Journal of Education, Learning, and Management (JELM)

ISSN: 3079-2541 (Online)

Volume 2 Issue 2, (2025)

https://doi.org/10.69739/jelm.v2i2.864

https://journals.stecab.com/jelm

Published by
Stecab Publishing

Research Article

The Mediating Effect of Student Teacher Relationship on the Student Engagement and Science Motivation

*[1]Laylanie A. Lacoste, [1]Hazel G. Carreon

About Article

Article History

Submission: July 21, 2025
Acceptance : August 20, 2025
Publication : September 02, 2025

Keywords

Education, Science Motivation, Student-Teacher Relationship, Student Engagement

About Author

[1] Department of Education (DepEd), Philippines

Contact @ Laylanie A. Lacoste
l.lacoste.543362@umindanao.edu.ph

ABSTRACT

Major problem in education is junior high school students' lack of enthusiasm and engagement in science, which is demonstrated by their low performance on test like PISA and their waning interest in the subject. The purpose of this study is to investigate student-teacher relationships, science motivation and student engagement levels. It also looked at whether the link between science motivation and student engagement is considerably mediated by the student-teacher interaction. A quantitative correlational research design with mediation analysis was used in this study. Variable level was determined using descriptive statistics, inter-variable correlation was calculated using Pearson's r, and mediation effects were evaluated using Sobel z-test in med graph frameworks. Standardized tools were used to evaluate behavioral aspects of the student-teacher connection; intrinsic, grade, career, and self-efficacy components of science motivation, cognitive and emotional characteristics of engagement. Using stratified random sampling, 348 Grade 7 to 10 students from public school in Pangantucan, Bukidnon were selected, based on Rao soft sampling criteria from a total population of 3,600. The results revealed high levels of student-teacher closeness. All three variables were significantly and positively correlated. Remarkably, the student-teacher relationship was found to partially mediate the relationship between engagement and science motivation. The results showed how crucial supportive student-teacher interactions are to raising students' enthusiasm and involvement. Junior high school students' interest in science may rise and science learning results may improve if student-teacher interactions are strengthened. school administrators in designing targeted interventions that promote interests in science education. The dwindling interest and passion of junior high students in science, as seen by their poor performance on extensice tests like PISA, is a reccuring problem in education. This study looked at how student-teacher connections function as mediator between science motivation, student engagement, and student-teacher interactions. Standardized measures of student-teacher connectivity, science interest, and engagement were used to collect data from 348 students in Grade 7-10 in public school in Pangantucan, Bukidnon. The findings revealed substantial positive relationships between all factors and high degrees of student-teacher intimacy. Crucially, it was discovered that the relationship between science motivation and engagement was partially mediated by the students-teacher relationship between science motivation and engagement was partially mediated by the student-teacher interaction. These results demonstrate how crucial supportive student-teacher interactions are in converting students interest into active participation. In order to help teachers and school administrators create focused interventions for scientific education. The study provides evidence that improving connections between teachers and students can increase students interest in science and improve learning results

Citation Style:

Lacoste, L. A., & Carreon, H. G. (2025). The Mediating Effect of Student Teacher Relationship on the Student Engagement and Science Motivation. *Journal of Education, Learning, and Management, 2*(2), 100-115. https://doi.org/10.69739/jelm.v2i2.864

1. INTRODUCTION

An understanding of the complex relationship between science motivation and student engagement has gained increasing attention in contemporary educational research, especially within the field of science education. As student go through the educational system, particularly in secondary school, their motivation to learn tends to decline. In line with Toma *et al.* (2021), this is frequently the result of a transition from exploratory, hands-on activities in earlier grades to more abstract, textbook-driven learning in later years trends and sustain long-term engagement. Science motivation refers to students' internal drive and interest in learning scientific concepts. However, a number of troublesome problems may prevent this drive. Science is seen as challenging by many students, particularly in Physics, Chemistry, and Genetics, which makes them less confident and inclined to participate.

Science motivation and student engagement are intimately related and reinforce one another. When science is taught as a static body of knowledge rather than as a dynamic process of discovery, students may not always understand the importance of science outside the classroom (Scheider *et al.*, 2020). According to these studies, learning environments that are encouraging and supportive-like those that provide student autonomy, meaningful feedback, and genuine scientific inquiry- are necessary to defy these tendencies and sustain long-term engagement (Fredricks *et al.*, 2021). Thus, motivating students to be interested in science helps them stay motivated, and students who are motivated stay interested (Reeve & Lee, 2022). Student engagement and the student-teacher relationship are closely connected because students are more likely to participate, maintain focus, and enjoy learning when they have positive, challenging and inherently satisfying.

Student engagement and the student-teacher relationship are closely connected because students are more likely to participate, maintain focus, and enjoy learning when they have positive, encouraging relationships with their teachers, because they feel protected, appreciated, and understood. Students are more involved in their studies and emotions when they have faith in and respect their lecturers (Liu *et al.*, 2024). Students' passion for science is greatly influenced by their relationship with their teachers. When student believe that their scientific professors appreciate and encourage them, their confident and excitement for studying grow.

The primary aim of this study is to examine the mediating effect of the student -teacher relationship on the student engagement and science motivation among junior high school students. Specifically, it seeks to investigate the following objectives: First, the level of student-teacher relationship in terms of commitment, closeness, and complementary, level of student engagement in terms of behavioral engagement, cognitive engagement and emotional engagement and lastly, the level of science motivation in terms of intrinsic motivation, self-efficacy, self-determination, grade- motivation, and career motivation. Furthermore, the study aims to determine the role of the student-teacher relationship as a potential mediating factor on the student engagement and science motivation. Finally, the researcher seeks to determine if student teacher mediates the relationship between student engagement and science motivation.

The null hypotheses were tested at the 0.05 level of significance. First, there is no significant relationship between the following variables: student engagement and science motivation, student engagement and student teacher relationship and science motivation respectively were also tested. Lastly, the null hypothesis of no mediating effect of student-teacher relationship between student engagement and science motivation.

The study also closes significant research gap in scientific education particularly in resource-poor and undeveloped areas like Pangantucan, Bukidnon. In these cases, environmental constraints and a lack of resources might occasionally make it difficult for students to participate effectively. The findings provide educators and policymakers with practical guidance on how to targeted student -centered interventions that increase scientific fervor and excitement. Ultimately, this study serves the broader goals of SDG4 by promoting compelling and responsive learning environments that are tailored to the diverse needs of students. Through these efforts the researcher hopes to raise science literacy and better prepare student for success in the classroom and in the job.

The result of this study will help in achieving inclusive, equitable, and high-quality education and to ensure possibilities for life long learning by 2030, the research provides evidenced-based strategies that promote Sustainable Development Goal (SDG4). The suggestions which include incorporating inquiry-based learning, reflective questioning, critical thinking, directly address the findings of identification of moderate levels of cognitive engagement and aid students in better analyzing assessing, and applying scientific information. Building stronger ties between students and teachers particularly in the area of commitment is based on the study' finding that these relationship have substantial impact on motivation and engagement and serve as a partial mediator. This strategy supports a safe welcoming and encouraging learning environment in addition to enhancing academic results which is consistent with SDG4's focus on high quality -education for all students.

It is advised that future researchers look into which particular engagement styles behavioral, emotional and cognitive have the biggest effects on science motivation. They should also look into how student-teacher relationships may vary in their effects based on age, gender, and school setting. It may be possible to obtain more context -specific and general findings that can guide scientific education policy and practice more broadly by extending the study to different regions or educational levels.

Given this gap, there is a pressing need to explore how teacher–student relationships mediate science motivation and engagement, providing evidence that can guide effective interventions for Philippine junior high school education. Although prior research has demonstrated that exellent student-teacher interactions and supportive classroom settings have an impact on student motivation and engagement, the majority of this data originates from Western or resource- rich contexts. Students frequently encounter additional difficulties in rural and underdeveloped places like Pangantucan, Bukidnon, which may have an impact on their engagement in scientific classes. Despite the obvious connections between motivation and engagement, little is known about the precise processes by

which student-teacher interactions affect this dynamic in the Philippine setting. Therefore, little is understood about how the relationship between science motivation and engagement among junior high school in the Philippines is mediated by student-teacher relationships.

2. LITERATURE REVIEW

Science motivation is anchored on Flow Theory, developed by Mihaly Csikszentmihalyi (1990). This theory is increasingly used in educational research to better understand and improve the motivation, and performance among learners. Flow is a mental state that occurs in an educational context when students are completely engaged, paying attention, and enjoying the learning process; they usually lose track of time and become self-conscious. This condition occurs when there is a proper balance between the learner's perceived abilities and the task's perceived difficulty, as well as when there are clear objectives and timely feedback.

Student-teacher relationship is anchored on John Bowlby's Extended Attachment Theory (2010) Contemporary research uses multi-informant and multi-contextual models to demonstrate how attachment relationships with various figures contribute distinctively to academic engagement. A 2025 structural equation modeling study in China indicated that father-child, mother-child, peer, and teacher-student attachments all strongly impacted student's learning motivation (Liu *et al.*, 2024). This indicates that strong relationships with peers and teachers, along with parental connecting. Support adolescents' academic motivation. Through the use attachments lenses, the connections between student and teachers in elementary and secondary education have been reconstructed. In both online and mixed learning settings, flow has been associated with students' continued intention to utilize learning systems; however, this association may be influenced by individual traits such as self-efficacy and digital literacy. All things considered the use of flow theory in education emphasizes the necessity of creating opportunities that are both fulfilling and appropriately demanding. It improves students 'academic achievement as well as their emotional and motivational well-being. Even if students get less close as the get older, strong teachers-students relationship are essentials for involvement in secondary school. Peer relationship also have a big impact on schooling. Strong peer relationship also fosters cooperative learning, trust and perseverance—all of which are critical for both in person and distant training. In Raufelder *et al.* (2025) overall, the network of interpersonal ties—parents, instructor, classmate, and school system—that affect students' mental health, engagements, self-management, and academic success in emphasized by the extended attachment theory in education According to Ryan and Deci's (2000) Self-Determination Theory, which form the basis of this study, these emotional bonds between student and teachers meet the students' basic psychological needs for competence and relatedness, both of which are essential for fostering intrinsic motivation and sustained learning engagement. By attending to these demands, intrinsic motivation is increased, particularly in scientific classes where many students struggle (Ryan *et al.*, 2020). One important factor influencing students 'passion for science is the teacher-student relationship. Student feel much confident and motivated to learn when they see that their scientific teachers' value and support them. Students are more willing to investigate scientific ideas, pose inquiries, and take academic chances in a supportive and safe settings a result of this viewpoint. These emotional ties between student and teachers satisfy the students 'basic psychological needs for competence and relatedness, which are both critical for promoting intrinsic motivation and sustained learning engagement,

According to Ryan and Deci's (2000) Self Determination Theory, which serves as the foundation for this study. This study is anchored on three major theories namely: Self-Determination Theory (SDT) by Ryan and Deci (2020), extended Attachment Theory by Yu *et al.* (2010), and Flow Theory by Csikszentmihalyi (1990). Then foundation of student involvement is the Self-Determination Theory, which focuses on meeting the three basic psychological demand of competence, relatedness, and autonomy. According to recent studies, student is more likely to exhibit greater academic motivation, perseverance, and well-being when these requirements are satisfied in learning environments (Vansteenkiste *et al.*, 2020; Liu *et al.*, 2023). Further evidence that supportive learning settings that meet these psychological demands greatly improve students' engagements and performance has come from studies by Howard *et al.* (2021) and Slemp *et al.* (2020). These environments encourage students' self-directed learning, where they study for enjoyment and a purpose rather than just to avoid difficulty or receive rewards. According to Self Determination Theory, to promote students' motivation to engage keenly with environmental sustainability education through problem-based learning. This framework is intended to guide science instructors 'pedagogical practices in secondary science courses. Progress requires a grasp of science motivation, especially in challenging fields like physics and chemistry.

Student Engagement is anchored on the Goal Theory (Locked & Latham, 1991) people's behavior and performance are shaped by the direction, purpose, and incentive that explicit objectives provide. In education reducing disengagement and increasing academic engagement particularly in high school can be achieved by coordinating students' personal objectives with specific success goals.

Research shows that inquiry -based and student centered methods may greatly increase interest and motivation (Ribeirinha, 2024). All things considered, researching science motivation aids teachers in creating successful plans to foster students' interest, self-assurance, and scientific literacy (Primasari *et al.*, 2022).The desire to study and investigate scientific ideas is known as science motivation, and it is essential for encouraging participation. Students are more likely to actively engage, persevere through difficulties and seek more education in STEM disciplines when they are interested in science (Scheider *et al.*, 2020). Similarly, high levels of engagement result in deeper comprehension, better problem-solving skills, and increased teamwork all of which are critical for thriving in academic and professional settings in the twenty-first century (Gillies, 2023). According to Li *et al.* (2023), fostering students' curiosity and developing lifelong learners who are prepared to succeed in professional and societies that

rely heavily on science require a learning environmental that engage them both emotionally and cognitively. As students' progress through secondary education, there is a continuous and concerning trend of a reduction in their enthusiasm, motivation and engagement in science, especially in disciplines like physics and chemistry that are seen as abstract or difficult. This decline is caused by a number of interrelated factors, including students' perception of science's difficulty, it's lack of relevance to everyday life, low self-efficacy, and instructional strategies that favor rote memorization over inquiry-based and experimental learning (Li *et al.*, 2022; Reeve & Lee, 2022). These have been raised time and time again by the Programme for international Student Assessment (PISA), which has shown that science literacy and participation vary greatly among nations. Concerns regarding students' capacity to apply scientific concepts in real-world or experimental contexts- a fundamental scientific literacy and experimental self-efficacy was raised by the 2028. PISA Results, which ranked nations like the Philippines among the lowest performing in science (Juan, 2025). Furthermore, motivational impediments are made worse, particularly for underrepresented groups, by gender stereotypes, socioeconomic inequality, and a lack of exposure to role models in STEM (Wang & Degol, 2021). These challenges are made worse by the gap between students' own interest and science lessons, which lowers intrinsic motivation. Science motivation and student engagement are intimately related and reinforce one another. When science is taught as a static body of knowledge rather than as a dynamic process of discovery, students may not always understand the importance of science outside the classroom (Scheider *et al.*, 2020). According to these studies, learning environments that are encouraging and supportive-like those that provide student autonomy, meaningful feedback, and genuine scientific inquiry- are necessary to defy these tendencies and sustain long-term engagement (Fredricks *et al.*, 2021). Thus, motivating students to be interested in science helps them stay motivated, and students who are motivated stay interested (Reeve & Lee, 2022). Student engagement and the student-teacher relationship are closely connected because students are more likely to participate, maintain focus, and enjoy learning when they have positive, encouraging relationships with their teachers, because they feel protected, appreciated, and understood. Students are more involved in their studies and emotions when they have faith in and respect their lecturers (Liu *et al.*, 2024). Students' passion for science is greatly influenced by their relationship with their teachers. When student believe that their scientific professors appreciate and encourage them, their confident and excitement for studying grow. This close relationship creates a safer and more welcoming environment in the classroom. In such settings, student is more likely to overcome challenges, research ideas, and ask questions. The teacher-student interaction in significant determinant of students' motivation for science. When student see that their scientific instructors appreciate and encourage them, they become considerably more self-assured and eager to study. Because of this view, students are more likely to explore scientific concepts, ask questions, and take academic risks in a safe and encouraging environment.

Figure 1 illustrates the key variables examined in this study, providing a visual representation of the conceptual framework and the relationships among the identified constructs. This framework guided the research design and data analysis, helping to clarify the mediating effect of student-teacher relationship in shaping student's motivation. Student engagement act as the independent variable which encompasses the cognitive, emotional, and behavioral investment of students in their learning experiences. It involves active participation, intrinsic motivation, positive emotions, and a sense of belongingness and relevance to the subject matter (Delfino, 2019). Student engagement is influencedby various individual, contextual, and instructional factors, including student – teacher relationship and science motivation.

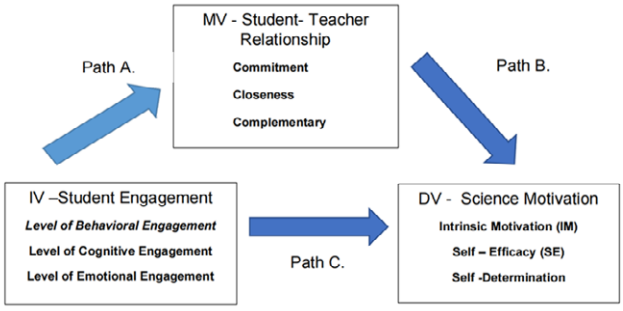

Figure 1. The Conceptual Framework showing the variables of the study.

The independent variable is Student Engagement which is adapted the survey questionnaire in the study of Delfino (2019). In their study, they examined the developmental trajectories of and the interplay between science motivation and student engagement. Additionally, student engagement indicators are: Behavioral Engagement, Cognitive Engagement and Emotional Engagement. Behavioral Engagement refers to how students participate in extracurricular, social, and academic activities. This involves following the rules, completing assignments, and attending class, how much effort student put into their education by using critical thinking, self-control, and conscientious methods to understand complex idea and develop challenging skills in known as cognitive engagement. Students' desire to participate in maintain learning activities in influenced by their feelings about this professors, friends, and school, which known as emotional engagement.

The mediating variable is the student teacher relationship which is adapted the survey questionnaire in the study of Jowett (2023). In this study the following indicators are Commitment, Closeness and Complementary. The phrase "commitment "describes a student's continuous attention, responsibility, and perseverance towed their learning goals, homework, and long-tern academic success. The term "closeness" describes the affection, trust, and emotional connection that students have with their instructors or others students; these qualities together support a positive and supportive learning environment. The term "complementary "describes how two individuals or objects enhance, complete, or support one another by providing qualities or skills that the other does lack, resulting in a more harmonious or useful whole. The student-

teacher relationship has been identified as an important factor that improves student learning and academic outcome. Teachers play significant role in education by helping students to achieve their goals thus, it plays as the mediating variable. Student-teacher relationship has been in existence since time immemorial. Across the globe, teachers are expected to relate with their students positively. Student-teacher relationship acts as a mediator in the relationship between student engagement and motivation. That is, student engagement is expected to exert both direct and indirect effects on student motivation, with the indirect effect operating through student-teacher relationship (Shahzadi & Nasreen, 2020). Numerous studies provide compelling evidence that strong relationships between teachers and students are essentials to each student's successful academic development. However, even much is known about the benefits of positive student-teacher relationship, the specific mediating role of these relationships in the link between engagement and science motivation at the junior high school level remains under-explored. This study aims to bridge that information gap by providing insights into how encouraging student-teacher interactions may boost teen passion for science and student involvement. Investigating how student participation and student-teacher interactions affect science motivation might yield valuable information for educators and policymakers. This information might help with the creation of focused interventions and teaching methods to encourage positive attitudes and a love of science among secondary school students. Addressing this gap in research would enhance our knowledge of the factors shaping students' science attitudes, ultimately guide in the creation of effective strategies to boost science literacy and interest.

Dependent variable of this study is the Science Motivation which is adapted from the study of Vysakh *et al.* (2020). The marker used in this study are grade motivation, self-efficacy, self-determination and intrinsic motivation. Theater "intrinsic motivation" describes the inner urge to do something for its own sake, independent of reward or demands from other sources, and motivated by one's own interest, enjoyment, or desire to learn. The term "self-efficacy" describe a person's belief in their ability to carry out tasks, achieve goals and get beyond challenges in certain situation. The ability of students to make choice and oversee their own education in line with their belief, interests, and goals—thereby encouraging autonomy and personal growth—is referred to as self-determination. The drive or desire that students have to do well in class or receive good marks in known as grade motivation. This driven is sometimes impacted by external rewards like recognition, praise or opportunities for development, all of which are essential for long term engagement and academic success. Intrinsic motivation, or learning for the enjoyment and curiosity it brings, has been shown to promote deeper cognitive engagement and better long-term learning outcomes in science. Intrinsically driven students are more inclined To go deeper into scientific concepts than is necessary, which fosters innovation and lifetime learning. According to (Chow *et al.*, 2021), self-efficacy the belief that one can achieve in science activities, especially in challenging fields like physics or chemistry- is a powerful predictor of perseverance and success. Confident in their abilities to succeed, students are more likely to work hard use effective learning strategies, and overcome obstacles.

Table 1. Summary of related literature on student- teacher relationship, student engagement, science motivation

Author(s) and Year	Title / Focus	Methodology	Key Findings
Mihaly Csikszentmihalyi (1990)	Science Motivation	Quantitative	Intrinsic Motivaton: People partcipate in flow activities for their own sake, they are motivated ny internal fufillment rather than material gains.
John Bowlby's	Student-teacher relationship	Conceptual / Theoretical Review	Healty teacher-student connection offer emotional safety that increase self assurance, involvement, and lerning.
Zhu *et al.* (2025)	Student-teacher relationship	Quantitative	This indicates that strong relationships with peers and teachers, along with parental connecting
Ryan and Deci's (2000)	Self-determination theory and facilitation of intrinsic motivation, social development, and well	Quantitative	Self-Determination Theory basis of this study, these emotional bonds between student and teachers meet the students' basic psychological needs for competence and relatedness
Howard *et al.* (2021) Slemp *et al.* (2020).	Pathways to student motivation:	Quantitative	While external driven or absent motivation hinders favorable educational achievements, autonomou skinds of motivation particularky delight and personally valued goals.
Slemp *et al.* (2020).	Systematic Review of SDT- Based Interventions on Organization		Self Determination Theory, to promote students' motivation to engage keenly with environmental sustainability education through problem-based learning.
Locked and Latham (1991)	Sudent Engagement	Quantitative	People's behavior and performance are shaped by the direction, purpose, and incentive

Delfino (2019).	Student Engagement/ Science Motivation	Quantitative	They examined the developmental trajectories of and the interplay between science motivation and student engagement. Additionally, student engagement indicators are: Behavioral Engagement, Cognitive Engagement and Emotional Engagement. Behavioral Engagement refers to how students participate in extracurricular, social, and academic activities.
Primasari *et al.* (2022)	Relationship quality in higher education and the interplay with student engagement and loyalty	Quantitative	All things considered, researching science motivation aids teachers in creating successful plans to foster students' interest, self-assurance, and scientific literacy
Jowett *et al.* (2023)	Teacher–student relationship quality as a barometer of teaching and learning effectiveness: Conceptualization and measurement	Quantitative	Study the following indicators are Commitment, Closeness and Complementary.
Wang and Degol (2021)	Classroom climate and children's academic and psychological wellbeing:	Quantitative	These challenges are made worse by the gap between students' own interest and science lessons, which lowers intrinsic motivation. Science motivation and student engagement are intimately related and reinforce one another.
Ribeirinh *et al.* (2024)	Slemp *et al.* (2020)	Quantitative	inquiry -based and student centered methods may greatly increase interest and motivation
Liu *et al.* (2024)	Effect of teacher-student relationship on academic engagement: the mediating roles of perceived social support and academic	Quantitative	Students' passion for science is greatly influenced by their relationship with their teachers. When student believe that their scientific professors appreciate and encourage them, their confident and excitement for studying grow.
Scheider *et al.* (2020)	Science Motivation	Quantitative	study and investigate scientific ideas is known as science motivation, and it is essential for encouraging participation. Students are more likely to actively engage, persevere through difficulties and seek more education in STEM disciplines when they are interested in science
Vysakh *et al.* (2020)	Science Motivtion	Quantitative	The marker used in this study are grade motivation, self-efficacy, self-determination and intrinsic motivation. Theater "intrinsic motivation" describes the inner urge to do something for its own sake, independent of reward or demands from other sources, and motivated by one's own interest, enjoyment, or desire to learn.
Ryan and Deci's (2000)	Student Engagement	Quantitative	Foundation of student involvement is the Self-Determination Theory, which focuses on meeting the three basic psychological demand of competence, relatedness, and autonomy.

3. METHODOLOGY

3.1. Research design

The researcher utilized a non-experimental, descriptive-correlational quantitative research design. This enables researchers to describe the levels of Mediating Effect of Student -Teacherrelationship on the Student Engagement and Science Motivation, examine the relationships between these variables, and investigate the mediating role of student-teacher relationship without manipulating any of the variables. Data collection was conducted in a span of one month from April 11to 16, 2025.

3.2. Participants and sampling technique

Based on the calculation of Rao soft Software, a total of 348 Junior High School students from grade 7-10, excluding those aged 17 above was taken as a respondent to this study from different public schools in the municipality of Pangantucan, Bukidnon which has a population of 3,600 as stipulated in the Department of Education Learner's Information System. (LIS). This calculation is base from Barclay, as mentioned by Memon *et al.* (2020). Using variables like population size, margin of error, and confidence level, this sample size calculator assists researchers in determining the right sample size. This calculator determines the bare minimum of respondents required for a researcher to get the required degree of accuracy using statistical methods. The researcher selected a sample from a larger group using the random sampling approach, which each number of the population has an equal and independent chance of being selected. This reduces bias and guarantees that the sample is representative of the population. Students in junior high school were chosen as responders because this is a critical time for fostering motivation and interest in science. Many students lose interest in science during these years because it is more difficult and they stop participating. Understanding their motivation and the importance of the connections between students and teachers might help put an early stop to this decline. Additionally, the study habits and attitudes of this age group are influencing their future academic choices, particularly in STEM fields.

3.3. Research instrument

There were three validated questionnaires used in this study, all reviewed by a panel of educational experts. Prior to data collection, the researcher secured permission from the school principal to conduct the study. The surveys, which included a modified tool to evaluate the student-teacher connection, were created after approval. The first instrument was the Student Engagement Questionnaire by Delfino (2019), with three indicators namely: behavioral, cognitive, and emotional engagement. The second was Vysakh *et al.* (2020)'s Science Motivation Questionnaire II, which included24 items and assessed `students' motivation in science using five indicators: career motivation, self efficacy, self-determination, intrinsic motivation, and grade motivation. Three key features of the contact were covered by the eleven items of Jowett's (2023) Student-Teacher contact Questionnaire. Each poll included a five-point Likert scale, where 1 represented "strongly disagree" and 5 for "strongly agree. "Indeterminate draft of the inventory checklist was submitted for validation to a panel who are expert in the field of science. The adapted questionnaire underwent initial analysis and translation before being submitted to evaluators for review. The required changes were made in response to their input, and the instrument was polished in preparation for formal acceptance. To boost its authenticity, an external validator was also hired. The required changes were made in response to their input, and instrument was polished in preparation for formal acceptance. To boost its authenticity, an external validator was also hired. The required changes were made in response to their input, and the instrument was polished in preparation for formal acceptance. To boost its authenticity, an external validator was also hired. It was pilot-tested in order to determine the reliability of each item using Cronbach Alpha. Based on the provided reliability statistics, the internal consistency of the three scales was assessed using Cronbach's alpha.Cronbach's alpha was used to assess the three scales' internal consistency. The Cronbach's alpha for the Student Engagement measure was 0.915, indicating satisfactory reliability. The science Motivation scale had a strong reliability with a cronbach's alpha of0.949, while the Student-Teacher Relationship measure demonstrated exceptional reliability with Cronbach's alpha of 0.0946.Higher alpha scores signify stronger internal consistency, and these values show that each scale's components reliably assess the intended structures. Following revisions and finalization of the questionnaire, the campus administration granted permission to conduct the study,and the instrument was given to the students. The researcher gathered the accomplished instrumentals soon as the respondents finished answering them. The data obtained from this investigation was tallied, computer-processed, analyzed, interpreted and added to the literature.

3.4. Data gathering procedure

In conducting this research, the researcher adhered to all necessary standards to ensure a rigorous study. After analysis and translation, the modified questionnaire was sent to the assessor's frothier consideration. The researcher completed the questionnaire for official validation after taking validators input into consideration and making the required changes. An outside validator was hired
to increase its credibility even more. The researcher arranged the necessary resources for validation at UMERC when the questionnaire was ready. A copy of the article was sent by the researcher to UMERC, Protocol No. UMERC-2025-084, to examine, offer suggestions, and validate ethical consideration. Additionally, a formal letter was submitted to the school principal requesting permission to conduct the study within the institution.

3.5. Data analysis procedure

This data employed different statistical tools to analyze the relationship between study engagement and science motivation in secondary students. Firstly, weighted means was calculated to determine the levels of student engagement, student-teacher relationship, and motivation. Secondly, Pearson correlation was use to assess the significant relationships between student engagement and student teacher relationship, and between student-teacher relationship and science motivation. Lastly, the mediating function of the student-teacher connection in the link between student engagement and
motivation towards scientific education was investigated using a Sobel z – test inside the Med graph framework

3.6. Ethical considerations

The researcher ensured that participants n this study fully understand that their participation is
completely voluntary. They were informed both in writing and verbally, that they have the absolute right to withdraw or leave the study at any stage of the research process at their

discretion, without any consequences, particularly without any impact on hazards such as psychological discomfort, social, repercussions, and legal issues, the researcher closely adhered to privacy and confidentiality rules. All gathered information was safely kept n a locked physical cabinet and a password-protected digital file that only the researcher could access. Participants identities remained anonymous and no personally identifiable information was disclosed anonymized data is to be shared with school administrators or policymakers, it was only occurred with prior approval from the ethics review board and in accordance with data protection policies. researcher ensured that participants are well-informed about the study's' purpose and that the inclusion and exclusion criteria are clearly communicated. Before engaging with respondents, the researcher obtained permission or a recommendation from the school administration or principal. Participants recruitment followed predefined selection criteria to ensure that only eligible individuals were included. With experience in educational research, the researcher worked closely with designated school personnel such as teachers or academic coordinators, to identify potential participants who meet the eligibility requirements. These school representatives assisted in the initial identification process while ensuring that recruitment remains voluntary an unbiased the researcher carefully assessed and minimized all potentials risks, including physical psychological, social, and economic risks. Since these factors may influence participants decisions to join the study, they were fully disclosed before obtaining consent. Some questions may cause students to feel inadequate or anxious. To ease any potential emotional distress, the researcher made in apparent that there were no right or wrong answers and that the responses were only used for research. Participants were urged to pause when needed and to avoid any questions that caused them discomfort. In order to help any participants who, feel emotional discomfort during or after the study, the researcher also worked with school guidance counselors. Respondents are among the man benefactors of the study conclusions, the searcher made sure. They were given a thorough explanation of the possible benefits of taking part. Participants got modest gifts of appreciation as a thank you for their time and participation, even though they were not directly paid. They also gained indirectly from the study's' findings, which may contribute to greater academic assistance, improved learning opportunities, and improved teaching methods. Grammarly, Turnitin, and other plagiarism checkers were not necessary because correct citation and paraphrasing were done using APA style to preserve originality and comply to ethical research norms. To ensure that the material adhered to academic integrity requirements and was original. a plagiarism detection technology was also utilized. The researcher informed the committee that there would be no conflict of interest in carrying conducting this inquiry. To preserve objectivity and adhere to ethical research standards, stringent protocols were implemented to prevent any conflicts. Openness in the data collection and analysis procedure made sure that only unbiased data could be used to support findings. Extra effort was taken to minimize bias, and the ethics committee was notified of any personal ties the researcher had with facilitators or participants. They may entail employing third-party data collectors, anonymizing responses, and independently verifying findings in order to maintain the integrity of the research process.

4. RESULTS AND DISCUSSION

4.1. Level of student engagement

The Students' Engagement of Grade 7-10 junior high school students of Pangantucan, Bukidnon were examined in this section using the analyzed statistical data. As shown in table 1 present the mean and standard deviation of student engagement. Most of the students has a high level of Behavioral engagement while few of them has a high level of cognitive engagement. It means that the students have a high level of engagement in science classes. The findings of this study suggest that students participate fully in class activities and exhibit high levels of behavioral engagement. Participants 'engagement in more complex cognitive functions, such analytical reasoning and critical reflection was somewhat lower. This emphasizes the necessity of improving teaching methods that develop higher order thinking abilities in order to increase students' cognitive engagement.

Table 2. Level of student engagement

Indicator	SD	Mean	Descriptive Level
Behavioral Engagement	0.55	3.83	High
Cognitive Engagement	0.55	3.56	High
Emotional Engagement	0.59	3.69	High
Overall	0.41	3.62	High

These results align with Kang Wu's (2022) research which emphasizes the part of behavioral engagement plays in fostering students' overall growth as their success. Strong behavioral engaged students frequently perform better academically comprehend the material better and persevere more successfully in science related tasks. In a similar (Li *et al.*, 2024) highlighted that actions including completing assignments on time actively participating in lab work and making significant contributions to group projects support deeper learning and a stronger understanding of scientific topics. According to research by Datu *et al.* (2025), competence satisfaction is a critical mediating factor in the development of both behavioral and cognitive engagement in primary science education and students' sense of relatedness to their science teacher is a critical component in promoting engagement in science learning. Increased engagement which is defined by efficient planning, internal motivation, significant social interactions and sustained task focus. It is also strongly linked to better academic achievement and emotional well-being which includes better grades and lower levels of adolescent's distress, according to a 2022 Austrian study. Additionally, recent research shows that Pangantucan students have a close bond with teachers are more likely to be actively involved in their education and achieve better academic results. According to the study's findings, students showed a high level of behavioral engagement especially when it came to their

regular adherence to routines and active participation in class activities. These findings corroborate those of Fredricks *et al.* (2021), who highlighted that behavioral engagement supports emotional health, constructive peer relationships, and a feeling of community within the school in addition to academic involvement. The results are also consistent with behaviorally engaged individuals who frequently exhibit important character traits resilience, self-control, and intrinsic motivation -qualities necessary for success throughout one's life. Despite generally high engagement levels, cognitive engagement emerged as the weakest among the measured dimensions. This might be explained by the local classroom methods predominance on rote learning and simple recall which restricts students' access to task that encourage critical analysis, problem -solving, and reflective thinking. Students comparatively low cognitive value ratings probably caused by death of inquiry-driven and intellectually stimulating activities. These results highlight how crucial it is to create science curricula that value critical thinking and in-depth comprehension over cursory memorizing. The prevalent emphasis on rote learning and basic memory in local classroom methods may be the cause of this, since it is restricting students' exposure to task that foster critical analysis, problem solving, and reflective thinking. Lack of intellectually stimulating and inquiry-driven activities is probably the cause of the students comparatively low cognitive value ratings. These results highlight the need of developing science education that places more emphasis on critical engagement and depth of knowledge than on memorizing at the surface level.

4.2. Level of science motivation

Students' motivation for science is described in this section based on an examination of statistical formation. As shown in the table 2, presents the mean and standard deviation of science motivation level among the students. It shows that most of the students has a high level of intrinsic motivation, while few of them has a high level in self-efficacy. It means that the level of science motivation among students were high. The overall mean for science motivation is 3.89 and has a standard deviation of0.62 which is considered high. This indicates that the Grade 7-10 public school students of the municipality of Pangantucan, Bukidnon generally approach science-related assignments and learning opportunities with great enthusiasm, diligence, and positive attitudes. Among the indicators, the intrinsic motivation showed the highest mean rating of 4.14, described as high; while self-Efficacy with the mean rating 3.71, described as high, respectively.

Table 3. Level of Science Motivation

Indicator	SD	Mean	Descriptive Level
Inrinsic Motivation	0.77	4.14	High
Self-Efficacy	0.76	3.71	High
Self-Determnation	0.74	3.76	High
Grade Motivation	0.99	3.84	High
Career Motivation	0.76	3.89	High
Overall	0.62	3.89	High

The findings of this study indicated that students in the municipality generally possess a high level of Intrinsic Motivation suggesting that science is personally fulfilling and pleasurable for them. "This indicates that their motivation to pursue science stems from a true interest and happiness with comprehending scientific topics, rather than just grades or prizes. The result affirmed with the study of Areepattamannil and Kaur (2021) that students have a strong intrinsic motivation to learn science and are very interested in it; yet, their confidence in their capacity to succeed in science assignments is marginally lower than their level of interest." It is further emphasized by Shin *et al.* (2019), the utility value of science, such as its relevance to personal and social goals, greatly boosts students' motivation for science and their willingness to participate in scientific-related activities. "This is consistent with thes tudy of Tas *et al.* Students that have a strong academic self-concept and a high task value perception are more involved in scientific classes which boost motivation and performance. Moreover, the related study emphasized that students' academic progress and motivation are only marginally affected by performance goals, which place an emphasis on demonstrating competence relative to others." Thus, in the study of Sabanal *et al.* (2023), in contrast to other motivating variables, such as the value of science learning, that are typically less significant.

4.3. Level of student-teacher relationship

This part of the study summarizes student teacher relationship based on the collected data of the Grade 7-10 public school students of the municipality of Pangantucan, Bukidnon. Table 3 displayed a high descriptive level of Student Teacher Relationship with an overall mean of 4.20 and a standard deviation of 0.67. The result showed how students perceive their interactions with their science teachers which suggests that students have a great sense of connection, trust, and support from their teachers. Among the indicators, closeness has the highest mean rating of 4.45 or very high; while commitment has the lowest mean of 3.90, described as high. This indicates that students in the municipality of Pangantucan, Bukidnon generally have a positive opinion of their interactions with their teachers.

Table 4. Level of Student-Teacher Relationship

Indicator	SD	Mean	Descriptive Level
Commitment	0.80	3.90	High
Closeness	0.77	4.45	High
Complementary	0.69	4.24	High
Overall	0.67	4.20	High

The result is congruent to the study of Dai (2023) and Liu (2023) that the positive student-teacher interactions, improve engagement, control emotions, and lessen learning anxiety. In line with their findings, this study demonstrated that even in cases when student engagement is initially low, excellent teacher-student relationships can increase students' motivation and confidence. On the other hand, commitment was found to be the lowest measure of student participation. This could be the result of a lack of long-term learning

assistance, a lack of real-world science exposure, or a lack of science resources. These findings imply that although teachers encourage and assist their students, more reinforcement of their long-term dedication to science is required through consistent and pertinent learning opportunities (Cavanagh *et al.*, 2017).

4.4. Correlation between science motivation, students' engagement and student- teacher relationship

The statistical analysis revealed significant positive correlations among student engagement, science motivation, and the student-teacher relationship among Grade 7 to 10 public school students in themunicipality of Pangantucan, Bukidnon. As shown in Table 4, the analysis revealed a low positive correlation between student engagement and science motivation, as well as between students 'engagement and the quality of the student-teacher relationship. To assess the statistical significance of these associations, a Pearson correlation analysis was performed. The results indicated a modest positive relationship between student engagement and science motivation, with a correlation coefficient of r=.445 and a p-value of 0.01-below the threshold of significance at 0.05-resulting in the rejection of the null hypothesis. The null hypothesis was likewise rejected due to a similar weak positive correlation between student involvement and the student-teacher connection (r=.482, p=.01). Furthermore, with a coefficient of r=.699 and a p-value of .01, a somewhat favorable association between science interest and the student-teacher relationship was discovered. The null hypothesis was further refuted by this statistically significant outcome.

Table 5. Overall significance of the relationship between levels of student engagement, science motivation,student-teacher relationship

	Critical Thinking Skills	Attitude Toward Science	Study Engagement
Critical Thinking Skills	1	.445**	.482**
Attitude Toward Science	.445**	1	.699**
Study Engagement	.482**	.699**	1

***. Correlation is significant at the 0.01 level (2-tailed).*

The analysis found a moderately favorable relationship between science motivation and student All observed correlations met the 0.05 significant level, lending credibility and consistency to the findings. engagement. This outcome is consistent with research by Nguyen (2021), who highlighted the importance of motivation in influencing many aspects of student's involvement. According to the study, encouraging a comprehensive motivating framework can significantly increase students 'engagement in scientific classes. On the other hand, Fuetrs *et al.* (2023) study of intermediate-level students found no statistically significant correlation between academic desire and involvement, and both were low. These disparate results emphasize the significance of focused interventions meant to increase student population engagement and motivation. Additionally, it was shown that the quality of the student-teacher interaction was favorably and highly correlated with science motivation. This finding is consistent with the work of Datu (2024),

who emphasized the crucial influence of supportive student-teacher interactions in cultivating sciencemotivation among learners. In particular, Datu's study showed that a high school student in the Philippines who had a close bond with their scientific professors were more likely to participate incidence related activities. This underscores the value of nurturing positive relational dynamics is the classroom to promote motivation. In a similar study of Alamgir *et al.* (2024) confirmed that positive teacher student relationships had a substantial direct effect on students' academic motivation in science subjects. The result of Bieg *et al.* (2025) further approved that teacher support, encompassing emotional and instrumental assistance, is crucial in satisfying students' basic psychological needs, thereby enhancing their intrinsic motivation and engagement in science learning. However, there was a somewhat favorable association between the student-teacher interaction and student involvement. The results are in line those of Snijders *et al.* (2022), who showed that student involvement an intentions to stick with their school are positively impacted by the quality of the student-teacher interaction. In order to foster a sense of commitment and belonging, their study emphasized the significance of trust and satisfaction in these partnerships. In a similar, Obermeier *et al.* (2024) highlighted in their secondary education research that a supportive and sympathetic student-teacher connection is essential to improving students' motivation, emotional and cognitive development. According to these findings, students' motivation to participate in academic activities and their general attitude toward school are significantly influenced by pleasant relationship experiences. By identifying perceived social support and academic pressure as mediating elements in the link between teacher support and student involvement, Liu (2024) provided more support for this viewpoint. The study revealed that nurturing teacher interactions can help reduce academic stress while simultaneously strengthening student involvement. Collectively. These studies underscore the critical role of positive interpersonal relationships in fostering both motivation and engagement among students.

4.5. Mediation analysis of the three variable

Presented below is the mediation result of the study. It demonstrated that science motivation and the student-relationship are significantly improved by the student engagement. According to the

correlation value of 0.482, students' correlation of 0.0445 between student engagement and scientific motivation suggest

that students who are more actively interested in their education are also more inclined to study science. Furthermore, there is a substantial positive association between science motivation and the student-teacher -relationship (r=0.699), indicating that students are more likely to be motivated in science-related activities. If they believe their professors are encouraging and helpful. The interaction between students and teachers is a crucial mediating element between student engagement and science motivation as evidenced by statistically significant of all correlations at the level of 0.01.Additionally, the path analysis showed that the following results were significantly with no change in sign: student engagement (x) to student -teacher relationship (m) to science motivation (y) and student engagement (x) to science motivation (y). This suggest that the study of student-teacher relationships partially mediates the relationship between teaching student engagement and science motivation. Table 5 shows that the percentage of the total effect of student engagement and science motivation that is mediated by student -teacher is 62.10 percent. This indicates that Sixty-two out of a hundred is the effect of factors of student's engagement and science motivation goes through its influenced of student-teacher relationship while remaining 38 out of a hundred represents direct effects. Since partial mediation took place in this study it can be understood that the student-teacher relationship is not the only reason of student engagement and science motivation of the junior high school students in the municipality of Pangantucan, Bukidnon.The relationship between academic motivation and effective engagement among pre-college students is mediated by the student-teacher relationship, according to a recent study by Valenzuela *et al.* (2024). According to their findings, effective engagement is positively predicted by academic motivation, and the student-teacher connection partially mediates this link. These results high lighthow crucial positive student-teacher relationships are in influencing students' emotional commitment to studying. The relationship between academic motivation and effective engagement among pre-college student is mediated by the students -teacher relationship, according to recent study by Valenzuela, Penuri *et al.* (2024). According to their finding, effective engagement is positively predict by academic motivation, and the student-teacher relationship connection partially mediates this link. These results highlight how crucial positive student-teacher relationships are in influencing students 'emotional commitment to studying. Extending this insight, it can be inferred that the student-teach relationship also partially mediates the impact of student engagement on students' motivation to learn

The triangular diagram shown in Figure 2 illustrated that every unit increase in student engagement corresponds to a 1.40-unit increase in student-teacher relationships. The analysis reveals that each unit increase in student-teacher relationship corresponds to a 0.50 unit rise in students' motivation to learn science. Furthermore, there is a 0.38-unit direct correlation between science motivation and student involvement. However, the direct impact of student involvement on science motivation drop top just 0.05 units, indicating a far lesser effect, when the mediating function of the student-teacher connection is taken out of the equation. When combined, the student-teacher connection serves as a mediating factor in the road from student engagement to science motivation. This is mostly because of the relationship between the instructor and students. These results demonstrate that student motivation in science is much increased when they have supportive and meaningful connections with their professors rather than being only determined by their level of involvement. Therefore, the student -teacher relationship acts as a partial mediator. Highlighting how important is to cultivate interpersonal relationship in educational environments in order to promote more motivation and interest in science study.

Table 6. Estimates for partial mediation/linear regression result

			Estimate	S.E.	C.R.	P-value
Student-Teacher Relationship	<---	Student Engagement	1.402	.137	10.256	***
Science Motivation	<---	Student Engagement	.380	.116	3.264	0.001
Science Motivation	<---	Student-Teacher Relationship	.586	.040	14.612	***

% Percentage Medation = 62.10

x = STUDENT ENGAGEMENT,
y = SCIENCE MOTIVATION,
m = STUDENT-TEACHER RELATIONSHIP

In order to better understand the connections between the study's key variable, structural the mediating role of the student-teacher connection was assessed using structural equation modeling (SEM). a concept of partial mediation is supported by the study, which finds strong correlation between student involvement, science motivation, and the caliber of student-teach interaction based on the liner regressions result shown in table 5. interestingly, the direct relationship between science motivation and student involvement was shown to be both statistically significant and substantial (estimate=1.402, SE = 0.137, C.R = 10.256, p <0.001). this indicates that student who demonstrate higher engagement are more likely to be motivated in science to perceive greater value greater value in their academic tasks. Second, a statistically significant direct correlation between the quality of the student-teacher interaction and student involvement was found (estimate = 0.380, SE =0.116, C.R. p=0.001). this suggest that students who are more involve in their education typically develop closer, more enduring relationship with their professors. Such a finding emphasizes how active involvement in the classroom may create important relational relationships and the mutually reinforcing nature of engagement and the teacher-student relationship. Additionally, the model demonstrated that science motivation

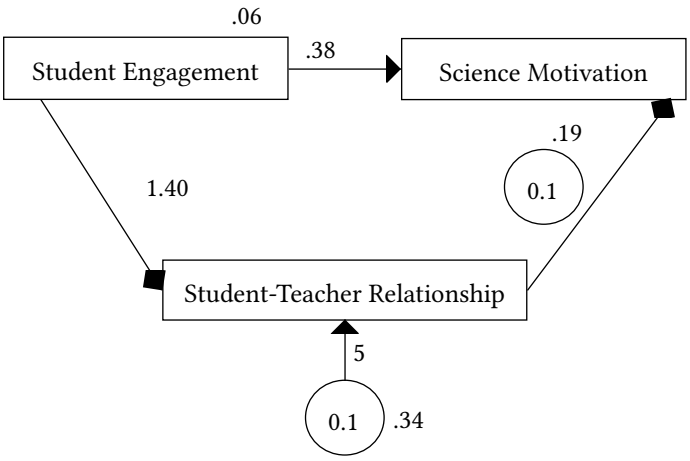

Figure 2. Mediation med graph

is insignificant predictor of student engagement, indicating that learning activities and classroom dynamics are more likely to be absorbed by students who are intrinsically motivated in science (estimate = 0.586, SE = 0.40, C.R. = p 14.612, p < 0.001). Believing that pupils who are driven, whether internally or externally, are more likely to put out effort and engage fully in class activities. All of these findings point to existence or partial meditation, in which the relation between science motivation and student engagement is mediated by the student-teacher relationship, but both direct pathways are still important. This framework implies that student engagement influences—academic motivation both directly and indirectly thought the strength of the relationships between student and teachers. The findings highlight how crucial inter personal relationship are in determining educational achievements. These student-teachers connection in fostering long-term engagement and academic motivation (Roorda *et al.*, 2019; Lui *et al.*, 2023) the outcome is consistent. These findings are consistent with some research highlighting the importance of helpful teachers. Relationships among students are linked to high levels of engagement, focus, and perseverance in the classroom. For example, children who had close relationship with their professors had far better levels of learning motivation and classroom engagement, according to a research Castillion *et al.* (2023) among junior high school student in Davao City, Philippines. with those of Pianta *et al.* (2020) who observed that emotionally supportive classroom environments promote student confidence, create a sense of safety, and increase learners' willingness to participate in academic tasks. The result is also congruent to the study of Xiong *et al.* (2020) that positive teacher-student relationships are correlated with higher teacher expectations, which in in turn encourage scholarly participation Wang *et al.* (2021) also confirmed that students are more likely to express their academic demands, ask for help, and stay motivated when the believe their professors are supportive and approachable. In addition to provide emotional support, these interpersonal relationships also act as motivators teaching strategies that aggressively support critical thinking skills development and student involvement, by promoting thought and engagement, teaching strategies that value student voice and dialogue--like Pascual's (2023) Socratic method-have been demonstrated to boost motivation. The study reaffirmed how important inquiry-base teaching strategies are for creating meaningful learning opportunities and boosting students' feeling of independence, particularly in the context of scientific education. Enhancing student engagement can both directly and indirectly improve student's academic motivation by enhancing healthy student-teacher relationship, according to the partial mediation model. Hence, teachers need to put an emphasis on creating teaching methods that encourage critical thinking and actively involve learners. Instructional techniques such sate Socratic method, which promote active participation and stimulate student engagement, have the potential to enhance learners' motivation in science education These findings are consistent with those of Pianta *et al.* (2020) who observed that emotionally \supportive classroom environments promote student confidence, create a sense of safety, and increase learners' willingness to participate in academic tasks. The result is also congruent to the studio Xiong *et al.* (2020) that positive teacher-student relationships are correlated with higher teacher expectations, which in in turn encourage scholarly participation, Wang *et al.* (2021) also confirmed that students are more likely to express their academic demands, ask for help, and stay motivated when the believe their professors are supportive and approachable. In addition to provide emotional support, these interpersonal relationships also act as motivators teaching strategies that aggressively support critical thinking skills development and student involvement, by promoting thought and engagement, teaching strategies that value student voice and dialogue--like Pascual's (2023) Socratic method-have been demonstrated to boost motivation. The study reaffirmed how important inquiry base teaching strategies are for creating meaningful learning opportunities and boosting students 'feeling of independence, particularly in the context of scientific education. engagement can both directly and indirectly improve student's academic motivation by enhancing healthy student-teacher relationship, according to the partial mediation model. Hence, teachers need to put an emphasis on creating teaching methods that encourage critical thinking and actively involve learners. Instructional techniques such as the Socratic method, which promote active participation and stimulate student engagement, have the potential to enhance learners' motivation in science education.

5. CONCLUSION

In light of the study's findings, the following conclusions are drawn: According to the survey, participants' student involvement was at a moderate level. "Students demonstrated mediocre levels of cognitive engagement (using techniques like reflection and problem-solving), emotional engagement (showing interest and delight in science), and behavioral engagement (participating in class activities). although they did participate In scientific classes to some extent, they might have been more consistent and involved in these subjects. In contrast, students demonstrate a high degree of enthusiasm for science. They scored highly on test such as self-efficacy in studying the topic, intrinsic motivation (interest in science its own sake), and goal orientation (the desire to achieve and improve at science). these findings indicate that although

students are highly motivated and confident in their scientific education, active engagement in science-related activities is not always the outcome if this motivation. Science and student involvement were shown to be significantly positively correlated. Motivation, suggesting that students' desire to learn science rises in tandem with their level of engagement. Furthermore, the study identified a moderate, positive, and statistically significant correlation between student engagement and the quality of the student-teacher relationship. A close relationship between them and their professors.

Similarly this study highlights the critical impact that student-teacher connections have in enhancing the relationship between engagement and motivation in science. Despite the fact that many students are driven and self-assured, these qualities by themselves do not ensure active participation in the absence of the instructors' caring and supporting interactions. According to Ryan (2020), the Self-Determination Theory, encouraging autonomy, competence, and relatedness in the classroom is crucial for converting motivation into meaningful engagement and better learning results. In addition to classroom tactics that encourage introspection, cooperation, and sustained involvement, future study should examine practical treatments such as teacher professional development programs that aim to improve relational and motivational behaviors. The creation of learning environments that stimulate and sustain students' interest in science would be facilitated by such initiatives.

Educators, including teachers, school leaders, and curriculum planners, should design lessons that promote strong student engagement, such as inquiry-based learning, collaborative activities, problem-solving activities, and encouraging reflective questioning. The study's findings show that students have positive science motivation and healthy student-teacher relationship but their engagement towards science activities are only moderately developed.

Acknowledging the significant correlation between student engagement, science motivation, and student-teacher relationship, it is encouraged that administrators endorse programs that blend student engagement with captivating science activities. Master teachers may develop lesson plans that relate scientific concepts to real-world issues, promoting engagement, motivation and healthy student-teacher relationship. Furthermore, updating the curriculum to incorporate more activities that stimulate student engagement—like experiments, open-ended questions, collaborative activities, and group projects—can enhance students' engagement and their enthusiasm for science.

For future researchers, it is recommended to pursue deeper into how student engagement influences the relationship between students' science motivation and their critical thinking skills. Given that this study identified student engagement as a key factor, future research could investigate which specific types of engagement—such as emotional, behavioral, or cognitive—have the most significant impact. Additionally, expanding the scope of research to include various age groups, educational institutions, or learning environments could provide a more comprehensive understanding and aid in developing teaching strategies that enhance both science motivation and critical thinking skills. Furthermore, examining the role of a positive student-teacher relationship in fostering student engagement and motivation could offer valuable insights for improving educational outcomes in science.

REFERENCES

Ahn, I., Chiu, M. M., & Patrick, H. (2021). Connecting Teacher and Student Motivation: Student-Perceived Teacher Need-Supportive Practices and Student Need Satisfaction. *Contemporary Educational Psychology, 64*, 101950.

Alamgir, M., Ali, M., & Rehman, A. (2024). Influence of teacher and student relationship on the academic motivation in the presence of academic emotions. *Journal of Development and Social Sciences, 5*(3), 1128–1140

Areepattamannil, S., Khurma, O. A., Ali, N., AlHakmani, R., & Kadbey, H. (2023). Examining the relationship between science motivational beliefs and science achievement in Emirati early adolescents through the lens of self-determination theory. *Large-scale Assessments in Education, 11*, Article 25. https://doi.org/10.1186/s40536 023 00175

Bieg, M., Reindl, M., & Dresel, M. (2025). Perceived teacher support and student engagement among higher education students: A systematic literature review. *BMC Psychology, 13*, 24

Bowlby, J. (1980). *Attachment and loss: Vol. 3. Loss: Sadness and depression*. Basic Books.

Broman, K., Garrecht, C., & Zander, L. (2021). Project-based learning and student flow experience in secondary education. *International Journal of STEM Education, 8*(1), 12. https://doi.org/10.1186/s40594-021-00277-3

Castillion, L. R., & Limpot, M. (2022). The mediating effect of effective teaching in the relationship between motivation in learning and student engagement. *EPRA International Journal of Research and Development (IJRD), 8*(7). https://doi.org/10.36713/epra10791

Cavanagh, A. J., Aragón, O. R., Chen, X., Couch, B. A., Durham, M. F., Bobrownicki, A., Hanauer, D. I., & Graham, M. J. (2017). Student buy-in to active learning in a college science course. *CBE—Life Sciences Education, 15*(4), ar76. https://doi.org/10.1187/cbe.17-06-0107

Chow, K., Yuen, M., & Li, C. (2021). The impact of academic self-efficacy on science learning outcomes. *Frontiers in Psychology, 12*, 748141. https://doi.org/10.3389/fpsyg.2021.748141

Cirkony, C., Fragkiadaki, G., & Gunstone, R. (2025). School Science: An Approach to Rethinking What Students Learn and How They Might be Better Engaged. *Science Education*. https://doi.org/10.1002/sce.21949

Csikszentmihalyi, M. (1990). *Flow: The psychology of optimal experience*. Harper & Row.

Dai, P. (2024). The influence of teacher-student relationship on students' learning. *Proceedings of the 4th International Conference on Education, Teaching and Learning (ICETL 2024)*. https://doi.org/10.54254/2753-7048/40/20240764

Datu, J. A. D., & Noltemeyer, A. (2024). Sense of relatedness and science engagement among Filipino high school students. *Psychology in the Schools, 61*(8), 3410-3420.

Delfino, A. P. (2019). *Impact of virtual training on the Filipino secondary school teachers' sense of efficacy in student engagement, instruction, instructional strategies, and classroom management*. ERIC. https://files.eric.ed.gov/fulltext/EJ1222588.pdf

Ekmekci, A., & Serrano, D. M. (2022). The impact of teacher quality on student motivation, achievement, and persistence in science and mathematics. *Education Sciences, 12*(10), 1–21. https://doi.org/10.3390/educsci12100649

Fang, K., Li, L., & Wu, Y. (2023). Research on student engagement in distance learning in sustainability science to design an online intelligent assessment system. *Frontiers in Psychology, 14*, 1282386.

Fredricks, J. A., Parr, A. K., Amemiya, J. L., Wang, M.-T., & Brauer, S. (2019). What matters for urban adolescents' engagement and disengagement in school: A mixed-methods study. *Journal of Youth and Adolescence, 48*(9), 1974–1991.

Fuertes, H. G., Evangelista, I. A., Jr., Marcellones, I. J. Y., & Bacatan, J. R. (2023). *Student engagement, academic motivation, and academic performance of intermediate level students*. Zenodo. https://doi.org/10.5281/zenodo.8037103

Furrer, C., & Skinner, E. (2019). Sense of relatedness as a factor in children's academic engagement and performance. *Journal of Educational Psychology, 95*(1), 148–162. https://doi.org/10.1037/0022-0663.95.1.148

Gillies, R. M. (2023). Using cooperative learning to enhance students' learning and engagement during inquiry-based science. *Education Sciences, 13*(12), Article 1242. https://doi.org/10.3390/educsci13121242

Howard, J. L., Bureau, J. S., Chong, J. X. Y., & Guay, F. (2021). Pathways to student motivation: A meta analysis of antecedents of autonomous and controlled motivations. *Review of Educational Research, 92*(1), 46–72. https://doi.org/10.3102/00346543211042426

Huyer, L. D., Callaghan, N. I., Dicks, S., Scherer, E., Shukalyuk, A. I., Jou, M., & Kilkenny, D. M. (2020). Enhancing senior high school student engagement and academic performance using an inclusive and scalable inquiry-based program. *npj Science of Learning, 5*, 17. https://doi.org/10.1038/s41539-020-00076-2

Jowett, S., Warburton, V. E., Beaumont, L. C., & Felton, L. (2023). Teacher–Student relationship quality as a barometer of teaching and learning effectiveness: Conceptualization and measurement. *British Journal of Educational Psychology, 93*(3), 842-861. https://doi.org/10.1111/bjep.12600

Kang, X., & Wu, Y. (2022). Academic enjoyment, behavioral engagement, self-concept, organizational strategy and achievement in EFL setting: A multiple mediation analysis. *PLOS ONE, 17*(4), e0267405. https://doi.org/10.1371/journal.pone.0267405

Klem, A. M., & Connell, J. P. (2018). Relationships matter: Linking teacher support to student engagement and achievement. In M. G. Sanders (Ed.), *Schooling students placed at risk: Research policy, and practice in the education of poor and minority adolescents*. Erlbaum.

Lazarides, R., & Buchholz, J. (2019). Teacher enthusiasm and self-efficacy, student-perceived mastery goal orientation, and student motivation in mathematics classrooms. *Teaching and Teacher Education, 77*, 64–73. https://doi.org/10.1016/j.tate.2018.09.004

Li, Q., & Qin, G. (2025). Multiple attachment perspectives: the relationship between interpersonal attachment from family and school environments and children's learning engagement. *BMC Psychology, 13*(1), 1-11.

Liu, H. Q., Du, X., Liu, J., Hoi, C. K. W., & Schumacker, R. E. (2023). Teacher-student relationship as aprotective factor for socioeconomic status, students' self-efficacy and achievement: A multilevel, moderated mediation analysis. *Current Psychology, 42*(4), 3268–3283. https://doi.org/10.1007/s12144-021-01709-3

Liu, X. (2024). Effect of teacher-student relationship on academic engagement: The mediating roles of perceived social support and academic pressure. *Frontiers in Psychology, 15*, Article 1331667.https://doi.org/10.3389/fpsyg.2024.1331667

Liu, Xiangliang (2024). *Effect of teacher-student relationship on academic engagement: the mediating roles of perceived social support and academic pressure*. https://doi.org/10.3389/fpsyg.2024.1331667

Maine, P. (2023). Explore Self-Determination Theory: Key Concept, its impact on motivation, behavior, and practical applications in various life aspects.

Martin, A. J., & Dowson, M. (2009). Interpersonal relationships, motivation, engagement, and achievement: Yields for theory, current issues, and educational practice. *Review of Educational Research, 79*(1), 327-365. https://doi.org/10.3102/0034654308325583

Memon, M. A., Ting, H., Cheah, J. H., Thurasamy, R., Chuah, F., & Cham, T. H. (2020). Sample size for survey research: Review and recommendations. *Journal of applied structural equation modeling, 4*(2), i-xx. https://doi.org/10.47263/JASEM.4(2)01

Ngo Hai, Q., Nguyen Thanh, H., & Nguyen, L. (2021). The roles of student engagement motivations in learning and

managing. *International Journal for Innovation Education and Research, 9*(4), 223.

Nuraysha, A. D. (2024). *Universitas Pendidikan Indonesia, Nanang Winarno, Universitas PendidikanIndonesia.* Wirawan Fadly.

OECD. (2023). *PISA 2022 results* (Volume I): The state of learning and equity in education. OECD Publishing. https://doi.org/10.1787/53f23881-en

Oliveira, A. W., Lopes, P. C., & Pinto, C. C. (2021). Teacher–student relationships and student well-being: The mediating role of basic psychological needs. *Teaching and Teacher Education, 106*, 103460. https://doi.org/10.1016/j.tate.2021.103460

Oliveira, M. A., Gama, A. S., & Carvalho, A. A. (2021). Capturing flow in gamified learning environments. *Smart Learning Environments, 8*(1). https://doi.org/10.1186/s40561-021-00175-6

Pascual, J. (2023). Investigating the effectiveness of the Socratic Method in promoting student engagement and critical thinking in online science classes during the COVID-19 pandemic. *UNIVERSITAS–The Official Journal of University of Makati, 11*(1), 106–115. https://journals.umak.edu.ph/universitas/article/view/170

Pianta, R. C., Hamre, B. K., & Allen, J. P. (2012). Teacher-student relationships and engagement: Conceptualizing, measuring, and improving the capacity of classroom interactions. Handbook of Research on Student Engagement, 365-386. https://doi.org/10.1007/978-1-4614-2018- 7_17

Primasari, R., Miarsyah, M., & Rusdi, R. (2020). Science literacy, critical thinking skill, and motivation: A correlational study. *JPBI (Jurnal Pendidikan Biologi Indonesia), 6*(2), 273-282.

Raufelder, D., Eid, M., & Regner, N. (2025). Teacher–student and peer relationships as protective factors in adolescence: A systematic review and meta-analysis of motivational and emotional outcomes. *Educational Psychology Review, 37*(2), 215–238. https://doi.org/10.1007/s10648-025-09732-z

Reeve, J., & Lee, W. (2022). Agentic engagement. In A. L. Reschly & S. L. Christenson (Eds.), *Handbook of research on student engagemen*t (pp. 95–107). Springer. https://doi.org/10.1007/978-3-031-07853-8_5

Reeve, J., & Lee, W. (2022). Agentic engagement. In A. L. Reschly & S. L. Christenson (Eds.), Handbook ofresearch on student engagement (pp. 95–107). Springer. https://doi.org/10.1007/978-3-031-07853-8_5

Ribeirinha, T., Baptista, M., & Correia, M. (2024). Investigating the impact of STEM inquiry-based learning activities on secondary school student's STEM career interests: A gender-based analysis using the Social Cognitive Career Framework. *Education Sciences, 14*(10), Article 1037. https://doi.org/10.3390/educsci14101037

Roorda, D. L., Koomen, H. M., Split, J. L., & Oort, F. J. (2019). The influence of affective teacher– student relationships on students' school engagement and achievement: A meta-analytical approach. *Review of Educational Research, 81*(4), 493-529. https://doi.org/10.3102/0034654311421793.

Ryan, R. M., & Deci, E. L. (2017). *Self-determination theory: Basic psychological needs in motivation, development, and wellness.* Guilford Press.

Ryan, R. M., & Deci, E. L. (2020). Self-determination theory and facilitation of intrinsic motivation, social development, and well–being. *American Psychologist, 55*(1), 68-78. https://doi.org/10.1037/0003-066x.55.1.68.

Sabanal, G. J. A., Reputana, K. G. D., Palwa, S. S., Labandero, C. L. H., & Alimbon, J. A. (2023). Motivation and academic performance of secondary students in science: A correlational study. *Asian Journal of Science Education, 5*(2), 20–29. https://doi.org/10.59960/ajse.v5i2.825

Schimmelpfennig, F. (2025). Effects of the teacher-student relationship on the learning and achievement motivation of high-tracking school students in adolescence. *European Journal of Psychology of Education, 40*(2), 1-26. https://doi.org/10.1007/s10212-025-00952-8

Schneider, B., Krajcik, J., Lavonen, J., Salmela-Aro, K., Klager, C., Bradford, L., ... & Bartz, K. (2022). Improving science achievement—Is it possible? Evaluating the efficacy of a high school chemistry and physics project-based learning intervention. *Educational Researcher, 51*(2), 109-121.

Skinner, E. A., Kindrmann, T. A., & Furrer, C. J. (2021). A motivational perspective on engagement and disaffection: Conceptualization and assessment of children's behavioral and emotional participation in academic activities in the classroom. *Educational and Psychological Measurement, 69*(3), 493525. https://doi.org/10.1177/001316440832 233.

Snijders, I., Wijnia, L., Rikers, R. M. J. P., Loyens, S. M. M., & Smeets, G. (2022). Relationship quality in higher education and the interplay with student engagement and loyalty. *British Journal of Educational Psychology, 92*(1), 1–18.

Toma, R. B., & Greca, I. M. (2018). The effect of integrative STEM instruction on elementary students' attitudes toward science. *Eurasia Journal of Mathematics, Science and Technology Education, 14*(4), 1383–1395. https://doi.org/10.29333/ejmste/83676

Valenzuela-Peñuñuri, R., Tapia-Fonllem, C. O., Fraijo-Sing, B. S., & Manríquez-Betanzos, J. C. (2024). Academic motivation and affective engagement toward science and math: the mediating role of self-efficacy. *Frontiers in Education, 9.*

Van den Broeck, A., Howard, J. L., Van Vaerenbergh, Y., Leroy, H., & Gagné, M. (2021). Beyond intrinsic and extrinsic motivation: A meta-analysis on self-determination theory's multidimensional conceptualization of work motivation. *Organizational psychology review, 11*(3), 240-273. https://doi.

org/10.1177/20413866211006173

Vansteenkiste, M., Ryan, R. M., & Soenens, B. (2020). Basic psychological need theory: Advancements, critical themes, and future directions. *Motivation and Emotion, 44*(1), 1–31. https://doi.org/10.1007/s11031-019-09818-1

Vysakh, K. K., Muthupalani, S., & Achuthan, K. (2020). Virtual experimental platforms in chemistry laboratory education and its impact on experimental self-efficacy. *International Journal of Educational Technology in Higher Education, 17*, Article 30. https://doi.org/10.1186/s41239-020-00204-3

Wang, M. T., Degol, J. L., Amemiya, J., Parr, A., & Guo, J. (2020). Classroom climate and children's academic and psychological wellbeing: A systematic review and meta-analysis. *Developmental Review, 57*, Article 100912. https://doi.org/10.1016/j.dr.2020.100912

Xiong, Y., Sun, X., Liu, J., & Wang P. (2020). Teacher expectations and student academic engagement: The mediating role of teacher-student relationships. *Educational Psychology, 40*(8), 952-968.

Yin, H., Wang, W., & Han, X. (2021). Flow experience and continued use intention in blended learning: Amoderated mediation model. *International Journal of Educational Technology in Higher Education, 18*, 28. https://doi.org/10.1186/s41239-021-00285-8

You, S., & Dang M. (2022). The role of self-determined motivation in science learning. *AsiaPacific Education Researcher, 31*(1), 63-76.

Zee, M., & Roorda, D. L. (2019). Student-teacher relationships in elementary school: The unique role of teacher and student perceptions in predicting school adjustment. *Journal of School Psychology, 69*, 49-61.

Zhang, Y., & Li, M. (2023). Perceived teacher-student relationship and growth mindset as predictors of student engagement in foreign language learning: The mediating role of foreign language enjoyment. *Frontiers in Psychology, 14*, 10240543.