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Influence of Technology Integration and Inquiry-Based Learning on Problem-Solving Skills in Science Among Junior High School Students

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Abstract — Poor problem-solving skills in science remain a challenge in education. This study examined the influence of inquiry-based learning (IBL) and technology integration on students' problem-solving skills. This study uses a diagnostic research design, stratified random sampling, a survey technique, and multiple linear regression analysis. The data collected from 215 respondents showed that only inquiry-based learning had a significant influence on the criterion, partly supporting the Social Cognitive Theory. Other determinants may be explored through the qualitative generated themes. A training program that promotes inquiry-based learning strategies and the purposeful integration of technology to strengthen students' scientific problem-solving competencies is proposed.

Keywords: Influence of technology integration, Inquiry-based learning, Problem-solving skills in science, Junior high school students

I. INTRODUCTION

Poor problem-solving skills in science among students have become a persistent educational concern, as these competencies are central to the development of scientific literacy and lifelong learning (OECD, 2020). Limited problem-solving skills hinder learners' ability to apply scientific knowledge to real-world issues, limiting their capacity for critical thinking, creativity, and innovation (OECD, 2025). Furthermore, studies have shown that junior high school students' problem-solving skills in science remain in the low category, indicating a significant challenge in achieving the desired outcomes of science education (Franestian, Suyanta, nad Wiyono, 2020).

Students' problem-solving skills in science remain a global concern, as shown in international assessments. Despites various interventions, low performance persists, particularly in Indonesia, where the 2018 PISA results indicated weak problem-solving skills. Studies by Docktor et al. (2020) reveal that many students struggle even with the initial stages of problem-solving. Similarly, research in Lebanon (Baltikian et al., 2024) found very low levels of problem-solving skills among secondary students, especially I applying scientific concepts. These findings highlight the ongoing global challenges of developing students' problem-solving abilities which are essential for real-worlds applications.

In the Philippines, the development of problem-solving skills in science among junior high school students remains a significant educational concern. Furthermore, Garzon (2023) highlighted that problem-solving skills in science among junior high school learners remain a significant challenge in classroom settings. In Davao City, several schools have reported that junior high school students struggle to apply scientific concepts effectively when solving problems. Local studies have revealed weak baseline performance among students on science problem-solving tasks (Anduyan, Cabrera, & Mangibunong, 2020). Similarly, Valdez & Bungihan (202a1) found that Filipino junior high school student ts possessed adequate knowledge but were unable to translate it into effective problem-solving, highlighting the need for instructional approaches that foster analytical thinking and the application of science concepts.

The persistent limitations in problem-solving skills among junior high school students threaten the development of scientific literacy and higher-order thinking. This deficiency hinders students' ability to analyze, evaluate, and apply scientific concepts to real-world situation, affecting both academic performance and future readiness for STEM careers. Despites existing interventions, a significant research gap persists in identifying effective strategies to improve problem-solving skills in science, underscoring the urgent need for targeted, evidence-based approaches. For this reason, this study is conducted.

This study highlights the role of technology integration and inquiry-based learning in enhancing students problem-solving skills in science. Aligned with SDG 4: Quality Education, it provides insights into strengthening students' ability to identify, analyze, and solve problems through innovative teaching approaches. The findings benefit students by improving their motivation, engagement, and academic performance in science. They also guide teachers in implementing student-centered strategies and support educational institutions, such as Holy Cross of Davao College, in developing effective learning environments. Furthermore, the results may assist the Department of Education in designing policies and programs that promote innovative and inquiry-driven science instruction. This study also serves as a reference for future researchers seeking to advance science education in the Philippine context.

Generally, this study found that technology integration and inquiry-based learning significantly influence junior high school students' problem-solving skills in science. Specifically, it aimed to determine the levels of technology integration in terms of perceived usefulness of technology, perceived ease of use; inquiry-based learning in terms of views and perceptions of IBL, effectiveness of IBL; students' problem-solving skills in science in terms of problem-solving confidence, approach-avoidance style, and personal control to determine the significant relationship between technology integration, inquiry-based learning, and problem-solving skills in science among junior high school students, to determine the significance of the individual and combined influence of technology integration and inquiry-based learning on problem-solving skills in science among junior high school students. This study was based on the Social Cognitive Theory by Albert Bandura 1986.

II. METHODOLOGY

This study employed the diagnostic design. The design is appropriate because it allows the researcher to describe the current levels of the variables and examine their relationships without manipulating respondents' natural setting (Best & Kahn, 2016). Moreover, it is a structured, problem-oriented research design used to examine current conditions, identify relevant patterns or relationships, and describe the strength of determinant factor influencing the outcome (Wisenthige, 2023; Samanth, 2024).

This study was conducted in selected public junior high schools within the Division of Davao Occidental, Region XI. These schools were chosen for their active efforts to integrate technology into classroom instruction and their emphasis on inquiry-based approaches in science subjects. The schools also provided a sufficient number of Grade 9 students who served as respondents in the study. The selection of these schools was based on their accessibility, availability of digital learning resources, and implementation of inquiry-based teaching practices.

The respondents in this study were Grade 9 students enrolled in selected public secondary schools during the School Year 2025-2026. From a total population of 482 students, a sample of 215 respondents was determined using Slovin's formula with a 5% margin of error (Sevilla et al., 1992). The study employed stratified random sampling, in which the population was divided into subgroups and respondents were selected in proportion to each subgroup. This method is used when the population has distinct groups to ensure fair representation, and it offers advantages such as reduced bias and improved accuracy (Creswell, 2014). Participants were officially enrolled students taking science courses with basic exposure to technology. Participation was voluntary with parental consent, while those not enrolled, frequently absent, transferred, or lacking consent were excluded.

The survey technique was used in gathering data. It is a method for collecting data through questionnaires or interviews (Creswell & Creswell, 2023) to obtain standardized information about respondents' attitudes, perceptions, or behaviors (Cohen et al., 2021). It is particularly useful in descriptive and correlational studies, as it enables researchers to describe trends and examine relationships among variables (Lawrence Nueman, 2020; Creswell & Creswell, 2023). It is advantageous for data collection from large, diverse populations, produces quantifiable data for analysis, supports generalization, enables rapid data collection, and ensures replicability through standardized procedures (Oranga & Matere, 2025).

Three survey questionnaires were adapted and modified for this study, and validators employed a five-point Likert scale to assess the instruments, yielding a mean rating of 4.66, interpreted as very high valid (Likert, 1932). Specifically, a 4-point Likert scale was used to evaluate participants' responses across the three research instruments, ranging from 1 – Strongly Disagree to 4 – Strongly Agree, to avoid central tendency bias (Koo, 2025). The first instrument the Technology Integration Questionnaire, was adapted from the technology Acceptance Model (TAM) proposed by Davis (1989). It consists of 12 items, designed to assess students perceived usefulness and perceived ease of use of technological tools in the classroom, with a Cronbach's alpha of 0.588.

The second instrument, the Inquiry-Based Learning Questionnaire was adapted from Baber (2021). It consists of 27 items designed to assess students' views, perceptions, and resilience in inquiry-based learning activities, with a Cronbach's alpha of 0.628.

The third instrument, the Problem-Solving Skills in Science Scale, was adapted from the Problem-Solving Inventory developed by Heppner and Petersen "(1982). It consists of 28 items designed to measure students' cognitive and behavioral approaches to scientific problem-solving, including confidence, personal control, and approach-avoidance style, with a Cronbach's alpha of 0.898.

In this study, the data analysis techniques used were descriptive, correlation, and multiple linear regression analyses. Descriptive analysis summarizes data using measures such as the mean and standard deviation, providing a clear over view of patterns and distributions without determining relationships between variables (Gravetter &Wallnau, 2021). In this study, the mean was used to assess the level of Problem-Solving Skills in Science, Technology Integration, and Inquiry-Based Learning, while the standard deviation was used to measure the variability of responses around the mean. Moreover, correlation analysis is used to determine the strength and direction of relationships between variables without establishing causation (Creswell & Creswell, 2023; Borg et al., 2021). The Pearson Product-Moment Correlation Coefficient was used to assess the relationships among Technology Integration, Inquiry-Based Learning, and Problem-Solving

Skills in Science. Lastly, multiple linear regression analysis is a statistical method used to examine the influence of predictor variables and to predict outcomes by identifying the strength and significance of relationships (Field, 2024).

In this study, it was used to determine the influence of Technology Integration and Inquiry-Based Learning on Problem-Solving Skills is Science. Moreover, the standardized beta coefficient was used to determine which predictor variable has the strongest influence on the dependent variable and to compare the relative effects of the predictors in the regression model (Roustaei, 2024).

The matrix was used to interpret the descriptive levels of each variable in the study. This approach provided a clear framework for describing students' engagement with technology, participation in inquiry-based learning, and their performance in problem-solving tasks, facilitating meaningful interpretation of the data.

Range of Mean	Descriptive Level	Technology Integration	Inquiry-Based Learning	Problem-solving skills in science
3. 26 – 4.00	Very High	Very Good	Very Good	Very Good
2.50 – 3.25	High	Good	Good	Good
1.75 – 2.49	Low	Poor	Poor	Poor
1.00 – 1.74	Very Low	Very Poor	Very Poor	Very Poor

Volume VI, Issue 5 May 2026, eISSN: 2799-0664

To measure and interpret the standard deviation, the following standard scheme is followed:

Standard Deviation Value Ranges and 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 > 1.5	Very Low Consistency Responses	High variability and lack of consensus

The significance of correlations was tested at a 0.05 confidence level. For the interpretation scale of r-value, the following schemes are 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 degree of influence and the overall predictive effects of technology integration and inquiry-based learning on problem -solving skills in science were analyzed using multiple linear regression, with unstandardized and standardized beta coefficients, assuming a linear relationship among the variables.

For the Scale of Beta (β) Coefficient Strength, the following scheme is used:

β Value Range	Strength of Influence
+ 0.00 - + 0.09	Very Weak
+ 0.10 - + 0.29	Weak
+ 0.30 - + 0.49	Moderate
+ 0.50 - + 0.69	Strong
+ 0.70 and above	Very Strong

Ethical considerations were strictly observed in this study on the influence of technology integration and inquiry-based learning on students' problem-solving skills in science. Prior to data collection, the research and its instruments were reviewed and approved by the Holy Cross of Davao College – Society for Moral Integrity and Legal Ethics (HCDC-SMILE). Permission to conduct the study was subsequently obtained from the Department of Education (DepEd) Division of Davao Occidental SDS Office, District PSDS, and the school principals. Participation of the Grade 9 student-respondents was voluntary, with informed assent and parental consent obtained after the study's purpose and procedures were explained. The study adhered to key ethical principles, including informed consent, privacy and confidentiality, justice, transparency, and risk minimization. All data were handled in accordance with the Data Privacy Act of 2012, ensuring confidentiality and that the information was used solely for research purposes. The researcher ensured fairness in respondent selection, maintained professionalism, considered cultural sensitivity, and committed to responsibly sharing the findings to help improve science education.

III. RESULTS AND DISCUSSION

Table 1 is a descriptive table. It contains the variables, namely technology integration, inquiry-based learning, and problem-solving skills, along with their respective indicators. It also includes the sample size, computed means, standard deviations, and the corresponding descriptive interpretations.

TABLE 1
DESCRIPTIVE STATISTICS (N=215)

Variables	Standard Deviation	Mean	Descriptive Level
Problem-Solving Skills in Science	**0.23**	**3.36**	**Very High**
Problem-Solving Confidence	*0.34*	*3.33*	*Very High*
Approach-Avoidance Style	*0.31*	*3.36*	*Very High*
Personal Control	*0.36*	*3.39*	*Very High*
Technology Integration	**0.34**	**3.68**	***Very High***
Perceived Usefulness	*0.36*	*3.71*	*Very High*
Perceived Ease of Use	*0.39*	*3.65*	*Very High*
Inquiry-Based Learning	**0.25**	**3.41**	**Very High**
Views and Perception	*0.28*	*3.42*	*Very High*
Effectiveness of Inquiry-Based Learning	*0.33*	*3.48*	*Very High*
Resilience in Inquiry	*0.37*	*3.35*	*Very High*

3.26-4.00=Very High; 2.5-3.25=High; 1.75-2.49=Low, 1.00-1.74=Very Low;

Table 1 specifically shows that the problem-solving skills in science variable had a mean of 3.36, indicating very high performance. This indicates that the respondents' problem-solving skills in science are very good. All indicators are also described as very high. The standard

Volume VI, Issue 5 May 2026, eISSN: 2799-0664

deviation of 0.23, indicating highly consistent responses, suggests a strong, relatively uniform perception among the respondents. Regarding technology integration, the variable had a mean of 3.68, indicating very high integration. This indicates that technology is highly integrated into the learning process, as perceived by the respondents. All indicators are also described as very high. The standard deviation of 0.34, indicating highly consistent responses, reflects a strong, uniform perception of technology integration. Furthermore, the inquiry-based learning variable obtained a mean of 3.41, indicating a very high level. This suggests that the respondents' inquiry-based learning is very good. All indicators are also described as very high. The standard deviation of 0.25, described as highly consistent responses, indicates a strong and uniform perception among respondents.

The variables on problem-solving skills in science, technology integration, and inquiry-based learning were all described as very high, indicating that the respondents consistently demonstrated strong problem-solving abilities, high exposure to technology integration, and positive engagement in inquiry-based learning.

Table 2 shows a correlation table. It contains the criterion and determinant variables. It also included the r-value, p-value, decision on Ho, and its corresponding interpretation.

TABLE 2
CORRELATION TABLE (N=215)

Variables	Problem-Solving Skills in Science			
	r-value	p-value	Decision on *H*0	Interpretation
Inquiry-Based Learning	0.26	<.001	Reject *H*0	Low Positive, Significant
Technology Integration	-0.02	0.695	Fail to Reject	Not Significant

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

Specifically, Table 2 shows that the correlation between inquiry-based learning and problem-solving skills in science variables yielded a p-value of 0.001, which is less than the 0.05 level of significance. Hence, the null hypothesis was rejected, indicating a statistically significant relationship between the variables mentioned. The corresponding r-value of 0.26 indicates a low positive correlation. This implies that as inquiry-based learning increases, student problem-solving skills in science also tend to improve.

On the other hand, the correlation between technology integration and problem-solving skills in science variables yielded a p-value of 0.695. This value exceeds the 0.05 significance level. Thus, the null hypothesis was accepted. This indicates no significant correlation between the variables cited. The corresponding r-value of -0.02 is negligible. This implies that when technology integration changes, there is no corresponding change in students' science problem-solving skills.

Inquiry-based learning showed a significant positive relationship with science problem-solving skills, whereas technology integration did not.

Table 3 presents a regression table. It contained the factors and the criterion variable, as well as unstandardized and standardized beta coefficients, standard errors, t-values, significance levels, a decision regarding the null hypothesis, and an interpretation.

TABLE 3
REGRESSION TABLE (N=215)

	Problem-Solving Skills in Science						
Variables	**Unstandardized Coefficients B**	**Std. Error**	**Standardized Coefficients Beta**	**t**	**Sig.**	**Decision on H_0**	**Interpretation**
(Constant)	2.53	0.28	–	9.00	<.001	_	–
Inquiry-Based Learning	0.24	0.06	0.26	3.93	<.001	Reject	Positive Significant Influence
Technology Integration	-0.01	0.04	-0.01	-0.12	0.900	Fail to Reject	Not Significant

$R = 0.26$ | $R^2 = 0.07$ | $F = 7.84$ | $p = <.001$
Level of Significance: 0.05
Decision Rule: Reject H_0 if $p < 0.05$

Specifically, Table 3 shows that the influence of inquiry-based learning determinant obtained a standardized beta coefficient of 0.26. This indicates that the influence of inquiry-based learning on the criterion variable is very weak. With the corresponding p-value of 0.001, the null hypothesis was rejected. It indicates that inquiry-based learning has a positive and significant effect on problem-solving skills in science. This implies that for every unit change in inquiry-based learning, there is a corresponding 0.26-unit change in science problem-solving skills. Moreover, the technology integration determinant obtained a standardized beta coefficient of -0.01. It indicates that the strength of influence of technology integration on the criterion is weak.

The corresponding p-value is 0.900; thus, the null hypothesis was accepted. It denotes that the influence of technology integration on problem-solving skills is science is not significant. This implies that for every unit change in technology integration, there is no corresponding change in science problem-solving skills.

The table also shows an R^2 value of 0.07. This indicates that the collective influence of the determinant variables on the criterion variable is very weak. The corresponding p-value of 0.001 is less than the 0.05 level of significance. Thus, the null hypothesis was rejected. This indicates that the combined influence of inquiry-based learning and technology integration on students' science problem-solving skills is statistically significant. This implies that for every unit change in the combined influence of the determinant variables, there is a corresponding 0.07 unit change in the criterion variable.

Inquiry-based learning had a positive, statistically significant effect on science problem-solving skills, whereas technology integration did not, Furthermore, although the combined influence of inquiry-based learning and technology integration on science problem-solving skills was statistically significant, the overall effect was weak.

Summary of Findings

Based on the statistical results, the study found that inquiry-based learning, rather than technology integration, has a significant relationship with students' problem-solving skills in science. Furthermore, the findings showed that inquiry-based learning significantly contributes to the development of students' problem-solving abilities, while technology integration alone does not demonstrate a significant individual influence. However, when combined, inquiry-based learning and technology integration collectively exert a significant influence on students' problem-solving skills in science, indicating that the integration of both approaches can still enhance learners' overall performance in scientific problem-solving.

The study reveals that inquiry-based learning is significantly correlated with students' problem-solving skills in science. This finding supports the claim that learners who engage in investigative, students-centered approaches tend to develop stronger analytical and critical thinking skills, thereby enhancing their ability to solve scientific problems (Urdanivia Alrcon et al., 2023). Furthermore, this current finding supports Lin et al. (2021), who reported that inquiry-based instruction improves students' problem-solving abilities. However, this current finding differs from the studies of Kirschner, Sweller, and Clark (2022), Lazonder, Harmsen, and Mayer (2021), who argued that inquiry-based learning may yield limited or inconsistent outcomes when learners lack sufficient prior knowledge or when instructional guidance is minimal, thereby reducing learning efficiency in science contexts.

On the other hand, the current findings reveal that technology integration is not significantly related to students' problem-solving skills in science. This suggests that high exposure to digital tools alone does not necessarily lead to improved academic performance. The current finding aligns with Chen et al. (2024), who emphasized that technology becomes effective only when meaningfully integrated into pedagogy, and with Siyam et al. (2025), who highlighted the essential role of teacher facilitation in maximizing its impact. Nevertheless, this result is not aligned with Kim and Hannafin (2021), Zhang et al. (2022), and Liu et al. (2023), who found that well-designed technology integration can significantly enhance students' problem-solving skills and conceptual understanding in science. Variation in findings may be attributed to differences in research context and sample size, as studies on technology integration often involve larger or different populations.

The findings of this study indicate that inquiry-based learning has a significant collective influence on students' problem-solving skills in science, though technology integration does not show a significant individual influence. The result affirms the study of Hala & Xhomara (2022), who reported that inquiry-based learning significantly improves students' scientific problem-solving skills. Similarly, the current finding supports the study by Lin, Castillo, and Ching (2021), which found that students exposed to inquiry-based science instruction demonstrated better problem-solving performance and higher-order thinking skills in science learning contexts. However, the current finding contradicts the study by Clark et al, (20006), which argued that inquiry-based and minimally guided instructional approaches may not effectively improve scientific problem-solving skills and learning outcomes, particularly when learners lack sufficient prior knowledge and instructional support. The difference in findings may be attributed to variations in instructional implementation, learner readiness, teacher facilitation, and research context between previous studies and the present study.

IV. CONCLUSION

Based on the findings, it was concluded that inquiry-based learning has a significant positive effect on students' problem-solving skills in science, whereas technology integration alone does not. Hence, Social Cognitive Theory by Bandura, which emphasizes that learning occurs through the dynamic interaction of personal factors, behavior, and environment, was partly supported.

V. RECOMMENDATION

Based on the conclusion, the following are recommended:

1. Future research may examine additional variables not covered in this study to account for the remaining unexplained variance in students' science problem-solving skills. Qualitative research may be undertaken to examine emerging themes such as students' learning motivation, collaborative skills, and metacognitive strategies that may influence problem-solving outcomes.
2. School administrators, policymakers, and teachers may collaboratively enhance students' problem-solving skills in science by implementing programs or training that promote inquiry-based learning strategies and the purposeful integration of technology, thereby strengthening students' scientific problem-solving competencies.

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