Exploring the relationship between student engagement and academic achievement in science: A study of junior high school students

Annie Satriani Achwani*, Taufik Rahman, Lilit Rusyati

Science Education Department, Universitas Pendidikan Indonesia, Dr. Setiabudi Street No. 229, Bandung, 40154, Indonesia.

*Corresponding author, email: anniesatrianiachwani@gmail.com

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Abstract
Academic success, especially in science education, is greatly influenced by student engagement, but its effects vary depending on socioeconomic status and past performance, leaving gaps in how each type of engagement specifically impacts junior high students. According to research, these interactions require more investigation in order to guide focused interventions, fair policies, and instructional strategies that improve student engagement and science proficiency, particularly for diverse student populations. This study investigates the relationship between junior high school scientific achievement and student involvement, with a particular emphasis on the engagement indicators that most accurately predict academic performance. This study uses a correlational research design to quantitatively examine the direction and degree of the association between junior high school students' academic achievement in science and their level of student involvement. Participants in the study were 100 eighth graders (31% male, 69% female) from a public junior high school in Bandung, West Java, Indonesia. There are two instruments used in the study, namely a questionnaire for student engagement and multiple-choice questions through online exams with the Pijar Sekolah application. Since all of the Spearman coefficients were weak and statistically insignificant ($p > 0.05$), the study found no significant correlation between academic achievement and student engagement (cognitive, behavioural, emotional, or social). These results suggest that engagement-focused therapies should be re-examined, and other indicators of academic performance should be investigated. In order to better understand these dynamics, future research should use longitudinal designs and include other variables (such as self-efficacy and institutional support).

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1. Introduction

An important component of academic success, especially in science education, is student engagement. The behavioral, emotional, and cognitive components of engagement all make distinct contributions to students' learning results (Chang et al., 2016; Chase et al., 2014; Lei et al., 2018). Higher levels of student engagement have been repeatedly linked to improved academic success (Carini et al., 2006; Chang et al., 2016; Lei et al., 2018). But there is a complicated relationship between engagement and achievement that depends on a number of variables, such as socioeconomic position, past performance, and motivational beliefs (Li et al., 2017; Tomaszewski et al., 2020). Although the relationship between involvement and academic performance has been demonstrated, little is known about the precise effects of the various forms of engagement (behavioral, emotional, and cognitive) on junior high school students' achievement in science. Research on how these correlations might change depending on the student population and other educational situations is also lacking (Bae & DeBusk-Lane, 2019; Chang et al., 2016; Tomaszewski et al., 2020). This incomplete knowledge makes it more difficult to create focused treatments that will improve student engagement and, in turn, scientific academic performance.

It is essential to comprehend the subtleties of how student engagement influences scientific academic progress for a number of reasons: (1) Educational Policy and Practice: knowledge gained from this study can help shape methods and policies meant to raise academic performance and student involvement (Chase et al., 2014; Finn & Zimmer, 2012); (2) Targeted Interventions: teachers can create more successful interventions by determining which engagement factors most accurately predict academic performance (Chang et al., 2016; Lei et al., 2018); and (3) Equity in Education: this study can help create more equitable educational practices by

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examining the effects of participation on students from various socioeconomic backgrounds (Tomaszewski et al., 2020).

Prior research has emphasized the significance of student engagement in fostering academic success. According to a meta-analysis of 69 studies, student involvement and academic performance are positively correlated. Achievement is significantly positively correlated with behavioral, emotional, and cognitive engagement (Lei et al., 2018). According to a different study, middle school students' scientific achievement was significantly predicted by their engagement profiles, such as whether they were behaviorally engaged or disengaged (Bae & DeBusk-Lane, 2019). Furthermore, studies have demonstrated that socioeconomic status can act as a mediator in the relationship between academic achievement and engagement, with students from poorer socioeconomic backgrounds frequently demonstrating lower levels of both (Tomaszewski et al., 2020).

A number of aspects highlight how urgent it is to investigate the connection between junior high school students' academic achievement in science and their level of engagement: (1) Decline in Engagement, the middle school years are crucial because they shape students' future academic paths and interest in STEM fields, yet there is a proven drop in science involvement at this time (Martin et al., 2021), and (2) Need for Contextual Learning, it is still difficult to translate scientific ideas into practical applications, thus in order to keep students' attention and engagement, more emphasis must be placed on contextual learning and motivation (Ilhami et al., 2025). Even while student involvement is acknowledged to be important, there are still a number of gaps in the present body of research: (1) Multidimensional Engagement, the multifaceted character of student engagement is frequently overlooked by current metrics, which primarily focus on behavioural factors while ignoring cognitive and emotional aspects (Kassab et al., 2022), (2) Integration of Social-Emotional Traits, it is frequently forgotten to include social-emotional characteristics like amiable disposition in the examination of science learning objectives. Students' participation and cooperation in group-based learning activities are greatly impacted by these characteristics (Ilhami et al., 2025), and (3) Effectiveness of Engagement Practices, although high-impact engagement practices have been shown to increase academic achievement, more research is needed to determine how they specifically affect certain student groups, especially in STEM disciplines (Adesope et al., 2021).

Although previous research emphasizes the significance of student involvement, more thorough studies are required to: (1) particular aspects of participation: the distinct ways in which behavioral, emotional, and cognitive aspects of participation all support scientific success; (2) contextual variations: the ways in which these associations change depending on the student demographics and various educational environments; and (3) longitudinal effects: how involvement affects scientific students' academic paths over time. The principal objective of this research is to investigate the correlation between junior high school students' academic performance in science and their level of student engagement. The study specifically aims to determine which engagement factors are most predictive of science accomplishment.

2. Method

The research method used is correlational design. In quantitative research, correlational designs are methods where researchers use the statistical process of correlational analysis to gauge the strength of the relationship (or association) between two or more variables. Whether the two variables are related or if one may predict the other is indicated by this degree of correlation, which is a numerical value (Creswell, 2012). The sampling technique used is convenience sampling, a non-probabilistic sampling method in which participants are chosen based on their accessibility to the researcher (Suen et al., 2014). Table 1 presents 100 eighth-graders from a public junior high school in Bandung, West Java, Indonesia, participated in the study. A typical demographic distribution for the area was represented by the fact that all participants were science students. The school's enrollment trends over the data collecting period are reflected in the gender imbalance.

Table 1. The identity of 8th grade students

Gender	Number	Percentage
Male (M)	31	31%
Female (F)	69	69%
Total	100	100%

The study uses two instruments: a questionnaire to gauge student engagement and multiple-choice questions from online tests using the Pijar Sekolah application. Telkom Indonesia created the Pijar Sekolah digital education platform to facilitate online learning in classrooms. Students can learn at their own pace with its specially designed practice questions, interactive learning resources, video tutorials, and tests. Additionally, the platform gives teachers and institutions the tools they need to effectively organize classrooms and track student development. By incorporating technology into the classroom, Pijar Sekolah hopes to close the gaps in educational equity throughout Indonesia, increase accessibility, and improve learning results. The Mid-Semester Assessment for grade 8 in the even semester of the 2024–2025 academic year contained 25 multiple-choice questions (four choices and only one correct answer) that were utilized in the study on academic

achievement in science. These questions were created by a team of science teachers at the school. The Pijar Sekolah application's distribution grid for the test questions is shown in Table 2.

Table 2. Grid of test items for academic achievement in science

No.	Topic	Number of Questions	Question Number
1.	Vibration	8	1, 2, 3, 4, 5, 6, 7, 8
2.	Wave	15	9, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24
3.	Light and Optical Instruments	2	10, 25

Figure 1 provides a textual representation of the flowchart for this research flow. The flowchart describes a correlational design that looks at the connection between eighth-grade students' academic achievement in science and their level of student engagement. Convenience sampling combined with correlational design strikes a balance between practicality and rigour in educational contexts. A test and a questionnaire are two tools that capture different facets of learning. The integration of Pijar Sekolah reflects Indonesia's real trends in digital learning.

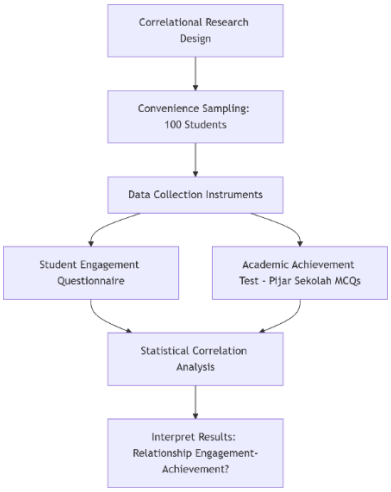

Figure 1. Research Flowchart

The integrated digital learning environment of Pijar Sekolah, created by Telkom Indonesia, was selected for this study because it improves accessibility, harmonises assessments, and advances Indonesia's objectives for educational digitalization. For this correlational study on engagement and achievement, the platform's automated test administration and self-paced learning resources (video tutorials, quizzes) guarantee accurate, unbiased academic achievement data. It is the perfect instrument to analyse tech-enhanced learning results in Indonesian public schools because of its scalability and cost-effectiveness, which meet real-world classroom needs, and Telkom's support, which guarantees alignment with government efforts to close educational gaps through technology.

Student engagement was measured using a questionnaire adapted from previous research with a 5-point Likert scale (Wang et al., 2016). The questionnaire was translated into Indonesian and administered to thirty-four eighth-grade students. From 33 statements, 21 statements were found to be fit. Winsteps Rasch was used to analyze the test findings, which are shown in Table 3.

Table 3. Winsteps Rasch analysis for student engagement questionnaire

Dimension	Statement	Winsteps Rasch			
		OUTFIT		PTMEASUR-AL	Decision
		MNSQ	ZSTD	CORR.	
Cognitive Engagement	I go through the work for science class and make sure that it's right.	.84	-.66	.30	Fit
	I think about different ways to solve a problem	.72	-1.16	.21	Misfit
	I try to connect what I am learning to things I have learned before	.79	-.93	.35	Fit
	I try to understand my mistakes when get something wrong	.81	-.61	.24	Fit
	I would rather be told the answer than have to do the work	1.74	3.04	.29	Misfit
	I don't think that hard when I am doing work for class	1.21	1.06	.18	Fit

Dimension	Statement	Winsteps Rasch			
		OUTFIT		PTMEASUR-AL	Decision
		MNSQ	ZSTD	CORR.	
	When work is hard I only study the easy parts	1.51	2.12	.36	Misfit
	Do just enough to get by in class	.99	.05	.37	Fit
Behavioural Engagement	I stay focused	1.01	.13	.42	Fit
	I put effort into learning science	1.04	.25	.41	Fit
	I keep trying even if something is hard	.82	-.63	.17	Fit
	I complete my homework on time	.75	-1.18	.35	Fit
	I talk about science outside of class	.68	-1.54	.38	Misfit
	I don't participate in class	1.13	.58	.49	Fit
	I do other things when I am supposed to be paying attention	1.45	2.03	.40	Misfit
	If I don't understand, I give up right away	.93	-.29	.53	Fit
Emotional Engagement	I look forward to science class	.83	-.71	.35	Misfit
	I enjoy learning new things about science	.78	-1.01	.24	Misfit
	I want to understand what is learned in science class.	.88	-.41	.24	Misfit
	I feel good when I am in science class.	.56	-2.26	.48	Fit
	I often feel frustrated in science class	1.18	.89	-.24	Fit
	I think that science class is boring	.93	-.28	.09	Misfit
	I don't want to be in science class	1.08	.41	.06	Fit
	I don't care about learning science	.76	-.75	.32	Misfit
	I often feel down when I am in science class	.66	-1.31	.31	Misfit
	I get worried when I learn new things about science	.96	-.15	.18	Fit
Social Engagement	I build on others' ideas.	1.21	1.06	.18	Fit
	I try to understand other people's ideas in science class	1.42	1.70	.03	Fit
	I try to work with others who can help me in science	1.49	1.99	.01	Fit
	I try to help others who are struggling in science	.75	-1.16	.49	Fit
	I don't care about other people's ideas	1.02	.18	.38	Fit
	When working with others, I don't share ideas	.85	-.58	.20	Misfit
	I don't like working with classmates	1.17	.83	-.10	Fit

3. Results and Discussion

In IBM SPSS Statistics, the Shapiro-Wilk test (for small samples <50) and the Kolmogorov-Smirnov test (for larger samples) are two often used techniques to test data normality. Make sure the data is input accurately in Data View first. Select Analyzee > Descriptive Statistics. After exploring, add the target variable to the list of dependent variables. Select Normality plots with tests under Plots, which will automatically produce both tests. Kolmogorov-Smirnov generates a statistic with a comparable meaning to the Shapiro-Wilk test, which yields a statistic and p-value where $p > 0.05$ indicates normality. Table 4 confirms tests of normality for student engagement and academic achievement.

Table 4. Normality test of student engagement and academic achievement using Kolmogorov-Smirnov test

Data	Gender	Significance Value (p)	Category
Student engagement	Male	0.003	Not normally distributed
	Female	0.200	Normally distributed
Academic achievement	Male	0.200	Normally distributed
	Female	0.000	Not normally distributed

In order to conduct a correlation study in IBM SPSS Statistics 25, make sure the variables (such as scale or ordinal) are appropriately defined and the data is appropriately organised in Variable View and Data View. To access the correlation dialogue, choose your variables for analysis by navigating to Analyse > Correlate > Bivariate. Select the relevant correlation coefficient (e.g., Kendall's tau-b for small datasets with tied ranks, Spearman for ordinal or non-normal data, Pearson for normally distributed continuous data) and indicate if a two-tailed (non-directional) or one-tailed (directional) significance test is required. Additionally, turn on features like asking descriptive statistics or highlighting important associations (shown with asterisks). Once

you click OK, IBM SPSS Statistics 25 creates a correlation matrix in the Output Viewer that shows p-values (where $p < 0.05$ indicates a meaningful relationship) and coefficients (r, which range from -1 to +1). According to the findings (Table 4), the data is not dispersed normally. Therefore, the correlational test would employ Spearman's rank correlation, a non-parametric test. Table 5 describes the correlation coefficient using Spearman for non-normal data.

Table 5. Spearman test for the correlation coefficient

Data		Academic Achievement
Student Engagement	Correlation Coefficient	-.104
	Sig. (2-tailed)	.305
	N	100
Cognitive Engagement	Correlation Coefficient	-.066
	Sig. (2-tailed)	.517
	N	100
Behavioural Engagement	Correlation Coefficient	-.058
	Sig. (2-tailed)	.568
	N	100
Emotional Engagement	Correlation Coefficient	.002
	Sig. (2-tailed)	.986
	N	100
Social Engagement	Correlation Coefficient	-.144
	Sig. (2-tailed)	.152
	N	100

Since all p-values (Sig. 2-tailed) are greater than the 0.05 cutoff, the Spearman correlation test results in Table 5 show no statistically significant connections between Academic Achievement and any of the engagement characteristics (Student, Cognitive, Behavioural, Emotional, and Social). Since the correlation coefficients are nearly 0, there are very few correlations. For example, Social Engagement has the highest negative but still negligible trend ($r = -.144$, $p = .152$), while Emotional Engagement has the poorest correlation ($r = .002$, $p = .986$). For every test, the sample size ($N = 100$) remains constant. These results imply that student involvement in all of its manifestations does not significantly predict academic achievement in this study. The absence of substantial connections might suggest that academic achievement is more heavily influenced by other, unmeasured factors. This result in line with the previous research which confirm learning analytics dashboards (LADs) do not appear to significantly increase academic accomplishment, according to this systematic review, which suggests that engagement tools may not have a substantial effect on academic outcomes (Kaliisa et al., 2024).

Different from the research results, there are several studies that contradict the conclusions. According to the meta-analysis, academic achievement and student engagement (behavioural, emotional, and cognitive) are significantly positively correlated (Chang et al., 2016). Academic achievement and general student engagement were found to be modestly positively correlated in another meta-analysis of 69 research, with variations depending on gender, cultural values, and reporting practices (Lei et al., 2018). According to the study, academic achievement is positively impacted by student engagement, with self-efficacy moderating the relationship and the adversity quotient acting as a mediator (Li et al., 2022). The study showed a strong correlation between undergraduate students' academic success and their behavioural, cognitive, and emotional engagement (Hasanov et al., 2021). Academic achievement and school involvement are predictive of one another, according to this long-term study, suggesting a reciprocal link (Chase et al., 2014). According to the study, academic attainment among first-year university students in Cambodia is greatly impacted by their participation in academically related activities (Heng, 2014). According to this study, academic attainment is greatly impacted by student involvement, which is influenced by cognitive and motivational factors (Dadandı & Yazıcı, 2024). The academic achievement and student engagement were positively correlated, especially when using problem-solving learning paradigms (Sankar & Benjamin, 2024). Academic success was favourably connected with involvement in learning communities, which improves student engagement (Gokpinar-Shelton & Pike, 2022).

The reasons why there was no discernible correlation between student engagement and academic achievement, a number of factors could be at play: (1) measurement and methodological issues, (2) complexity of engagement, and (3) individual differences. Factor (1) that studies with small sample sizes may be underpowered, making it challenging to identify meaningful associations even when they do exist (McGrath, 2016). If there were only a few participants in the study, this might have played a role. The reliability and selection of measurement instruments can affect the outcomes. Inconsistent results may result from differences in the methods used to measure academic achievement and engagement (Hasanov et al., 2021). Self-report measurements, for example, are susceptible to biases like social desirability, which may compromise the data's veracity (Gerber et al., 2013). Factor (2) describes the concept of engagement is intricate and multifaceted, with elements of behaviour, cognition, and emotion (Hasanov et al., 2021). Potential links may be obscured if the study did not fully capture all dimensions or if the dimensions were not examined independently (Schnitzler et

al., 2021). Cultural values, teacher-student interactions, and the learning environment are some of the contextual factors that affect engagement (Xie et al., 2024). Variations in these variables between studies may produce different outcomes (Chang et al., 2016; Lei et al., 2018). Factor (3) describes the relationship between academic achievement and engagement can be moderated by individual differences in motivation and personality traits. For instance, it has been demonstrated that engagement and, in turn, academic achievement are positively impacted by conscientiousness and a strong sense of purpose (Xerri et al., 2018). Additionally, financial class, gender, and ethnicity may influence academic performance and involvement. According to studies, these factors may result in various patterns of involvement and academic performance (Sontam & Gabriel, 2012). Another strategy can complete with the peer assessment, not only focus on self-assessment. This is supported by there is a substantial association between students' achievement and peer assessment across all indicators, while there is a correlation between self-assessment and students' achievement in one indicator and between peer and self-assessment in six of ten (Nurismawati et al., 2025).

Numerous studies have shown a good association between academic accomplishment in science and student involvement, which is well-established. This synopsis investigates this connection, especially as it relates to scientific subjects like vibration, waves, light, and optical devices. Students' comprehension and interest in vibrations and waves can be increased by including them in practical exercises and experiments. These ideas can become more concrete and interesting through real-world applications, such the use of tuning forks or wave simulations (Ahmadaliev et al., 2022). Student engagement can be greatly increased by teaching light and optical instruments through interactive labs and real-world applications (such as using telescopes or microscopes). Through these exercises, students can better understand how theoretical ideas apply to real-world situations (Ahmadaliev et al., 2022). Critical technologies including lasers, fiber-optic transmission, medical imaging (such as endoscopes), and optical sensors are all supported by optics, which propels developments in computer, healthcare, and telecommunications. Quantum mechanics and technologies like solar cells and LED lighting rely heavily on the dual nature of light (as waves and photons). Teaching more general physics ideas, such as wave behaviour, refraction, and quantum phenomena, can be facilitated by using optics (Putri et al., 2024).

4. Conclusion

Since all Spearman correlation coefficients were small and statistically non-significant ($p > 0.05$), the study comes to the conclusion that there is no meaningful relationship between academic accomplishment and student engagement (cognitive, behavioural, emotional, or social). This implies that engagement by itself might not have a direct impact on academic achievement in this situation, underscoring the possible significance of additional elements like motivation, instructional effectiveness, or outside support networks. It is advised that future studies broaden the scope of the enquiry by adding more variables (such as socioeconomic characteristics, self-efficacy, or the learning environment) and using mixed-methods approaches to investigate underlying mechanisms. Longitudinal studies may also shed more light on the dynamics of involvement over time and their postponed impacts on performance.

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