Science Education in Capturing Industry-based Innovative Traits of Diverse Learners through AI and Teaching Strategies

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HOW TO CITE:

Rocelyn R. Alabata (2026). Science Education in Capturing Industry-based Innovative Traits of Diverse Learners through AI and Teaching Strategies. International Journal of Special Education, 41(12s), 912-925

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ABSTRACT:

Higher education is facing increasing pressure to respond to rapid technological advancements, shifting labor market demands, and the growing need for graduates who are not only knowledgeable but also adaptable and innovative. This study explored the status of science education in one of the emerging regions in the Philippines, the Zamboanga Peninsula, focusing on how instructional practices align with the development of students' skills and competencies needed in modern, technology-driven industries. Twenty college students enrolled in science-related courses were interviewed about their experiences. Narratives from one-on-one interviews were analyzed to extract themes and analyzed using reflexive thematic analysis. The findings revealed that students develop innovation-related competencies through continuous interaction with AI tools, instructors, and peers within structured learning environments. Learners exhibited improvement in creativity, problem-solving skills, decision-making abilities, and learner autonomy as they observed guidance from AI systems and instructional models. In this context, teachers and AI applications functioned as cognitive and procedural models by giving structured explanations, alternative solutions, and constructive feedback, which helped in facilitating the internalization of systematic thinking processes and the gradual development of independent problem-solving capabilities. Narratives highlighted that both AI-assisted learning and teacher-mediated instruction operate as social learning mechanisms that cultivate industry-relevant competencies through observation, imitation, feedback, and continuous cognitive engagement. Nevertheless, the study highlights the potential for integrating social learning processes into AI-assisted learning and classroom instruction to enhance the development of students' higher-order cognitive skills, innovation-related competencies, and industry-relevant capabilities.

Keywords: artificial intelligence, classroom instruction, innovation, science education, social learning theory

Introduction

Higher education institutions are increasingly under pressure to produce graduates who are prepared for the future and equipped with the competencies needed to adapt to rapid technological changes across various industries (Naseer et al., 2025). It is widely recognized that advancements in artificial intelligence (AI), automation, and related technologies are reshaping the modern employment landscape, making career readiness a central requirement for students (Koch et al. 2025; Naseer et al., 2025).

However, curricular and pedagogical reforms that directly respond to these emerging demands remain limited (Naseer et al., 2025). Hence, the goal of this study was to examine how science education in the Zamboanga Peninsula region of the Philippines responds to the evolving needs of various industries. The locale is a rapidly developing economic region in the country, gaining recognition as an emerging industry for education, agriculture, trade, and technological advancement. Its ongoing socioeconomic transformation provides a relevant context for examining how educational systems respond to evolving industry demands (Moreno & Sulasula, 2024).

Social learning believes that learning occurs through continuous interaction between individuals, their environment, and the behaviors they observe within social contexts (Mukhalalati et al., 2022). It emphasizes that people acquire knowledge, skills, and attitudes not only through direct instruction but also by watching others, interpreting their actions, and reflecting on the outcomes of those behaviors (Rumjaun & Narod, 2025). This process highlights the importance of modeling, imitation, feedback, and cognitive engagement in shaping learning outcomes (Krishna et al., 2024).

In the context of science education, the student learning process emphasizes key instructional strategies such as scaffolding, self-monitoring, and modeling to support learner development (Azzaroiha et al., 2025). In science learning, these strategies are particularly valuable as they help students manage complex and abstract concepts, engage in scientific inquiry, and develop evidence-based reasoning skills. In addition, they encourage learners to actively construct understanding through experimentation, collaboration, and reflection, which are essential processes in science education (Ferniawan et al., 2025). Along their learning journey, students require the guidance and support of more knowledgeable individuals, particularly teachers, who serve as facilitators in clarifying concepts, demonstrating proper scientific processes, and providing timely feedback (Feri et al., 2022).

Social learning requires interaction between personal factors, behavior, and environment, along with key constructs such as modeling, self-efficacy, outcome expectations, and self-regulation (Bandura, 1999; Mukhalalati et al., 2022). In education, this suggests that learners develop knowledge and skills through continuous interaction, feedback, and cognitive engagement within their learning environment.

In response to rapidly evolving and technology-driven industries that demand innovation, critical thinking, and adaptability (Koch et al., 2025; Naseer et al., 2025), higher education institutions are expected to produce graduates who are future-ready and capable of meeting complex workplace demands. Social learning has been identified as a potential mechanism in science education for developing these competencies, particularly through student-centered instruction, scaffolding, self-monitoring, and modeling strategies (Bhardwaj et al., 2025). These approaches encourage inquiry-based learning, collaboration, and reflective practice, which strengthen innovation-related skills. However, the application of social learning in developing industry-based innovative traits, especially within AI-enhanced educational contexts, remains limited.

Literature Review

Social Learning Theory, also referred to as Social Cognitive Theory, was developed by psychologist Albert Bandura. This theory emphasizes that learning occurs within a social context where individuals acquire new behaviors by observing and imitating others (Feri et al., 2022).

As industries are growing, they are becoming increasingly dynamic, technology-driven, and highly competitive, requiring workers who can continuously adapt to new systems, tools, and workplace demands (Koch et al. 2025). This rapid development has led to a stronger emphasis on innovation, critical thinking, and lifelong learning, where employees are expected not only to perform assigned tasks but also to solve complex problems and contribute to organizational improvement (Naseer et al., 2025).

However, higher education institutions are increasingly expected to produce graduates who are prepared for the future and possess the competencies needed to adapt to and respond effectively to fast-paced technological changes across various industries. To address this issue, this study examines the application of Social Learning Theory perspectives in enhancing the development of students' skills within science education.

Bandura introduced Social Learning Theory based on human behavioral studies, explaining that learning occurs in social contexts not only through direct experience but also by observing others and the consequences of their actions (Bandura, 2012; Bandura & Walters, 1977). This process, known as observational learning, shows that individuals learn new behaviors by watching models, which Bandura identified as an effective learning strategy (Mukhalalati et al., 2022).

Bandura later expanded SLT by integrating cognitive and motivational processes, and in 1986 renamed it Social Cognitive Theory to highlight the importance of cognition in understanding and performing behaviors (Mukhalalati et al., 2022). Social Cognitive Theory emphasizes that learning results from the dynamic interaction between personal factors, behavior, and the environment (Bandura, 1999), and includes key concepts such as modeling, outcome expectations, self-efficacy, and self-regulation (Mukhalalati et al., 2022).

Social learning could serve as an effective mechanism in science education for addressing the evolving needs of various industries and producing industry-ready graduates. For example, student-centered teaching strategies place strong emphasis on innovation, encouraging learners to move beyond memorization toward deeper critical and creative engagement with their education (Bhardwaj et al., 2025).

It fosters an inquiry-based mindset where students are motivated to ask questions, seek their own answers, and critically examine complex ideas (Nurhidayah & Wahyudi, 2026). Similarly, Social Learning Theory explains that innovation and problem-solving skills are strengthened through reciprocal interaction between the learner, the environment, and observed behaviors. As students engage in exploration and experimentation, they receive feedback from peers and instructors, which helps improve their understanding and decision-making processes (Mukhalalati et al., 2022).

Student learning process emphasizes key instructional strategies such as scaffolding, self-monitoring, and modeling to support learner development. Scaffolding, self-monitoring, and modeling are complementary instructional strategies that progressively support learner independence by guiding goal setting, reflection, and observation of effective learning practices, ultimately enhancing autonomy, metacognitive awareness, and academic performance (Bhardwaj et al., 2025).

The application of social learning in capturing industry-based innovative traits remains limited and underdeveloped, especially in the context of artificial intelligence (AI) and evolving classroom settings. This study is expected to address this gap by providing a deeper understanding of how observational learning, collaboration, and guided instructional practices contribute to the development of innovation-related competencies among students.

Objectives

This study explored the experiences of university students in Zamboanga Peninsula, Philippines about how the science education system in the region captured innovative traits through AI-assisted learning and teaching strategies.

1. To explore how AI-integrated science education influences the development of industry-based innovative traits among diverse college learners.
2. To explore how teaching strategies helped enhance their creativity, problem-solving skills, adaptability, and other innovation-related competencies relevant to industry demands.

Methodology

Research Design

This study applied a qualitative research design to explore the experiences of university graduates regarding how the science education system develops industry-based innovative traits through AI-assisted learning and teaching strategies. Specifically, an exploratory design was applied to identify the key experiences of the participants in utilizing

AI tools, engaging with science learning activities, and experiencing instructional approaches that promote creativity, critical thinking, adaptability, collaboration, and problem-solving skills. Exploratory research provides a deeper understanding of phenomena by revealing underlying experiences, identifying significant perspectives, and generating insights that may support the development of relevant practices and effective solutions (Chavez et al., 2024).

Research Setting

The study was conducted in the Zamboanga Peninsula, Philippines, involving university students enrolled in science-related programs. The locale was selected as it is a growing economy in the country, increasingly recognized as an emerging hub for education, agriculture, trade, and technological development (Moreno & Sulasula, 2024). This setting allowed the researchers to explore how educational practices influence students' development of innovation-related competencies aligned with emerging industry demands.

Participants of the Study

Purposive sampling was employed to deliberately select participants who could provide rich and relevant information for the study. In this study, twenty participants were selected based on specific criteria: (1) a college student enrolled in the academic year 2025–2026; (2) exposed to AI-assisted learning tools, including generative AI applications used for academic tasks; (3) currently enrolled in science-related courses or programs; (4) actively engaged in classroom activities that incorporate innovative or technology-enhanced teaching strategies; (5) willing to share their experiences regarding the use of AI and instructional methods in their learning process; and (6) capable of providing informed responses relevant to the objectives. This sampling technique ensured that the participants had direct and meaningful experiences related to the research focus (Nyimbili & Nyimbili, 2024).

Research Instrument

Semi-structured interview questions were the primary instrument used in gathering responses from the participants. This approach allowed the researchers to prepare a guided set of questions while still providing flexibility to probe deeper into participants' answers and explore emerging ideas during the interview process. Follow-up questions were also used to clarify responses and capture richer, more detailed insights, ensuring a comprehensive understanding of the participants' lived experiences (Chavez et al., 2026). **Table 1** below presents the semi-structured interview questions used in this study.

Objectives	Interview Questions
To explore how AI-integrated science education influences the development of industry-based innovative traits among diverse college learners.	1. How have your experiences with AI-integrated tools in science education influenced the way you develop innovative ideas or approaches in your academic tasks? 2. In what ways has the use of AI in your science learning activities helped you build skills that are relevant to real-world or industry-based problem solving?

	3. Can you describe specific instances where AI-assisted learning contributed to your ability to think critically or generate new solutions in your coursework?
To explore how teaching strategies helped enhance their creativity, problem-solving skills, adaptability, and other innovation-related competencies relevant to industry demands.	1. How do the teaching strategies used by your science instructors help you develop creativity and adaptability in learning complex topics? 2. In what ways have classroom activities or instructional methods improved your problem-solving and collaboration skills? 3. Can you share experiences where a specific teaching strategy significantly enhanced your confidence or ability to meet industry-related learning demands?

Data Gathering Procedure

Data gathering was conducted in an organized and ethically grounded manner to ensure the integrity of the qualitative research process. Participants were formally contacted and invited to participate in the study. Before the interviews commenced, informed consent was secured, with a clear explanation of voluntary participation and strict assurance of confidentiality and anonymity.

The interviews were carried out through telephone calls or via Messenger, depending on the participants' availability and preferred communication platform. These modes were selected to overcome geographic constraints and to facilitate easier access for respondents located in regional areas. Each interview lasted approximately 45 to 60 minutes, providing sufficient time for an in-depth exploration of participants' experiences and perspectives.

All interview sessions were audio-recorded with the consent of the participants to ensure the accuracy of transcription and subsequent analysis. In addition, field notes were taken to document contextual details, observable reactions, and relevant narrative elements during the data collection process.

Data Analysis

The primary data for this study was narratives provided by university students. A reflexive thematic analysis approach was employed to systematically interpret and make sense of the participants' accounts (Chavez et al., 2026).

All interview recordings were transcribed verbatim to preserve the authenticity and accuracy of the participants' original responses. The analysis began with repeated reading of the transcripts to achieve data immersion and develop a comprehensive understanding of the content.

Initial coding was conducted to identify meaningful units of information within the data. These codes were then grouped into broader categories representing recurring patterns across participants' experiences. Through an iterative and reflective analytic process, these categories were further refined into overarching themes that capture relationships, contextual influences, and institutional dynamics within the classroom setting.

Attention was given to recurring challenges and corresponding instructional responses as articulated by the participants. Throughout the analytical process, reflexive practices were maintained to mitigate potential researcher bias and strengthen interpretive rigor.

Results

Objective 1. To explore how AI-integrated science education influences the development of industry-based innovative traits among diverse college learners.

Question 1. How have your experiences with AI-integrated tools in science education influenced the way you develop innovative ideas or approaches in your academic tasks?

Theme 1: AI as a Catalyst for Idea Generation

Students described AI-integrated science education as a tool that expands their capacity to generate new ideas and explore alternative methods in academic tasks. The use of AI supports brainstorming processes, allows instant access to diverse information, and helps learners refine their concepts, which helped in strengthening their creativity in completing assignments and scientific outputs.

"Mas naging madali para sa akin ang mag-isip ng mga bagong ideya dahil sa paggamit ng AI sa science subjects." *Translation: "It became easier for me to think of new ideas because of using AI in science subjects."*

"Kapag gumagamit ako ng AI, mas lumalawak ang mga option ko sa paggawa ng assignments at experiments." *Translation: "When I use AI, my options in doing assignments and experiments become broader."*

"AI helps me brainstorm more ideas before I finalize my output."

"Because of AI, I am able to enhance my creativity in doing science tasks and improve my outputs."

Theme 2: AI-Guided Learning Support

Students emphasized that AI tools assist them in breaking down complex scientific problems into more manageable parts. Strategies such as guided explanations, simulations, and step-by-step assistance helped students develop structured and efficient problem-solving strategies, which improved the quality and accuracy of their academic work.

"I understand difficult science topics better when AI breaks down the explanation step by step."

"Nakakatulong ang AI sa akin lalo na 'pag nalilito ako sa mga complicated problems dahil ginagabayan ako sa tamang process." *Translation: "AI helps me especially when I get confused with complicated problems because it guides me through the correct process."*

"Because of AI step-by-step guidance, I am able to solve science problems more accurately and systematically."

"I oftentimes use ChatGPT in completing my science assignments, especially when I need help in understanding difficult concepts and organizing my ideas into a clearer structure. It assists me in generating explanations, summarizing lessons, and providing step-by-step guidance in solving problems."

Theme 3: Independent Learning

AI-integrated science education encouraged students to become more independent and adaptable in their learning processes. Learners reported that they were able to explore topics beyond classroom discussions, adjust their learning pace, and adopt different strategies depending on task demands. This developed innovation-oriented traits aligned with academic and industry expectations.

"Mas natututo akong mag-isa sa science dahil sa AI, lalo na kapag gusto kong mag-explore ng topics na hindi na-discuss sa klase." Translation: "I am able to learn independently in science because of AI, especially when I want to explore topics not discussed in class."

"When I use AI, I can adjust my own learning pace depending on how difficult the lesson is."

"I become more independent in learning because I no longer immediately rely on the teacher when I don't understand something."

Question 2. In what ways has the use of AI in your science learning activities helped you build skills that are relevant to real-world or industry-based problem solving?

Theme 1: Improved Problem-Solving Skills

Students reported that the use of AI in their science learning activities helped them develop stronger analytical and problem-solving skills. AI tools had assisted them in interpreting complex scientific data, breaking down problems into manageable steps, and identifying logical solutions. These experiences had contributed to more structured and efficient approaches to solving academic tasks aligned with real-world problem-solving demands.

"AI helped me a lot before because I understood better how to break down difficult science problems."

"When I use AI, it becomes clearer to me how to explain and solve complicated data or concepts."

"Natuto akong mag-isip nang mas logical at systematic dahil ginagabayan ako ng AI sa kada step [ng problem-solving]." *Translation: "I learned to think more logically and systematically because AI guided me through each step of problem-solving."*

"Because of AI, my way of answering science tasks and activities became more organized and efficient."

Theme 2: Practical Competencies

Participants indicated that AI-supported learning had enabled them to acquire competencies that were applicable to real-world and industry contexts. Through simulations, guided explanations, and applied problem scenarios, students had gained exposure to practical situations that mirrored workplace challenges, thereby strengthening their readiness for industry-based tasks and expectations.

"Mas naintindihan ko kung paano gamitin ang science knowledge sa practical problems na pwede ma-experience sa trabaho." *Translation: "I better understood how to use science knowledge in practical problems I may experience in work."*

"When editing pictures for presentations, I use Gemini to edit it to make it more presentable."

"Because of AI-guided learning, I became more prepared for tasks that are similar to those in the industry."

"ChatGPT helped me see how concepts work in an actual real-world setting."

Theme 3: Strengthened Decision-Making

The use of AI in science learning had improved decision-making and adaptive thinking of students. Learners had become more flexible in selecting appropriate strategies for different tasks, evaluating alternative solutions, and adjusting their solutions based on feedback and outcomes. This had contributed to the development of innovation-oriented skills essential in dynamic and technology-driven environments.

"When I am making my thesis and unsure of the concept I am thinking about, I asked ChatGPT to clear my mind. This allows me to make decisions."

"Nakatulong ang AI para ma-evaluate ko kung alin sa mga ideas ko ang mas effective at practical sa isang task." *Translation: "AI helped me evaluate which of my ideas were more effective and practical for a task."*

"When I get confused with my thesis or concepts, I use ChatGPT to clear my mind and make better decisions."

"I became more careful in making decisions because I could compare different possible solutions using AI."

Question 3. Can you describe specific instances where AI-assisted learning contributed to your ability to think critically or generate new solutions in your coursework?

Theme 1: AI as a Cognitive Scaffolding Tool

Students described AI-assisted learning as a support system that helped them unpack complex coursework such as coding, laboratory interpretation, and scientific analysis. With step-by-step explanations and guided outputs, AI enabled learners to better understand underlying concepts and strengthen their critical thinking processes when solving academic problems.

"When I have complex laboratory tasks, I use AI to understand the instructions and interpret the results more clearly."

"AI helped me understand difficult topics because it gave me simpler and more organized explanations."

"Dahil sa AI, mas naging systematic ang pag-iisip ko sa pag-solve ng problems kasi ginagabayan ako sa bawat step ng analysis." Translation: *"Because of AI, my thinking became more systematic in solving problems since I was guided in every step of the analysis."*

"In times when I struggle with coding and science concepts, AI helped me a lot because it guided

me step by step so I could better understand the process."

Theme 2: AI-Driven Validation

Students highlighted that AI tools served as a means of checking, validating, and refining their work. Through feedback on coding errors, clarification of scientific interpretations, and alternative explanations, students were able to evaluate the accuracy of their outputs and improve the quality of their academic outputs through critical reflection and revision.

"Sometimes when coding my projects using Python, Google Colab's suggestions for codes really helped me in finishing my work. It allowed me to keep on track of the process."

"ChatGPT sometimes helped me interpret the images I got from the microscope, which made it easier for me to understand what I was observing and draw better conclusions from the results."

"When working on programming tasks, AI tools guided me in identifying errors in my code, which helped me critically evaluate my output and improve it." Translation: *"Kapag gumagawa ako ng programming tasks, tinutulungan ako ng AI tools na ma-identify ang errors sa code ko, kaya mas napag-iisipan ko nang mabuti ang output ko at na-iimprove ko ito."*

"There were instances when AI suggested alternative explanations for my science outputs, which encouraged me to compare ideas and choose the most accurate solution."

Theme 3: Expansion of Alternative Thinking Pathways

AI-assisted learning encouraged students to explore different methods and perspectives in completing coursework. Exposure to AI-generated suggestions and alternative solutions allowed learners to compare different methods, rethink their initial answers, and develop more innovative and flexible problem-solving strategies applicable to academic and real-world contexts.

"When I use AI, I see different ways of solving a task. It helps me not remain limited to the first answer that comes to my mind."

"AI presents different perspectives and approaches that allow me to compare which solution is more effective for a problem."

"I use AI as a guide to develop alternative ideas and improve my ability to think critically in solving problems."

"Halimbawa, sa paggawa ng thesis ko last time, sinunod ko una yung process na nasa isang study. Pero nang gumamit ako ng AI at na-validate ko, nakita ko na may mas maayos at mas angkop palang process." *Translation: "For example, in my thesis, I initially followed the process described in a study. However, when I used AI and validated its responses, I realized that there was a better and more appropriate process."*

Objective 2. To explore how teaching strategies helped enhance their creativity, problem-solving skills, adaptability, and other innovation-related competencies relevant to industry demands.

Question 1. How do the teaching strategies used by your science instructors help you develop creativity and adaptability in learning complex topics?

Theme 1: Improve Creative Exploration

Science instructors' teaching strategies encourage students to explore ideas, generate original approaches, and connect concepts beyond traditional explanations. Through interactive activities, inquiry-based tasks, and opportunities for independent thinking, learners develop creativity in understanding and applying complex scientific concepts.

"When our science instructor uses activities that require independent thinking, I become more encouraged to find different ways to understand and answer a scientific problem."

"Ang mga strategy like discussions at inquiry-based activities nakatulong sa akin na maka-create ng sariling ideya." Translation: "Strategies such as discussions and inquiry-based activities help me create my own ideas."

"Through hands-on activities and problem-solving tasks, I learn to view a concept from

different angles and create more creative solutions."

"The teaching approaches of our instructor help me connect scientific concepts to real situations, allowing me to develop broader ways of thinking."

Theme 2: Strengthen Problem-Solving Skills

Teaching strategies that involve real-world applications, collaborative activities, and analytical tasks help students develop their ability to identify problems, evaluate solutions, and make informed decisions. These learning experiences enhance students' confidence in addressing complex scientific and industry-related challenges.

"Activities that involve real-life situations help me practice analyzing problems and thinking of possible solutions."

"Through group activities and discussions, I learn to listen to others' ideas and combine different perspectives to develop better solutions."

"The problem-based activities of our science instructor teach me not to give up when a topic is difficult, but instead find ways to understand it."

"Because of analytical tasks and application-based lessons, I become more prepared to face complex problems that I may encounter in the workplace."

Theme 3: Developing Adaptability

Science instructors' use of varied teaching methods, technologies, and learning activities helps students adjust to different learning situations and perspectives. These approaches promote flexibility, resilience, and the ability to adapt to changing demands in academic and professional environments.

"Because of the different teaching methods used by our science instructor, I learn to adjust depending on the type of lesson and how it is being taught."

"The use of technology and different learning tools in class helps me become more flexible in learning and adapt more quickly to new ways of studying."

"Sa mga pagkakataong nag-iiba ang activities at approach ng pagtuturo, natututo akong maging resilient at hindi madaling ma-stress sa mga new situations." Translation: "When teaching activities and approaches change, I *learn to become resilient and not easily stressed by new situations."*

Question 2. In what ways have classroom activities or instructional methods improved your problem-solving and collaboration skills?

Theme 1: Structured Learning Tasks

Classroom activities such as case studies, problem-based tasks, and guided exercises strengthen students' ability to break down complex problems into manageable parts. These instructional methods encourage critical thinking, logical reasoning, and step-by-step analysis, allowing learners to develop more effective and evidence-based solutions.

"When there are case studies or problem-solving activities in class, we are not immediately given the answer. We really need to break down the problem step by step, so I learn to think more clearly and in an organized way."

"Yung mga activities na may case studies or real-life situations, tinutulungan kami mag-analyze ng problem step by step. Tapos habang ginagawa namin yun as group, natututo din akong makinig sa ideas ng iba at mag-adjust kung may mas magandang suggestion sila." *Translation: "Activities with case studies or real-life situations help us analyze problems step by step. While doing it as a group, I also learn to listen to others' ideas and adjust if they have better suggestions."*

Theme 2: Group-Based Learning Activities

Instructional methods that involve group work, peer discussions, and collaborative tasks improve students' ability to communicate ideas, share responsibilities, and work toward common goals. Through interaction with peers, learners develop

teamwork, cooperation, and openness to different perspectives in solving academic tasks.

"Sa mga group activities namin sa class, mas natutunan kong makipag-coordinate sa mga kaklase ko kasi kailangan naming pag-usapan talaga kung paano namin sosolusyunan yung task. Hindi pwedeng kanya-kanya lang, dapat may agreement talaga para maging maayos yung output." *Translation: "In our group activities, I learned how to coordinate with my classmates because we really need to discuss how we will solve the task. It cannot be done individually; there must be an agreement to produce a good output."*

"During problem-solving activities, I am pushed to think more deeply because it is not just about answering, but also explaining. I realized that discussing ideas in a group is better because it increases the options we can consider."

Theme 3: Interactive and Student-Centered Instruction

Interactive classroom activities and student-centered teaching methods enhance students' ability to adapt their thinking and adjust strategies based on group input and situational demands. These experiences promote flexibility, openness to feedback, and the ability to refine solutions through continuous collaboration and reflection.

"Kapag yung class namin is more on discussion at activities kaysa puro lecture, mas napipilitan akong mag-isip on the spot at mag-adjust depende sa ideas ng classmates ko. Hindi lang kasi ako yung dapat mag-isip, kundi lahat kami nagco-contribute." *Translation: "When our class is more on discussion and activities rather than pure lecture, I am pushed to think on the spot and adjust based on my classmates' ideas. It's not just me thinking, but all of us contributing."*

"Interactive activities in class teach me that my first answer is not always correct, so I also need to listen to others and improve my ideas based on group feedback."

Question 3. Can you share experiences where a specific teaching strategy significantly enhanced your confidence or ability to meet industry-related learning demands?

Theme 1: Experiential Learning

Students expressed that teaching strategies involving real-world applications, simulations, and practical activities helped them gain confidence in applying theoretical knowledge. Through this, learners developed a stronger sense of preparedness and assurance in handling complex academic and professional demands.

"Kapag may mga activities kami na parang real-life scenarios, mas nafe-feel ko na parang nasa actual work setting na rin kami. Doon ko mas naiintindihan kung paano gamitin yung mga lessons sa tunay na situation, hindi lang basta memorization." Translation: *"When we have activities that are like real-life scenarios, I feel like we are already in an actual work setting. That's where I better understand how to use the lessons in real situations, not just memorization."*

"Simulations and practical tasks in class are very helpful because I learn to make decisions on my own. It's not just theory, but we actually do it, so I gain more confidence in my skills."

Theme 2: Skills-Based Instruction

Instructional strategies that focus on hands-on tasks, problem-solving activities, and performance-based assessments enhanced students' ability to meet industry expectations. These approaches helped learners develop technical competence, analytical thinking, and practical skills that are directly applicable to future workplace environments.

"In activities that require actual output, like problem-solving tasks or performance-based requirements, I get exposed to how work is done in a real industry setup. That's where I feel my skills are really developing, not just theory."

"Kapag may mga problem-solving assessments, napipilitan akong gamitin yung analytical thinking ko at hindi lang basta magbigay ng sagot. Mas natututo akong mag-explain at mag-justify ng ideas ko, which I know is important sa industry." Translation: *"When there are problem-solving assessments, I am pushed to use my analytical thinking and not just give answers. I also learn to explain and justify my ideas, which I know is important in the industry."*

Theme 3: Constructive Feedback

Teaching strategies that include scaffolding, mentoring, and feedback-based instruction contributed to students' growing confidence in their abilities. Continuous guidance from instructors and peer feedback allowed learners to refine their outputs, improve performance, and develop a stronger belief in their capacity to meet industry-related demands.

"Kapag binibigyan kami ng feedback ng instructor after ng outputs namin, mas nakikita ko kung saan ako nagkulang at paano ko pa siya mapapaganda. Hindi siya nakaka-demotivate, actually mas lalo pa akong na-eencourage mag-improve." *Translation: "When our instructor gives feedback after our outputs, I see where I fell short and how I can improve it. It's not demotivating; instead, it even encourages me to improve more."*

"Through repeated corrections and suggestions from instructors and classmates, I become more confident because I learn to refine my work until it meets real industry standards."

Discussion

The status of science education in the Zamboanga Peninsula region widely influenced students' competencies relevant to industry-based innovative traits. A key aspect for the success of science education was the implementation of social learning processes.

Social learning theory explains that people learn new behaviors, skills, and attitudes by observing others within a social context rather than through direct experience alone (Krishna et al., 2024). It emphasizes the role of modeling, imitation, and observation, where individuals pay attention to how others behave, remember what they see, and later reproduce those behaviors if they believe they are useful or rewarded (Rumjaun & Narod, 2025).

In relation to social learning, this study noted that students learn not only from teachers' direct instruction but also from peers' behaviors, group interactions, feedback, and classroom experiences, which collectively shape their thinking, motivation, and performance. Likewise, students develop creativity, adaptability, and other innovation-related competencies by actively engaging with both instructional models and peer interactions in the classroom.

In the context of AI-integrated science education, AI such as ChatGPT, Gemini, Google AI summary, functions as a form of "model" that students observe and learn from, particularly through its generated solutions, explanations, and suggested approaches. Although AI is not a human agent, students cognitively process its outputs in a similar manner to observing expert demonstrations, which influences how they construct knowledge and develop innovative academic behaviors.

Zhou and Schofield (2024) suggested that AI could help in the development of introductory-level learning tasks. This allows students acquire essential information needed to establish a strong foundation for more complex learning. This was also evident in this study as AI tools can provide step-by-step explanations, simplified summaries, and immediate feedback that support learners in understanding basic concepts more efficiently. This structured support helps reduce cognitive overload and allows students to gradually progress toward higher-order thinking skills.

Social learning emphasized that that learners do not simply imitate behaviors but actively regulate and evaluate them (Saka, 2025). In this case, students use AI outputs to guide their learning independently, adjusting pace, strategies, and exploration based on perceived needs. This indicates that observational input from AI supports the development of self-directed learning behaviors, strengthening autonomy and adaptability in academic tasks.

Furthermore, social learning is evident in how students learn creativity through observing and engaging with instructional models provided by their science instructors. Inquiry-based activities, discussions, and hands-on tasks serve as behavioral demonstrations that students observe and replicate in their own cognitive processes.

Teachers shape the direction of the teaching and learning process as well as its outcomes. As professionals, they function as active facilitators of learning who contribute significantly to

enhancing the overall quality of education (Rahma & Istanto, 2025). In fact, teachers should be skilled in guiding students to actively listen, engage in critical thinking, and develop new understandings and competencies within the classroom environment (Feri et al., 2022). From the perspective of social learning, students acquire structured problem-solving strategies by observing how teachers analyze real-life situations, evaluate possible alternatives, and arrive at appropriate solutions. This process is further strengthened through collaborative activities, where learners exchange ideas and improve their thinking based on social interaction and feedback from others (Darwin, 2025).

Industries require highly effective graduates who are not only knowledgeable in their field but also capable of applying their skills in practical, real-world situations. In today's competitive and technology-driven environment, employers seek individuals who demonstrate strong critical thinking, problem-solving abilities, adaptability, and collaboration skills (Koch et al. 2025).

This study revealed that science education can respond to industry needs by drawing on the principles of social learning processes, particularly through AI-assisted learning and teacher-facilitated instruction. Strategies such as observation, modeling, and interaction, students are able to develop both cognitive and practical skills that align with workplace expectations. AI tools and teacher demonstrations serve as learning models that guide students in understanding complex processes, while collaborative classroom activities reinforce communication, teamwork, and reflective thinking.

Conclusion

Learning occurs through observation, interaction, and cognitive processing within a social environment, where individuals acquire new skills and behaviors by observing models such as teachers, peers, and even AI-generated outputs. In this study, both AI-integrated learning tools and teacher-facilitated instructional strategies functioned as learning models that guided students in understanding how to think, respond, and perform academic tasks. Through continuous exposure to these models, learners were able to internalize innovation-oriented skills that are essential in academic and industry contexts.

Observational learning, imitation, feedback, and cognitive processing work together to shape students' creativity, problem-solving abilities, and adaptability. These competencies are highly aligned with the demands of modern industries, which increasingly require graduates who can think critically, collaborate effectively, and adjust to rapidly changing technological and workplace environments. In this regard, schools can further strengthen their effectiveness by anchoring their instructional principles in social learning within the context of modern, technology-enhanced education.

Recommendations

Schools may incorporate AI tools as structured learning supports for brainstorming, explanation, and problem-solving activities. This ensures that students are guided in generating ideas and understanding complex concepts while gradually developing independent thinking aligned with industry demands.

Science instructors should consistently demonstrate systematic problem-solving processes during lessons. Students can observe, imitate, and internalize effective strategies for analyzing and solving real-world scientific problems.

Schools should design more group-based tasks such as case studies, inquiry projects, and problem-based learning activities. These experiences allow students to learn from peers, exchange ideas, and refine their outputs through social feedback and interaction.

Teachers should provide timely, specific, and constructive feedback on student outputs. Regular feedback cycles, combined with peer evaluation, can help learners reflect on their performance, correct mistakes, and continuously improve their academic and practical competencies.

Curriculum developers should ensure that learning activities simulate workplace scenarios and industry expectations. This allow students develop creativity, adaptability, and problem-solving skills that are directly transferable to professional environments.

References

Azzaroiha, C., Redhana, I. W., & Suma, K. (2025). The effect of scaffolding strategies on learning outcomes in science learning: A systematic literature review. *Jurnal Penelitian Pendidikan IPA*, *11*(1), 45-55.

Bandura, A. (1999). Social cognitive theory of personality. *The coherence of personality: Social-cognitive bases of consistency, variability, and organization*, 185-241.

Bandura, A. (2012). On the functional properties of perceived self-efficacy revisited. *Journal of management*, *38*(1), 9-44.

Bandura, A., & Walters, R. H. (1977). *Social learning theory* (Vol. 1, pp. 33-52). Englewood Cliffs, NJ: Prentice-hall.

Bhardwaj, V., Zhang, S., Tan, Y. Q., & Pandey, V. (2025, February). Redefining learning: student-centered strategies for academic and personal growth. In *Frontiers in Education* (Vol. 10, p. 1518602). Frontiers Media SA.

Chavez, J. V., Cuilan, J. T., Mannan, S. S., Ibrahim, N. U., Carolino, A. A., Radjuni, A., ... & Garil, B. A. (2024, November). Discourse analysis on the ethical dilemmas on the use of AI in academic settings from ICT, science, and language instructors. In *Forum for Linguistic Studies,* 6(5), 349-363.

Chavez, J. V., Salvaleon, R. G., Suazo, M. L. S. A., Miralles, A. C., Cerna, M. C. S. D., Dammang, S. K. M., ... & Calzada, K. P. D. (2026). Academic leaders' experiences of inclusive education through the lens of positive psychology. *Journal of Qualitative Research in Education*, 96-111.

Chavez, J. V., Salveleon, R. G., Eustaquio, M. T. L., Adalia, H. G., Rosaldo, M. P. T., Quinto, J. B., ... & Nazareth, I. M. (2026). Practices and strategies of informal assessments on grammar rules among second language learners. *Int J Eval & Res Educ*, *15*(3), 2379-2389.

Darwin, D. (2025). Collaboration In Teaching: The Role Of Teachers, Students, And Technology In Effective Learning. *MSJ: Majority Science Journal*, *3*(3), 252-258.

Feri, M., Maemonah, & Husna, N. (2022). Analysis of social attitudes of elementary school learners with the application of Albert Bandura's learning theory. *EduHumaniora: Jurnal Pendidikan Dasar,* 14(2), 149–157.

Ferniawan, F., Ramdani, A., Rokhmat, J., Jufri, A. W., & Sukarso, A. A. (2025). Research Trends in Scaffolding Inquiry Models Integrated with Local Wisdom on Student Scientific Creativity: Bibliometric Analysis 2020-2025. *International Journal of Science Education and Science*, *2*(2), 112-121.

Koch, V., Tomasevic, D., Pacher, C., & Zunk, B. M. (2025). Preparing students for industry 5.0: Evaluating the industrial engineering and management education. *Procedia Computer Science*, *253*, 2219-2228.

Krishna S, L., Prasad C, J., & S, A. (2024). The impact of artificial intelligence in reshaping education: An analysis based on learning theories. In *ITM web of conferences* (Vol. 68, p. 01008). EDP Sciences.

Moreno, F., & Sulasula, J. (2024). Administration of Local Economic Development: Case Study of the Zamboanga Peninsula Region, Philippines. *ScienceOpen Preprints*.

Mukhalalati, B., Elshami, S., Eljaam, M., Hussain, F. N., & Bishawi, A. H. (2022). Applications of social theories of learning in health professions education programs: a scoping review. *Frontiers in medicine*, *9*, 912751.

Naseer, F., Tariq, R., Alshahrani, H. M., Alruwais, N., & Al-Wesabi, F. N. (2025). Project based learning framework integrating industry collaboration to enhance student future readiness in higher education. *Scientific Reports*, *15*(1), 24985.

Nurhidayah, E., & Wahyudi, H. (2026). Transformation of the paradigm of Arabic language learning based on student-centered learning: A systematic literature review study (2015–2025). *IDEAS: Journal on English Language Teaching and Learning, Linguistics and Literature*, *14*(1), 418-440.

Nyimbili, F., & Nyimbili, L. (2024). Types of purposive sampling techniques with their examples and application in qualitative research studies. *British Journal of Multidisciplinary and Advanced Studies: English Lang., Teaching, Literature, Linguistics & Communication, 5(1),* 90-99.

Rahma, S. F. A., & Istanto, I. (2025). The role of teachers in strengthening character as role models for students to instill the value of honesty in the era of Society 5.0. *Proceeding ISETH (International Summit on Science, Technology, and Humanity)*, 944-949.

Rumjaun, A., & Narod, F. (2025). Social learning theory—albert bandura. In *Science education in theory and practice: An introductory guide to learning theory* (pp. 65-82). Cham: Springer Nature Switzerland.

Saka, N. T. (2025). Social learning theory. *Exploring adult education through learning theory*, 135-162.

Zhou, X., & Schofield, L. (2024). Using social learning theories to explore the role of generative artificial intelligence (AI) in collaborative learning. *Journal of Learning Development in Higher Education*, (30).