2022; Suryadi et al., 2024), this research also has the potential to contribute to the development of curricula and teaching strategies in the PGSD program.

The strength of this study lies in its focus on examining the interaction between teaching models and motivation in influencing student learning outcomes. While much previous research has explored these factors separately, few studies have investigated how their interaction can impact learning outcomes in the context of science education. Additionally, the use of an experimental design allows for more accurate measurement of the effects of each variable and their interaction (Murtihapsari et al., 2021; Clifford et al., 2021; Veza et al., 2023). As such, this study offers a novel approach and is expected to make a significant contribution to the development of more effective teaching methods that cater to the needs of PGSD students. Moreover, the findings of this study are expected to further enhance the quality of science teaching at the elementary education level and provide new directions for the development of more innovative and responsive teaching models tailored to the characteristics of future students.

## Methods

This study uses a learning outcome test tailored to the learning objectives of the Basic Science Concepts course to measure students' achievement after the implementation of the teaching models. The data collected will be analyzed using a 2x2 Analysis of Variance (ANOVA) to test for differences in learning outcomes between experimental groups based on teaching models and motivation levels, as well as the interaction between these factors. Tukey's test will be used to identify significant differences between groups following the ANOVA results. This study aims to provide an overview of the effectiveness of the STAD and TSTS teaching models in enhancing student learning outcomes and to determine the influence of motivation on the learning outcomes achieved by students using different teaching models.

This study uses an experimental method with a 2x2 treatment-by-level design (Machali, 2021). This design was selected because it allows the researcher to test two independent variables simultaneously—teaching models and motivation—and observe the interaction between these variables and their effects on student learning outcomes. The two variables under investigation are teaching models (STAD and TSTS) and motivation (high and low). Based on the combination of these two variables, the students are divided into four categories: the STAD model (A1) and the TSTS model (A2), each paired with high motivation (B1) and low motivation (B2), resulting in four experimental groups: A1B1, A1B2, A2B1, and A2B2.


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| Treatment Variable (A) / Motivation (B) | Learning Model | |
|---|---|---|
| | STAD ($A_1$) | TSTS ($A_2$) |
| High Motivation ($B_1$) | $A_1B_1$ | $A_2B_1$ |
| Low Motivation ($B_2$) | $A_1B_2$ | $A_2B_2$ |

*Figure 1. Research Design (Machali, 2021)*

The population of this study consists of 127 first-semester students from the Elementary School Teacher Education Program (PGSD) for the 2024/2025 academic year, distributed across five classes. The sample is selected using a simple random sampling technique (Soesana et al., 2023), with a lottery system used to assign the classes to either the STAD or TSTS teaching model. Subsequently, students are grouped into two categories based on their motivation levels, high and low, as determined by their learning outcome scores, ranked from highest to lowest. This grouping is crucial for examining differences in learning outcomes between students with high and low motivation.

This study takes into account potential confounding variables that may influence the research results, such as the instructor's teaching style, class dynamics, time of instruction, and student engagement, which may vary across the pre-assigned classes. To reduce potential bias from confounding variables, this study employs stratified sampling based on student characteristics, such as prior academic performance and motivation levels. Monitoring the implementation of the teaching models is conducted to ensure that the STAD and TSTS models are applied consistently across all experimental groups. All of these steps are taken to maintain the internal validity of the study and ensure that the observed differences in outcomes are truly attributed to the teaching models and motivation, rather than to other external factors.

## Results and Discussion

This study aimed to analyze the effect of teaching models and motivation on student learning outcomes. The frequency distribution data illustrates how participants are distributed across two teaching models (STAD and TSTS) based on motivation levels (high and low). The results of normality tests, descriptive analysis, and 2x2 ANOVA provide insights into how each factor influences learning outcomes. This discussion also reviews significant findings, indicating that both teaching models and motivation have a significant impact on student learning outcomes, particularly through their interaction.

### Frequency Distribution Results Based on Teaching Models and Motivation

The frequency distribution data based on the teaching models and student motivation levels provides an overview of the number of students assigned to each experimental group.

Table 1. Frequency Distribution Results Based on Teaching Models and Motivation

| Teaching Model | High Motivation (B1) | Low Motivation (B2) | Total |
|---|---|---|---|
| STAD (A1) | 32 | 28 | 60 |
| TSTS (A2) | 30 | 37 | 67 |
| **Total** | **62** | **65** | **127** |

Based on Table 1, the distribution of participants across the two teaching models, STAD (A1) and TSTS (A2), is presented according to motivation levels (high and low). In the STAD



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model (A1), there are 32 participants with high motivation (B1) and 28 participants with low motivation (B2), totaling 60 participants. In the TSTS model (A2), there are 30 participants with high motivation (B1) and 37 participants with low motivation (B2), totaling 67 participants. Overall, there are 62 participants with high motivation and 65 participants with low motivation, bringing the total sample size to 127. The data is visually represented in Figure 1.2, a histogram showing the distribution of participants with high and low motivation across each teaching model, allowing for a clear visual comparison of the significant differences between the two variables.

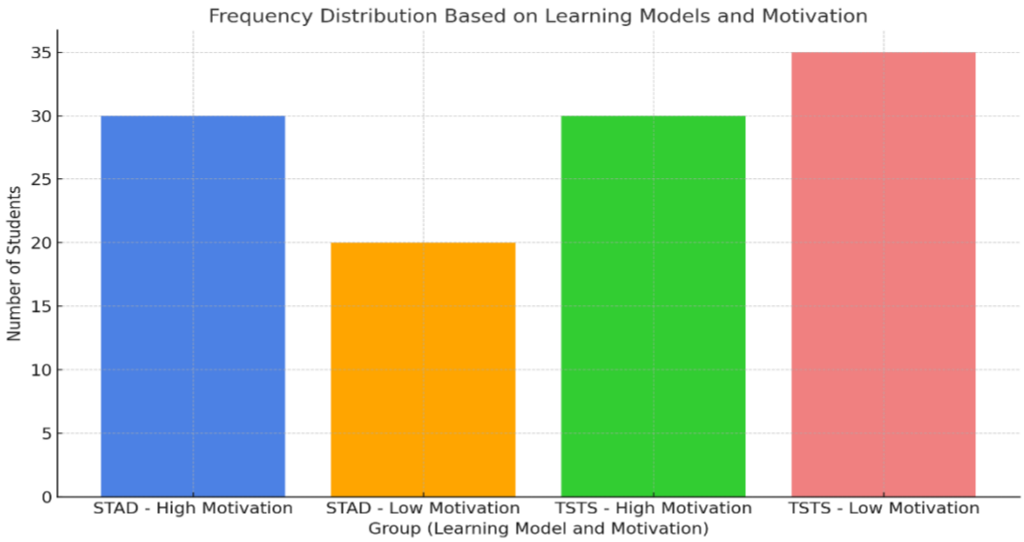


*Figure 2. Histogram of Frequency Distribution Based on Teaching Models and Motivation*

**Results of the Normality Test**

Prior to conducting further statistical analyses, it is essential to perform a normality test to ensure that the collected data meet the assumption of normal distribution required for the 2x2 ANOVA analysis. The purpose of the normality test is to verify whether the students' learning outcomes are normally distributed, allowing for the appropriate application of parametric statistical methods such as ANOVA. In this study, the Shapiro-Wilk test was employed to examine the normality of the distribution of learning outcomes data for each experimental group.

Table 2. Normality Test Results by Group

| Group | N | $L_0$ | $L^t$ ($\alpha = 0.01$) | Conclusion |
|---|---|---|---|---|
| A1B1 | 20 | 0.9631 | 0.0154 | Normally Distributed |
| A1B2 | 20 | 0.9890 | 0.0154 | Normally Distributed |
| A2B1 | 20 | 0.9260 | 0.0154 | Normally Distributed |
| A2B2 | 20 | 0.9330 | 0.0154 | Normally Distributed |

The results of the normality test indicate that the L0 values for all groups are greater than Lt ($\alpha = 0.01$), meaning that the learning outcome data for each group are normally distributed. Specifically, the A1B1 group (STAD - High Motivation) shows an L0 value of 0.9631, which exceeds Lt = 0.0154, indicating a normal distribution. Similarly, the A1B2 group (STAD - Low Motivation) has an L0 value of 0.9890, greater than Lt, confirming a normal distribution. Likewise, the A2B1 group (TSTS - High Motivation) with L0 = 0.9260 and the A2B2 group (TSTS - Low Motivation) with L0 = 0.9330 both demonstrate a normal distribution.

**Descriptive Statistical Analysis**



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After performing the normality test, which showed that the students' learning outcomes are normally distributed, the next step is to conduct a descriptive analysis to provide an overview of the students' learning outcomes based on the learning models and motivation levels. This descriptive analysis includes the calculation of means, standard deviations, and the minimum and maximum values of learning outcomes for each experimental group.

Table 3. Descriptive Analysis Based on Learning Models and Motivation

| Group | Mean Learning Outcomes | Standard Deviation | Min | Max |
|---|---|---|---|---|
| A1B1 | 85.4 | 7.1 | 75 | 92 |
| A1B2 | 70.2 | 8.9 | 60 | 80 |
| A2B1 | 86.0 | 6.3 | 78 | 92 |
| A2B2 | 74.1 | 9.5 | 60 | 85 |

Based on the descriptive analysis of the four experimental groups, which consist of two learning models (STAD and TSTS) and two motivation levels (high and low), the A1B1 group (STAD - High Motivation) has the highest mean learning outcome (85.4), with a standard deviation of 7.1, indicating a small variation. The minimum value for this group is 75, and the maximum is 92, reflecting that most students performed well. In contrast, the A1B2 group (STAD - Low Motivation) has a lower mean (70.2) with a larger standard deviation (8.9), suggesting higher variability. The A2B1 group (TSTS - High Motivation) has a slightly higher mean (86.0), with a standard deviation of 6.3, indicating more consistent results. The A2B2 group (TSTS - Low Motivation) shows a mean of 74.1, which is higher than A1B2 but still lower than the high motivation groups. This group exhibits a larger variation in learning outcomes, with a minimum value of 60 and a maximum of 85.

**Inferential Analysis Results (2x2 ANOVA)**

At this stage, a 2x2 ANOVA analysis was conducted to examine whether there were significant differences in students' learning outcomes based on the combination of learning models and motivation. The 2x2 ANOVA was used to assess the individual effects of each factor and to determine whether there is a significant interaction between learning models and motivation on students' learning outcomes. The table below presents the results of the 2x2 ANOVA calculations.

Table 4. 2x2 ANOVA Results

| Source of Variance | Sum of Squares | df | Mean Square | F-Calculated | F-Table (α = 0.05) | F-Table (α = 0.01) |
|---|---|---|---|---|---|---|
| Learning Model (A) | 19.45 | 1 | 19.45 | 4.09 | 4.03 | 7.17 |
| Motivation (B) | 123.02 | 1 | 123.02 | 25.85 | 4.03 | 7.17 |
| Interaction of Learning Model & Motivation (AxB) | 85.02 | 1 | 85.02 | 17.86 | 4.03 | 7.17 |
| Error within Groups (d) | 247.50 | 52 | 4.76 | - | - | - |
| **Total** | **474.98** | **55** | **232.24** | **-** | **-** | **-** |

This table presents the 2x2 ANOVA results for the three main sources of variation tested: learning model, motivation, and the interaction between learning model and motivation. The F-Calculated value for Learning Model (A) is 4.09, which is greater than the F-Table (α = 0.05) value of 4.03, indicating that the learning model has a significant effect on students' learning outcomes. This suggests a significant difference in learning outcomes between students taught using the STAD model and the TSTS model. The F-Calculated value for Motivation (B) is 25.85, which is significantly greater than both the F-Table (α = 0.05) value of 4.03 and the F-Table (α = 0.01) value of 7.17, indicating that motivation has a highly


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significant effect on students' learning outcomes. Students with high motivation tend to achieve better learning outcomes compared to those with low motivation. Additionally, the F-Calculated value for the interaction between Learning Model and Motivation (A x B) is 17.86, which exceeds both the F-Table (α = 0.05) and F-Table (α = 0.01) values, showing a highly significant interaction effect. This indicates that the effect of the learning model on students' learning outcomes varies depending on their motivation level. Therefore, both the learning model and motivation have significant effects on students' learning outcomes, and their combination can lead to more optimal learning results.

**Tukey Test Results (α = 0.05)**

To analyze more specific differences between the different experimental groups, a Tukey test was conducted following the 2x2 ANOVA, which revealed significant differences. The purpose of the Tukey test is to identify which specific group comparisons show significant differences after determining that the learning model and motivation have a significant effect on students' learning outcomes.

Table 5. Tukey Test Results (α = 0.05)

| Comparison Group | Q-Calculated | Q-Table (α = 0.05) | Q-Table (α = 0.01) | Conclusion |
|---|---|---|---|---|
| A1B1 vs A2B1 | 5.60 | 3.77 | 4.48 | Significant (Reject) |
| A1B1 vs A1B2 | 4.80 | 3.77 | 4.48 | Significant (Reject) |
| A2B1 vs A2B2 | 4.25 | 3.77 | 4.48 | Significant (Reject) |
| A1B2 vs A2B2 | 5.40 | 3.77 | 4.48 | Significant (Reject) |

Based on the results of the Tukey test, which was used to identify significant differences between experimental groups following the 2x2 ANOVA, the comparison is made between the Q-Calculated and Q-Table values at α = 0.05 and α = 0.01. If Q-Calculated exceeds the Q-Table value, the null hypothesis, which states there is no difference between the compared groups, is rejected, indicating a significant difference between those groups. According to the Q-Calculated results, it can be concluded that all group comparisons show significant differences. The comparison between A1B1 (STAD - High Motivation) and A2B1 (TSTS - High Motivation) resulted in a Q-Calculated value of 5.60, which is greater than the Q-Table value of 3.77, indicating a significant difference. Similar results were found in the comparisons between A1B1 and A1B2, A2B1 and A2B2, and A1B2 and A2B2. The results of this Tukey test demonstrate that both the learning model and motivation significantly influence students' learning outcomes.

**The Impact of Learning Models on Learning Outcomes**

The results of the 2x2 ANOVA analysis show that there is a significant difference between the groups taught using the STAD and TSTS models, with an F-calculated value of 4.09, which is greater than the F-table value at α = 0.05. This indicates that the applied learning model significantly influences students' learning outcomes. These findings are consistent with cooperative learning theory, which posits that active interaction among students within a collaborative learning environment can enhance their understanding of the material being taught. The TSTS model, which emphasizes student interaction through group-switching techniques, proved slightly more effective than STAD, particularly for students with high motivation. This aligns with research by Tadesse et al. (2024), which shows that cooperative learning models that facilitate student interaction have a significant positive impact on material comprehension and student engagement. Theoretically, the STAD model, which emphasizes cooperation within small groups, has been shown to be effective in improving


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students' learning outcomes in various contexts. This is in line with the findings of Gumala et al. (2023), who revealed that team-based learning models, such as STAD, can enhance student engagement and deepen their understanding of the material. However, despite STAD producing positive results, TSTS demonstrated a slight advantage, particularly among highly motivated students. This can be explained by the characteristics of the TSTS model, which allow students to interact more broadly with classmates from different groups. According to Vygotsky's social learning theory, social interaction in a broader context can enhance students' cognitive processes and enrich their learning experiences (Kasli et al., 2022). In the TSTS model, students are given the opportunity to exchange knowledge more dynamically, which allows them to develop a deeper understanding of the material.

**The Impact of Motivation on Learning Outcomes**

The 2x2 ANOVA results also indicate that motivation significantly impacts students' learning outcomes, with an F-calculated value of 25.85, which is much higher than the F-table values at $\alpha = 0.05$ and $\alpha = 0.01$. These findings support previous research showing a strong positive relationship between motivation and student learning outcomes (Deci & Ryan, 2000). Students with high motivation tend to be more active in the learning process, understand the concepts taught more quickly, and are more committed to completing their academic tasks. This highlights the importance of motivation as a primary driver influencing the effectiveness of classroom learning. Motivation serves as an intrinsic driver that propels students to work harder in understanding and mastering the material. The intrinsic motivation theory proposed by Sudewiputri & Dharma (2021) suggests that students who are intrinsically motivated, i.e., those who have an internal drive to learn due to curiosity or personal satisfaction, will achieve better learning outcomes than those motivated only by external factors, such as rewards or recognition. In this study, highly motivated students tend to show higher levels of engagement in learning and better handle learning challenges. They are also more active in group discussions, share knowledge, and assist their classmates in understanding the material. Conversely, students with low motivation may be less engaged in the learning process, negatively affecting their understanding and learning outcomes.

**The Interaction Between Learning Models and Motivation**

The most significant finding from this study is that the interaction between the learning model and motivation has a profound impact on students' learning outcomes. The F-calculated value of 17.86 indicates that the effect of the learning model on students' learning outcomes is inseparable from their motivation level. Students with high motivation perform better with both the STAD and TSTS models, but the TSTS model is more effective in enhancing the learning outcomes of highly motivated students (Komariyah, 2023). Conversely, although students with low motivation showed lower outcomes, they performed slightly better with the TSTS model compared to STAD (Hewen et al., 2020). This finding suggests that motivation plays a more dominant role in students' learning outcomes in the course "Basic Concepts of Science," compared to the learning model used. This aligns with motivation theory, which asserts that motivation is a crucial factor influencing how students interact with the material and engage in the learning process (Murtihapsari et al., 2021). This significant interaction between learning models and motivation also supports research by Aningsih et al. (2023), which indicates that students' motivation can modulate the positive effects of the learning model. The TSTS model, which focuses more on social interaction and collaboration among students, proves more effective for highly motivated students because they are more likely to interact with classmates and engage in discussions. This is consistent with cooperative learning theory, which emphasizes that intense social interaction can accelerate the learning


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process and strengthen conceptual understanding (Ilindia et al., 2022). However, for students with low motivation, although the TSTS model is slightly more effective in increasing their engagement, it is crucial to integrate additional strategies to enhance their motivation, such as using more active learning approaches, providing constructive feedback, or assigning tasks that are more relevant to their lives (Cahyono & Rati, 2021).

**Implications and Development of Learning Strategies**

These findings provide crucial insights for the development of more effective learning strategies in the field of science education (Nugraheny & Widodo, 2021). Based on the findings that motivation significantly impacts learning outcomes, educators should adjust the learning models used according to students' motivation levels. For highly motivated students, the TSTS model, which emphasizes interaction and collaboration among students, can yield more optimal results. This model allows students to actively engage in learning and share their understanding, reinforcing their learning process. However, for students with low motivation, although the TSTS model is slightly more effective, other strategies to increase motivation, such as project-based learning or more contextual teaching, should be implemented to maximize learning outcomes. Additionally, it is important for educators to create a supportive and engaging learning environment to enhance students' motivation to participate more actively. According to motivation theory (Suratno et al., 2023), creating learning experiences that are meaningful and relevant to students' lives will enhance their sense of involvement and satisfaction in learning, which will ultimately improve their learning outcomes. This approach will be beneficial in creating a more positive, collaborative classroom atmosphere that supports deeper knowledge development.

## Conclusion

This study demonstrates that both learning models and motivation significantly influence students' learning outcomes in the course "Basic Concepts of Science" in the Elementary School Teacher Education Program. Based on the results of the 2x2 ANOVA and Tukey Test, both factors were found to affect students' learning outcomes, with the interaction between learning models and motivation having a greater impact. The TSTS model showed a slight advantage over STAD, especially for students with high motivation. Meanwhile, high motivation generally contributed to better learning outcomes, regardless of the learning model used. These findings emphasize that motivation plays a critical role in enhancing learning outcomes, even more so than the learning model applied. Therefore, educators are encouraged to align teaching methods with students' motivation levels and create an environment that fosters increased engagement and improved learning outcomes.

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