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Student Innovativeness as Mediator Between Science Competence and Attitudes Toward Science and Technology Among Junior High School Students

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Abstracts — Negative attitudes toward science and technology are a global concern. This study determined the mediating effect of innovativeness on the relationship between competence in learning science and attitudes toward science and technology. Using predictive research design and mediation analysis on data collected from 280 participants selected through stratified random sampling, the findings revealed that innovativeness partially mediates the relationship between competence in learning science and attitudes toward science and technology, the model explained 38% of the variance, indicating that 62% of the variance may be attributed to other factors not included in the study. These results support Social Cognitive Theory emphasizing the interaction of cognitive, personal, and behavioral factors in shaping student outcomes. The study further recommends conducting additional research to explore other mediating variables that may account for the remaining 62% of the variance. Moreover, it suggests that educational leaders implement innovation-focused seminars and workshops to enhance students' attitudes toward science and technology.

Keywords: Student innovativeness, science competence, attitudes toward science and technology, junior high school students

I. INTRODUCTION

Negative attitudes toward science and technology remain a persistent global concern among secondary school students, as evidenced by declining interest and engagement across educational contexts (Barmby et al., 2008; Osborne et al., 2003; Potvin & Hasni, 2014)—many view science as uninteresting, difficult, or irrelevant to daily life. Several studies highlight this concern in science education literature (Bennett & Hogarth, 2009; Sheldrake, 2017; Elliniadou, 2021). As science and technology continue to drive global development, negative attitudes toward these fields raise serious concerns for educational systems worldwide (Organisation for Economic Co-operation and Development [OECD], 2019, 2025; United Nations Educational, Scientific and Cultural Organization [UNESCO], 1983).

This issue is evident across countries (Fulmer et al., 2019). For instance, research in Indonesia documents students' negative attitudes toward science. Studies indicate that these attitudes manifest as disengagement and low student participation across Southeast Asia (Maison et al., 2023). In Europe, recent studies from Poland show that learners' attitudes toward science significantly affect their engagement, indicating that unfavourable perceptions remain a concern in this region as well (Taghap & Addani, 2024). In China, a large-scale study found that about 15% of students exhibit negative attitudes toward science. Research indicates that these attitudes are associated with lower academic performance and reduced student engagement (Li et al., 2024; Wang et al., 2025).

In the Philippines, studies examine students' attitudes toward science and report wide variations in interest and engagement. Some learners show limited interest and weak engagement in science tasks (Mutya et al., 2024). Alimbon et al. (2023), states that additional research links attitudes to how students perceive and respond to scientific concepts and classroom experiences.

Negative attitudes among junior high school students are associated with lower performance and reduced participation in science activities. These also lead to declining interest in science-related careers (Limbaga & Borlio, 2025). Negative attitudes can hinder the development of key skills like critical thinking and problem-solving (Taghap & Addani, 2024).

According to Mao et al. (2021), this problem threatens both academic outcomes and the growth of a scientifically literate, competent population, underscoring the urgency of this study.

This study advances Sustainable Development Goal 4 (SDG 4) by fostering student engagement and appreciation of science and technology. It aligns with Philippine educational objectives and the mission of Holy Cross of Davao College. The study promotes scientific literacy, critical thinking, and values-oriented learning. The study's findings will benefit students, educators, and the academic community. They will highlight the importance of positive attitudes in enhancing educational quality and contributing to national development (Hall et al., 2024).

The objective of this study is to determine the significance of the mediating effect of innovativeness on the relationship between competence in learning science and attitudes toward science and technology. Specifically, it aims to determine: the levels of student innovativeness in terms of inventiveness, motivation and pride, and leadership; the level of student competence in learning science in terms of scientific inquiry and communication; the level of students' attitudes toward science and technology in terms of the value of science to society, attitudes toward school science, and intrinsic motivation for science; the significance of the correlation between competence in learning science, innovativeness, and attitudes toward science and technology; the significance of the direct effect of competence in learning science on attitudes toward science and technology, controlling for innovativeness; the significance of the indirect effect of competence in learning science on attitudes toward science and technology through innovativeness; and the significance of the total effect of competence in learning science on attitudes toward science and technology. This study was based on the Social Cognitive Theory by Alber Bandura in 1986.

II. METHODOLOGY

This study utilised a predictive research design. A predictive research design is a quantitative approach that aims to examine and forecast relationships among variables by determining how one variable influences another. In studies involving mediation, this design goes beyond identifying simple relationships by estimating the magnitude and pathways of effects among variables. Moreover, a predictive research design enables researchers to determine the

extent or magnitude of these effects. Using statistical techniques, it quantifies the strength of an independent variable's predictive power over a dependent variable, thereby providing insight into the practical significance of these relationships and improving the model's predictive accuracy (Gaskin et al., 2023). In this study, competence in learning science served as the independent (determinant) variable, attitudes toward science and technology as the dependent (criterion) variable, and innovativeness as the mediating variable.

This study was conducted in public junior high schools under Cluster 6 of the Division of Davao City, supervised by the Department of Education (DepEd) in Region XI. These schools operate in a mixed rural–urban setting and implement the national K–12 curriculum. They serve students from diverse socioeconomic backgrounds. The division ensures standardised curriculum delivery, teacher supervision, student assessment, and the implementation of educational programs to maintain quality and equitable secondary education.

The study sampled 280 junior high school students from a population of 1,024 learners. Respondents were selected based on the following criteria: they had to be currently enrolled in the 2025–2026 school year, be members of the Junior High School Department, and provide signed consent and assent forms. Students enrolled in special education programs with individualised learning plans, those not officially enrolled, and those who did not provide consent were excluded from the study. The selected participants appropriately represent the target population relevant to the study's objectives. This study employed stratified random sampling, which divides the population into homogeneous groups (strata) and randomly selects participants from each stratum to ensure reliable and representative results (Fricker, 2008). Once the strata are defined, a random sample is drawn from each group, ensuring that every member of the population has an equal probability of selection (Garg, 2016; Salkind, 2007). The sample size was determined using proportionate stratified sampling (n = 280). The distribution of participants per grade level was as follows: Grade 7 – 80 participants; Grade 8 – 72 participants; Grade 9 – 58 participants; and Grade 10 – 70 participants.

The study utilised a survey questionnaire as the primary data-gathering instrument. This method uses standardised written questions, such as closed-ended items and rating scales, to efficiently collect measurable data on respondents' attitudes, behaviours, and perceptions from

large groups. It is appropriate for objective measurement, comparison, and pattern or relationship identification, making it widely used in descriptive, correlational, and predictive research designs (Hansen & Świderska, 2023). In this study, the survey questionnaire enabled systematic quantification of variables, supported hypothesis testing, and enhanced reliability and statistical analysis due to uniform responses (Creswell & Creswell, 2018). This study used three adapted and modified survey questionnaires. The first measure of competence in learning science (Chang et al., 2011) consisted of 29 items and had a Cronbach's alpha of 0.918. The second measured student innovativeness (Christensen & Knezek, 2018; Baran et al., 2019) and consisted of 18 items, with a Cronbach's alpha of 0.876. The third measured students' attitudes toward science and technology (Bellová et al., 2021) and consisted of 16 items, with a Cronbach's alpha of 0.834. Before data collection, the researcher validated all instruments, conducted pilot testing, and assessed their reliability. This study employed three data analysis techniques: descriptive analysis, correlation analysis, and mediation analysis. The responses to the items in the three adapted instruments were analysed and interpreted using appropriate statistical treatments, as outlined below.

Mean Scale	*Level*	*Competence in learning science*	*Innovativeness*	*Attitude towards science and technology*
4.20-5.00	Very High	Excellent	Excellent	Excellent
3.40-4.19	High	Very Good	Very Good	Very Good
2.60-3.39	Moderate	Good	Good	Good
1.80-2.59	Low	Poor	Poor	Poor
1.00-1.79	Very Low	Very Poor	Very Poor	Very Poor

The following is the Standard Deviation Value Interpretation:

Range	*Description*	*Interpretation*
SD ≤ 0.50	Highly Consistent Responses	Strong and uniform perception
SD = 0.51 – 1.00	Moderately Consistent Responses	Acceptable consistency
SD = 1.01 – 1.50	Low Consistency Responses	Differing views or experiences
SD > 1.50	Very Low Consistency Responses	High variability and lack of consensus

In this study, the significance of the correlation is tested at 0.05 confidence level. The following is the standard measure for the interpretation scale of *r*-value, the following scheme is used:

Computed r	*Descriptive Interpretation*
+/- 1.00	Perfect correlation
Between +/- 0.75 – +/- 0.99	High correlation
Between +/- 0.51 – +/- 0.74	Moderately high correlation
Between +/- 0.31 – +/- 0.50	Moderately low correlation
Between +/- 0.01 – +/- 0.30	Low correlation
0.00	No correlation

The standard measure for the interpretation of the strength of the mediation is as follows:

Proportion Mediated	*Interpretation*
< 0.20	Weak Mediation
0.20 – 0.50	Moderate Mediation
> 0.50	Strong Mediation

The study adhered to ethical standards to protect the rights and welfare of the respondents. Informed consent was obtained by clearly explaining the study's purpose, procedures, and voluntary nature, with participants signing consent and assent forms in compliance with the Department of Education (DepEd) requirements. Confidentiality and anonymity were ensured by not collecting any identifying information. Proper authorization was secured from DepEd, and ethical clearance was obtained from the SMILE Ethics Review Board. These measures reflect the researcher's commitment to ethical and responsible research conduct. The study was conducted from August to October 2025. The planning phase began in May, followed by instrument validation and pilot testing in July. Data collection was carried out in October among selected junior high school students. Data analysis, including correlation and mediation analysis, was performed in November. The writing and interpretation of results were completed in December, and final revisions and submission were done in February-March 2026.

III. RESULTS AND DISCUSSIONS

Table 1 presents the descriptive statistical results of the study. It includes the variables involved: student innovativeness, student competence in learning science, and students' attitude toward science and technology, along with their respective indicators, standard deviations, means, and descriptive levels.

TABLE 1
DESCRIPTIVE TABLE (N=280)

Variables	SD	Mean	Descriptive Level
Student Innovativeness	**0.38**	**4.18**	High
Inventive	0.39	4.21	Very High
Motivation and Pride	0.40	4.38	Very High
Leadership	0.57	3.94	High
Student Competence in Learning Science	**0.35**	**4.12**	High
Scientific Inquiry	0.37	4.16	High
Communication	0.38	4.08	High
Students' Science and Technology Attitude	**0.38**	**4.28**	Very High
Value of Science to Society	0.40	4.37	Very High
Attitude towards School Science	0.46	4.25	Very High
Intrinsic Motivation	0.54	4.28	Very High

The table shows that student innovativeness had a mean of 4.18, which is high and indicates a very good level. Two of its indicators were rated very high, while one indicator was rated high. The standard deviation of 0.38 indicates moderately consistent responses, suggesting acceptable consistency among respondents. For student competence in learning science, the overall mean is 4.12, which is high and indicates a very good level of competence. All indicators were rated high. The standard deviation of 0.35 likewise reflects moderately consistent responses, indicating acceptable consistency. Meanwhile, students' attitude toward science and technology had a mean of 4.28, indicating an excellent level. All indicators were rated very high. The standard deviation of 0.38 indicates moderately consistent responses, showing acceptable consistency among respondents.

Overall, students' attitude toward science and technology received the highest descriptive rating and was the most evident among respondents. Both student innovativeness and competence

in learning science were also rated positively, with innovativeness slightly higher than competence.

Table 2 presents the correlation analysis between the determinant variables and the criterion variable. It includes the r-values, p-values, decisions on the hypotheses, and their interpretations.

TABLE 2
CORRELATION TABLE (N=280)

	Students' Science and Technology Attitude			
	$r - Value$	$p - Value$	Decision on Ho	Interpretation
Student Innovativeness	.532	$< .001$	Reject	Significant
Student Competence in Learning Science	$.537$	$< .001$	Reject	Significant

Level of Significance: 0.05
Decision Rule: Reject H_0 if $p < 0.05$

The table shows that the correlation between student competence in learning science and attitude toward science and technology yielded a p-value of < .001, which is less than the 0.05 level of significance. Therefore, the study rejects the null hypothesis, indicating a significant relationship between the two variables. The corresponding r-value of 0.537 indicates a moderately high positive correlation, suggesting that as competence in learning science increases, attitude toward science and technology also improves. Similarly, the correlation between student innovativeness and attitude toward science and technology yielded a p-value of < .001, which is also below the 0.05 level of significance. Thus, the study rejects the null hypothesis, indicating a significant relationship. The r-value of 0.532 indicates a moderately strong positive correlation, suggesting that greater innovativeness is associated with a more positive attitude toward science and technology.

Overall, both student innovativeness and student competence in learning science show significant positive relationships with students' attitudes toward science and technology.

Table 3 presents the mediation analysis. It includes the path/effects, estimated beta coefficients, standard errors (SE), Z-values, p-values, decisions on the hypotheses, and interpretations.

TABLE 3
MEDIATION TABLE (N=280)

Label	Path / Effect	Estimate (B)	SE	Z-value	p-value	Decision on H_0	Interpretation
A	Student Competence in Learning Science → Student Innovativeness	0.681	0.0529	12.86	<.001	Reject H_0	Significant
B	Student Innovativeness → Student Attitude towards Science and technology	0.321	0.0666	4.81	<.001	Reject H_0	Significant
c'	Student Competence in Learning Science → Student Attitude towards Science and technology (direct effect)	0.357	0.0741	4.82	<.001	Reject H_0	Significant
a × b	Indirect Effect (Mediation)	0.218	0.0505	4.32	<.001	Reject H_0	Significant
c (Total Effect)	Student Competence in Learning Science → Student Attitude towards Science and technology (Total)	0.576	0.0574	10.03	<.001	Reject H_0	Significant

Level of Significance: 0.05
Decision Rule: Reject H_0 if $p < 0.05$
Mediated proportion: 0.218/0.576=0.38

The table shows that the direct effect of student competence in learning science on attitude toward science and technology, controlling for innovativeness, is estimated at 0.357 ($p < .001$), which falls short of the 0.05 level of significance. Thus, the study rejects the null hypothesis, indicating that the direct effect is significant. The indirect effect of competence in learning science on attitude toward science and technology, mediated by innovativeness, has an estimated beta of 0.218 ($p < .001$). The analysis indicates that the indirect effect is significant; therefore, the study rejects the null hypothesis. Furthermore, the results show a total effect of 0.576 ($p < .001$), confirming that competence in learning science significantly influences attitudes toward science and technology. The results indicate that innovativeness partially mediates the relationship

between competence in learning science and attitude toward science and technology. The proportion mediated is 0.38 (38%), which suggests a moderate level of mediation.

IV. SUMMARY OF FINDINGS

The findings indicate a significant relationship between competence in learning science and attitudes toward science and technology. These findings align with Adarlo (2022), who found that students with more positive attitudes toward science tend to exhibit higher proficiency and better performance. Similarly, the results are consistent with Labrador et al. (2024), who asserted that students' motivation, attitude, and self-belief are key factors influencing their competence in science. Their findings show that positive attitudes contribute to improved science learning outcomes and overall proficiency. However, the present findings contradict those of Taghap (2024), who reported no significant relationship between students' attitudes and their achievement in science. The findings indicate that, in some contexts, factors other than attitudes may exert a stronger influence on science performance.

The findings reveal a significant relationship between innovativeness and attitudes toward science and technology. These results support Cujba and Pifarré (2024), who found that innovative, technology-enhanced learning approaches significantly improve students' attitudes toward academic subjects, suggesting that exposure to innovation fosters more positive perceptions and engagement in learning. Similarly, the findings align with Yuan et al. (2022), who explained that students' attitudes toward technology play a crucial role in enhancing motivation and learning outcomes in innovative educational environments. Overall, the results indicate a strong link between innovativeness and positive attitudes toward science and technology. On the other hand, the findings contrast with those of Bacani et al. (2025), who found that positive perceptions of innovative technologies do not necessarily lead to improved academic competence. Their study indicates that students may express favourable attitudes toward technological innovations while still demonstrating low performance or limited understanding in science-related subjects.

The results indicate that student innovativeness significantly mediates the relationship between competence in learning science and attitude toward science and technology. This finding supports Hu et al. (2025), who explained that learning-related factors influence innovation capability both directly and indirectly through engagement, highlighting the role of innovation-related constructs as mediating mechanisms in learning processes. Similarly, the findings are consistent with Loleta (2025), who revealed that students' competence influences outcomes through mediating variables such as engagement and innovation-related learning processes. These findings support the view that innovation-oriented constructs help explain how competence shapes attitudes and outcomes in STEM education. However, it contradicts Nugraha et al. (2025), who argued that innovation-related variables do not always function as significant mediators. Their results indicate that some predictors may have non-significant effects, suggesting that innovativeness does not consistently explain the relationships among variables.

V. CONCLUSION

The study concludes that innovativeness partially mediates the relationship between competence in learning science and attitudes toward science and technology. This conclusion aligns with Social Cognitive Theory, which posits that interactions among cognitive, personal, and behavioural factors shape human behaviour. In this study, competence in learning science represents the cognitive process, innovativeness reflects self-efficacy, and attitude toward science and technology represents behavioural outcomes. The results confirm that these components interact in shaping students' learning experiences and attitudes.

VI. RECOMMENDATIONS

Aligned with Social Cognitive Theory, it is recommended that future researchers are encouraged to explore additional mediating variables to account for the remaining 62% of unexplained variance in the model and educational leaders and school administrators may implement innovation-focused activities, such as seminars and workshops, to enhance students' attitudes toward science and technology.

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