

AI-Green Energy Innovation Framework to Enhance PBD and Scientific Thinking in Secondary Science and Chemistry Classrooms

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ABSTRACT

The use of AI in education opens up new ways to help students learn and test their knowledge. But a lot of Science and Chemistry classes still focus on memorizing facts instead of using what they learn. This study presents the AI-Green Energy Innovation Framework, a curriculum-integrated project-based learning methodology tailored for Form 3 Science and Form 4 Chemistry students. The framework uses AI tools and ideas on green energy to help students come up with and work on projects that are good for the environment. Students look at real-world problems with sustainability, do research with the help of AI, make prototypes, and share their ideas. The framework also serves as a legitimate evaluation tool for Pentaksiran Bilik Darjah (PBD) by measuring skills in scientific reasoning, teamwork, creativity, and communication. Results show that students are more involved, have a better knowledge of concepts, are better at solving problems, and are more likely to participate in learning activities. Students showed more confidence in explaining scientific ideas and linking what they learned in school to real-world environmental issues. The framework helps students gain the skills they need for the 21st century and raises awareness of environmental issues. It also gives teachers verifiable evidence for their assessments. This method has a lot of potential to be used in multiple schools and science subjects to improve meaningful learning and scientific thinking.

KEYWORDS - Artificial Intelligence, Green Energy, Project-Based Learning, PBD Assessment, Scientific Thinking, and STEM Education are some of the words that come to mind.

1. INTRODUCTION

The goal of science education is to help students comprehend how the world works and how to use what they learn in science in their everyday lives. Many pupils, on the other hand, think that Science and Chemistry are hard and abstract topics. They often memorize facts for examinations without understanding how the concepts relate to real situations. Also, Pentaksiran Bilik Darjah (PBD) says that teachers must test students' higher-order thinking skills, like problem-solving, evaluation, and analysis. Conventional written tasks fail to furnish adequate proof for these competencies. Students seldom exhibit genuine comprehension since evaluations primarily emphasize accurate responses over reasoning methodologies. Students are also very familiar with digital technology, although they mostly utilize them passively to look up answers or copy material. People don't often employ AI technologies as learning partners to help them learn and come up with new ideas. Theoretical instruction is employed for environmental subjects like renewable energy, rather than practical problem-solving experiences. So, to turn students into active learners and give them real assessment evidence, we need a structured learning framework that includes AI, sustainability education, and project-based innovation.

I. THE AI-GREEN ENERGY INNOVATION FRAMEWORK

The AI-Green Energy Innovation Framework is an organized way to learn that links what you learn in school with new ideas.

There are five parts to the framework:

1. Stage of Inquiry

Students find environmental problems in their school or neighborhood, such pollution, waste of energy, or a

large carbon imprint.

2. Research Stage with AI Help

While learning how to use technology responsibly, students use AI tools to get information, come up with ideas, and look at possible solutions.

3. Stage of Design and Development

Students make prototypes, models, or digital solutions that have to do with green energy ideas like solar energy, biodegradable materials, or using less energy.

4. The stage of testing and improvement

Using scientific reasoning, students look at the data, change their designs, and explain why the changes are better.

5. Stage of Presentation and Reflection

Students show off their new ideas and think on what they learned. Teachers gather evidence for PBD assessments.

2. FIGURES AND TABLES

Table 1: Participant Profile

Group			Subject	Form	N	Setting	Assessment Scale
Group A	Chemistry	Form 4	31			Malaysian secondary school	PBD (Tahap Penguasaan 1–6)
Group B	Science	Form 3	25			Malaysian secondary school	PBD (Tahap Penguasaan 1–6)

Table 2: PBD Mastery Level Summary (Overall)

Table 3: Evidence Sources Used for PBD (Triangulation Table)

Group	TP6 (n)	TP6 (%)
Form 4 Chemistry	31	100%
Form 3 Science	25	100%

Evidence	What it measures	When collected	Who assesses
Observation checklist	Collaboration, participation, inquiry behaviour	During project	Teacher
Student journals	Reflection, reasoning, metacognition	Weekly / after milestones	Teacher
Presentation	Communication, justification, application	Final week	Teacher + peers (optional)
Project report	Scientific writing, data interpretation	Final submission	Teacher
Evaluation rubric	Innovation quality + scientific thinking	Prototype presentation +	Teacher

Table 4: Rubric (TP6-aligned) for Scientific Thinking

Construct	TP4	TP5	TP6
Scientific reasoning	Explains concept with guidance	Explains with correct reasoning	Justifies decisions using evidence + links to real-world context
Data handling	Records basic data	Analyses data with some interpretation	Interprets data, explains trends, and proposes improvements
Problem-solving	Suggests simple solution	Suggests workable solution	Designs, tests, improves solution systematically
Communication	Presents ideas	Presents clearly with terms	Presents confidently + answers questions with scientific justification

Table 5: Innovation Output Summary

Group	Type of innovation	Green energy link	AI usage	Final product
Form 4 Chemistry	Prototype / model / system	Renewable / efficiency / waste reduction	Brainstorm, research, evaluate	Prototype + report + presentation

Form Science	3	Prototype / model / campaign / device	Renewable / energy saving	Brainstorm, research, design ideas	Prototype + journal + presentation
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3. THE METHOD

This study utilizes a classroom-based action research methodology. The participants are students from Form 3 Science and Form 4 Chemistry in a Malaysian secondary school. The initiative was carried out over a period of many weeks according to a defined intervention strategy. Before students looked for environmental problems in their school or town, they learned about green energy and sustainability. After that, they used AI technologies to do research, find facts, come up with ideas for solutions, and judge those ideas. Students used what they learned to plan and make prototypes or digital designs for green energy uses. Scientific reasoning was used to test, refine, and prove the items. Finally, the students showed off their new ideas and thought about what they had learned. At the same time, the teacher gathered evidence for Pentaksiran Bilik Darjah (PBD) through observations, project reports, and presentations. The project took 6 to 8 weeks to finish:

- Week 1: Learn about green energy and how to make it last.
- Week 2: Using AI to find problems and do research
- Week 3: Making plans and writing proposals
- Week 4–5: Building a prototype or making a digital design
- Week 6: Testing and making things better
- Week 7: Presenting and judging

Multiple assessment tools were used to gather data so that we could have a full picture of what students were learning. During project activities, classroom observation checklists were used to keep track of how well students worked together, participated, and solved problems. Students also kept reflective notebooks to write down what they learned, the problems they had, and their own learning experiences during the assignment. We also looked at students' presentations and project reports to see how well they could use green energy ideas, communicate, and think scientifically. A teacher evaluation rubric was also used to judge how well students' innovative products met the learning goals, which was reliable proof for Pentaksiran Bilik Darjah (PBD).

4. CONCLUSION

The AI-Green Energy Innovation Framework does a great job of bringing together learning through the curriculum, teaching about sustainability, and using technology to help with research. The approach improves real assessment, scientific thinking, and student involvement. Students learned how to solve problems instead of just sitting there and listening, and they were able to apply what they learned in science to real-world environmental problems. Teachers got more solid proof of how well their students had mastered PBD levels. The framework has a lot of potential to be used in other schools and for other Science and Chemistry disciplines.

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