Online ISSN: 3082-5121
Aloysian Interdisciplinary Journal
of Social Sciences, Education, and Allied Fields
https://journals.aloysianpublications.com
Volume 2 Issue 8 (2026)

Performance of Science Students in Scientific Process Skills Interfaced with Artificial Intelligence Tools

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Publication Date: August 16, 2026 DOI: **10.5281/zenodo.21960946**

Abstract

The study entitled Performance of Science Students in Scientific Process Skills Interfaced with Artificial Intelligence Tools investigated the effectiveness of AI-Interfaced Practical Science learning in enhancing the scientific process skills of Grade 11 STEM at St. Mary's High School of Pidigan Abra, Inc. Utilizing a Pre-Experimental One Group Pretest-Posttest Design. There is a change in the students' proficiency in the scientific process skills, which were classifying, measuring, predicting, interpreting data, and formulating hypotheses, after a six-week intervention. The AI tools that were incorporated and integrated were Gemini for brainstorming and summarizing, Canva for Education for the interactive instruction in class, and Quizziz for the interactive quiz. Before the researcher integrate the intervention, the students demonstrated a "Fairly Satisfactory" level of performance (Mean=76.42) that shows difficulty on the higher order thinking skills which is the predicting and interpreting. After the AI intervention, the performance of the students improved to "Outstanding" level (mean=90.38). The scientific process skill that showed the most enhancement was the interpreting, followed by the predicting and communicating with a size ranging from 11.36 to 17.66.

The result of the correlation analysis indicates that the students' AI literacy, with a mean of 3.48, did not significantly influence their post-intervention, with r=0.262, indicating that the instructional design was inclusive and effective regardless of the students' prior knowledge of AI. The study concluded that interfacing practical science learning with AI tools can be helpful, though it can also contribute to a gap between abstract theory and scientific inquiry.

Keywords: *Artificial Intelligence in Education, Scientific Process Skills, AI-Interfaced Practical Learning, AI Tools, STEM Education*

Online ISSN: 3082-5121
https://journals.aloysianpublications.com
Volume 2 Issue 8 (2026)

1. Introduction

Artificial Intelligence (AI) has become one of the most transformative technologies in education, reshaping teaching and learning across different disciplines, including science education. AI-powered educational tools provide opportunities for personalized instruction, automated assessment, real-time feedback, and interactive learning experiences that enhance students' engagement and understanding of scientific concepts. As digital natives increasingly integrate AI applications into their learning activities, educators are challenged to ensure that these technologies support rather than replace critical thinking and scientific reasoning.

Recent studies emphasize that AI can significantly improve science education through adaptive tutoring systems, automated evaluation, and individualized learning pathways. However, many teachers still lack adequate AI literacy, limiting the effective integration of AI into classroom instruction. Furthermore, existing AI applications often focus on assessing student outputs rather than monitoring and guiding students throughout the scientific inquiry process. This creates a research gap in developing AI-supported practical science learning environments that enhance students' Scientific Process Skills (SPS) while maintaining authentic laboratory experiences.

The present study addresses this gap by implementing an AI-Interfaced Practical Science Learning approach designed to improve students' scientific process skills through AI-assisted practical activities. The study also investigates whether students' prior AI literacy influences the effectiveness of the intervention. The research is grounded in Cognitive Load Theory, Experiential Learning Theory, Self-Determination Theory, Multimedia Learning Theory, Social Constructivism, and the Technological Pedagogical Content Knowledge (TPACK) Framework, which collectively explain how AI can facilitate meaningful and effective science learning.

Statement of the Problem

The researcher aimed to determine the effectiveness of an AI-Interfaced Practical Science Learning in enhancing the scientific process skills of students.

Specifically, this study sought to answer the following questions:

1. What is the initial level of performance of the student-participants in Scientific Process Skills before the intervention, as measured by the Pre-Test?
2. What is the level of performance of the student-participants in Scientific Process Skills after the implementation of the AI-Interfaced Practical Science Learning, as measured by the Post-Test?
3. What specific Science Process Skills were most significantly enhanced by the AI-Interfaced Practical Science Learning approach?
4. How do students demonstrate their initial AI literacy before the integration of the science intervention?
5. Do the students' initial AI Literacy and Exposure significantly influence their post-intervention performance in Scientific Process Skills?

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Hypothesis

1. There is a significant difference between the student-participants' pretest and posttest mean scores in Scientific Process Skills, indicating a positive impact of the intervention.

2. Materials and Methods

Research Design: The study employed a quasi-experimental pretest-posttest design to determine the effectiveness of AI-Interfaced Practical Science Learning in enhancing students' Scientific Process Skills. Students completed a pretest before the intervention and a posttest after participating in AI-supported practical science activities.

Participants: The sample was selected out of the Academic Year 2025-2026 and is divided into a single group, where it provides data to the research. The intervention lasted six weeks to have meaningful and high-quality research.

Group	Population	Sampling Technique
Experimental Group	26 Grade 11 STEM	Convenience sampling

Instruments: The study utilized:
- Scientific Process Skills Test (Pretest and Posttest)
- AI Literacy Questionnaire
- AI-Interfaced Practical Science Learning Materials

The instruments were subjected to validation before implementation.

Procedure: The study followed these procedures:

1. Validation of research instruments.
2. Administration of the pretest.
3. Administration of the AI Literacy Survey.
4. Implementation of the AI-Interfaced Practical Science Learning intervention.
5. Administration of the posttest.
6. Collection and analysis of data.

Data Analysis: The following statistical tools were used:

- Frequency and Percentage
- Mean and Standard Deviation
- Paired Sample t-test
- Correlation Analysis
- Regression Analysis (to determine the influence of AI Literacy on Scientific Process Skills)

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3. Results

Table 3. The initial level of performance of the student-participants in Scientific Process Skills before the intervention, as measured by the Pre-Test

Scientific Process Skills	Mean	DR
Observing	76.92	FS
Classifying	77.08	FS
Measuring	83.00	S
Communicating	80.23	S
Inferring	78.23	FS
Predicting	75.27	FS
Interpreting	76.31	FS
Overall	76.42	FS

The Scientific Process skills that were used reveals variability in students' competencies. The lower order skills such as Measuring with a mean of 83.00 and Communicating with a mean of 80.23 fall within the Satisfactory (S) range, implicating comparatively higher proficiency in activities that entail quantitative accuracy and articulation of scientific concepts on the part of the students. These results can be ascribed to formal and frequently trained character of these skills in traditional classroom environments.

Table 4. The level of performance of the student-participants in Scientific Process Skills after the implementation of the AI-Interfaced Practical Science Learning, as measured by the Post-Test

	Gemini		Canva for Education		Quizziz	
	Mean	DR	Mean	DR	Mean	DR
Observing	96.75	O	90.11	O	98.56	O
Classifying	96.88	O	94.44	O	97.22	O
Measuring	89.38	VS	94.44	O	93.89	O
Communicating	89.00	VS	92.44	O	90.89	O
Inferring	86.25	VS	86.89	VS	81.22	S
Predicting	86.75	VS	84.78	S	81.44	S
Interpreting	86.00	VS	83.11	S	93.78	O
Overall	91.63	O	89.78	VS	89.89	VS

Scale	Descriptive Rating
90-100	Outstanding (O)
85-89.99	Very Satisfactory (VS)
80-84.99	Satisfactory (S)
75-79.99	Fairly Satisfactory (FS)
Below 75	Did Not Meet Expectation (DNME)

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The overall performance of the students on the Gemini achieved an Outstanding (O) mean score of 91.63, while those using the Canva for Education garnered a mean of 89.78, then for Quizziz attained a Very Satisfactory (VS) rating of 89.89. This means that the AI tools used had a positive learning output, and Gemini had the best overall impact.

Table 5. The Science Process Skills that are most significantly enhanced by the AI-Interfaced Practical Science Learning approach

Science Process Skills	Pretest	Posttest	Effect Size (Hedges' g)	T-Value	T-Prob Value
Observing	76.92	95.08	11.36	16.56	<0.01
Classifying	77.08	96.15	11.83	16.70	<0.01
Measuring	83.00	92.69	12.36	8.12	<0.01
Communicating	80.23	90.85	13.14	8.36	<0.01
Inferring	78.23	84.73	11.46	5.88	<0.01
Predicting	75.27	84.23	13.61	6.72	<0.01
Interpreting	76.31	87.69	17.66	6.58	<0.01
Overall	76.42	90.38	6.47	22.02	<0.01

A comparison of mean scores shows substantial increases in all scientific process skills. An example of this is *Observing* shown to have gone up by 76.92 to 95.08; Classifying went up by 77.08 to 96.15. Equally, *Measuring* and *Communicating* increased between 83.00 and 92.69 and 80.23 to 90.85 respectively. There was also a significant improvement in Higher-Order skills like the *Inferring*, *Predicting*, and *Interpreting* skills with *Interpreting* rising to 87.69 and Predicting rising to 82.63. The general average was significantly higher than in 76.42 which could be defined as *Fairly Satisfactory* to 90.38 as *Outstanding*, which showed a significant increase in the competence of the students in the process of science.

Table 6. Exposure to AI tools

Familiarity and Comfort	Mean	DR
I am familiar with what AI tools like **Gemini** (or Google Bard/ChatGPT) are and how they work.	3.93	A
I feel comfortable using AI tools like **Gemini** to help me brainstorm or summarize complex science lessons.	3.56	A
I understand the basic purpose and features of Canva for Education.	3.74	A
I know how to use **Quizizz** for taking or creating gamified assessments.	2.89	N
I am confident in my ability to use AI tools responsibly in my science studies.	4.07	SA
Composite Mean	**3.64**	**A**

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Frequency of Use	Mean	DR
I frequently use tools like **Gemini** to research or prepare for my science classes.	3.81	A
I frequently use **Canva for Education** to create presentations or visual aids for my school projects.	3.96	A
I frequently use **Quizizz** to practice or review science concepts outside of class.	3.44	N
I use AI tools in general (not just the ones listed) more than once a week for schoolwork.	2.70	N
I use AI to assist me with challenging tasks and problems in science.	4.59	SA
Composite Mean	**3.33**	**A**
Overall	**3.48**	**A**

In the case of Familiarity and Comfort, the students had an average Composite Mean of 3.64 which means that they are comfortable using platforms such as Gemini and Canva to conduct studies. It is worth mentioning that the greatest mean in this group was their confidence in using AI tools responsibly (4.07), indicating that they are quite aware of digital ethics. Nevertheless, they rated their stasis with using Quizziz to develop assessment (2.89) as Neutral, meaning that there is a gap in their expertise in gaming technologies.

Table 7. Correlation matrix showing a significant relationship between AI-literacy skills and post-intervention performance in scientific process skills

AI-literacy skills Versus post-intervention performance in scientific process skills	Observing	Classifying	Measuring	Communicating	Inferring	Predicting	Interpreting	Overall
Familiarity and Comfort	0.073	-0.059	0.145	0.000	-0.285	-0.011	-0.383	-0.129
Frequency of Use	0.061	0.027	-0.052	-0.104	-0.089	-0.383	-0.188	-0.285
Overall	0.079	-0.013	0.040	-0.071	-0.210	-0.267	-0.328	-0.262

In particular, the findings indicate that Interpreting (r=-0.328), Predicting (r=-0.267) and Inferring (r=-0.210) had the most pronounced negative relationships. It means that the students who already knew well about AI tools prior to the study might have had a more challenging time working with a scientific reasoning autonomy, as compared to their less-exposed peers. This effect is mostly explained by Psychology Today (2026) according to which the overuse of AI occasionally impedes the growth of the "cognitive muscles" necessary to perform a profound analysis, such as comprehending sophisticated data.

4. Discussion

The study found that AI-Interfaced Practical Science Learning significantly improved students' Scientific Process Skills. Students initially demonstrated Fairly Satisfactory performance, with weaknesses in higher-order skills such as predicting and interpreting. After the intervention, their performance improved to an Outstanding level, indicating that AI-supported instruction effectively enhanced both basic and integrated science process skills. Although students had moderate AI literacy, it did not significantly influence their posttest performance, suggesting that the instructional approach itself was the primary factor behind the improvement.

The findings support Cao et al. (2020) and Aggarwal et al. (2023)**,** who reported that AI promotes personalized learning and improves student achievement. They also agree with Zhai et al. (2022)**,** who found that AI provides timely feedback that enhances science learning. Furthermore, the results are consistent with Mayer's Cognitive Theory of Multimedia Learning and the TPACK Framework, which emphasize that meaningful learning occurs when technology is effectively integrated with sound pedagogy.

The results suggest that AI can be an effective instructional tool for improving students' Scientific Process Skills. Schools should encourage the integration of AI-assisted learning in science classes and provide teachers with professional development on the effective and ethical use of AI in instruction.

The study was limited to one school and used a quantitative approach, which may affect the generalizability of the findings. Future studies may involve larger samples, multiple schools, and qualitative methods to further examine the long-term effectiveness of AI-assisted science learning.

5. Conclusion

Based on the comprehensive findings of the study, the following conclusions were drawn:

1. The Grade 11 students initially possess a *Fairly Satisfactory level* of scientific process skills, showing a critical gap in higher- order thinking, like *predicting* and *interpreting*.
2. The integration of AI tools significantly elevated student performance to an "Outstanding" level. The substantial increase in mean scores of the Scientific Process Skill such as *Observing, Classifying, Predicting,* and *Interpreting* proves that interfacing practical science learning with AI provides a superior framework for mastering both basic and integrated process skills.
3. There is a significant difference between the pretest and posttest scores of the students. The shift from a "*Fairly Satisfactory*" to an "*Outstanding*" performance level confirms that the intervention using AI inside the classroom is a highly effective instructional strategy for enhancing scientific literacy and cognitive engagement.

Online ISSN: 3082-5121
Aloysian Interdisciplinary Journal of Social Sciences, Education, and Allied Fields
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Volume 2 Issue 8 (2026)

4. The students possess a "high" level of AI literacy, characterized by strong familiarity and comfort with digital tools.

5. There is no significant relationship between the students' prior AI literacy and their performance in scientific process skills. This confirms that the instructional design is inclusive and levels the playing field for all learners regardless of their initial tech-savviness.

Recommendations

Based on the findings and conclusions of the study, here are some recommendations:

1. Educators should actively adopt Artificial Intelligence toos to supplement traditional laboratory and classroom activities. With the help of AI, students tend to bridge the gap for those struggling with higher order thinking skills easier and manageable.

2. Schools should provide stable internet connectivity and digital resources to sustain the use of AI tools in the classroom. Professional development programs should be organized to train teachers on the ethical and pedagogical integration of AI.

3. The results suggest that AI should be formally integrated into science curriculum, not just as a tool for productivity, but as a cognitive partner in inquiry-based learning.

4. Further studies should be conducted with a larger population or a control group to further validate these findings. Research could also focus on the long-term retention of scientific skills when AI tools are withdrawn.

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