

RESEARCH ARTICLE

Building confidence and updated mindset of science and tech teachers through professional development training techniques in the science-industry settings

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ABSTRACT

This research explores the impact of industry-based professional development on science and technology educators' confidence and mindset. The study, conducted in the Central Visayas, Philippines, involved 25 experienced science teachers with at least six years of teaching experience. Through structured interviews and open-ended surveys, the research aimed to understand how exposure to industry practices influences teaching methods, curriculum planning, and educators' professional growth. The findings underscore the moderately significant role of industry-based professional development in improving science and technology education in the Philippine context. This study contributes to educational reform by presenting how these experiences build instructional confidence, enhance curriculum relevance, and foster interdisciplinary teaching strategies, particularly in developing nations. The study also supports psychological theories such as social facilitation highlighting increased teacher performance through peer and expert interaction and schema change, which explains how teachers reconstructed their prior knowledge through industry exposure. These theoretical lenses helped interpret the shifts in mindset, confidence, and instructional behavior.

Keywords: Confidence; updated mindset; science and tech teachers; professional development; training techniques; science-industry setting

1. Introduction

The primary responsibilities of academic institutions include connecting students to their lessons through meaningful assignments and equipping teachers to actively engage with their students^[1]. Traditionally, assessment responsibilities lie solely with instructors and predominantly rely on summative assessment methods^[2]. Teachers are essential contributors to shaping future generations, especially in science and technology education. However, the fast-paced advancements in scientific knowledge and industry practices often create a divide between conventional teaching strategies and practical applications. Professional development programs designed around industry settings moderately contribute to bridging the

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gap between traditional classroom instruction and the realities of scientific practice. In contexts such as the Philippines, where educational gaps and economic demands coexist, such programs play a notable role in redefining instructional quality and curricular relevance. Offering hands-on experiences, these initiatives enhance teachers' instructional techniques and understanding of current practices. Such programs emphasize integrating technological tools into teaching, ensuring that curricula align with industry standards while preparing students for dynamic job markets^[3,4]. For instance, employing technological tools in lesson instruction has proven effective in fostering critical thinking skills and conceptual understanding. However, for these tools to be effective, educators must be confident in their abilities to utilize them^[5]. Through these efforts, educators gain opportunities to refine their approaches and create an environment conducive to learning and engagement, a responsibility teachers hold dearly^[6].

Collaborating with industry professionals creates an environment where teachers can develop innovative teaching strategies and strengthen their confidence in delivering lessons. A classroom atmosphere characterized by positive student-teacher relationships, freedom of expression, openness to students' opinions, and the use of higher-order thinking materials is a crucial factor in promoting advanced cognitive skills^[7,8]. Moreover, a teacher's approach to fostering either mastery or performance-focused learning environments significantly impacts students' outcomes. These interactions align with the psychological concept of social facilitation, where performance improves through engagement with skilled individuals. For educators in science and technology, such engagements serve as a bridge between theoretical knowledge and practical applications, allowing them to make classroom concepts more tangible and relatable. In the Philippines, science education is undergoing a transformation marked by the integration of technology and innovative instructional methods^[9]. This cooperative effort strengthens educators' shared commitment to improving the quality of education.

Industry-based training programs also reshape the mental frameworks teachers utilize to organize and convey knowledge. This cognitive restructuring process, referred to as schema modification, enables educators to view and interpret information through the lens of modern technological advancements and practices. Schemas, defined as mental structures that organize and interpret environmental information, form the foundation of cognitive development^[10,11]. Experiencing the application of scientific concepts in real-world scenarios, teachers gain the ability to incorporate these insights into their curriculum. This approach not only engages students more effectively but also introduces them to career pathways they might not have considered previously. Educators who adopt growth mindsets show a positive correlation with the academic and personal development of their students, fostering a mindset that prioritizes improvement and adaptability over fixed notions^[12].

The integration of social facilitation and schema modification into professional development programs highlights the transformative influence of industry exposure on education. Teachers emerge from these programs with enhanced confidence and the skills needed to act as facilitators of meaningful and engaging learning experiences^[13]. These developments are instrumental in equipping students with the knowledge and skills necessary to thrive in a scientifically advanced and interconnected world.

2. Literature review

2.1. Science and technology education

In recent decades, science and technology education has gained significant global attention due to its vital contribution to enhancing societal living standards, fostering economic growth, and supporting global competitiveness^[14,15]. Higher education institutions play a key role in equipping students with essential

competencies needed to navigate societal changes and adapt to the continuous evolution of the workplace. To meet the demands of the future job market, students must develop a diverse set of skills, including critical thinking, problem-solving, communication, collaboration, technical proficiency, and information literacy^[16]. Despite the recognition of the need for educational innovations, many teachers face uncertainties about how these changes affect their professional roles. This uncertainty can lead to conflicts with their professional identity and resistance to implementing learner-oriented practices^[17].

Professional development is a process focused on enhancing teachers' competencies to achieve improved student outcomes. Villegas-Reimers^[18] emphasized that such development is multifaceted, often involving coaching and reflective practice. In contrast, Mizell^[19] proposed a more school-based model centered on continuous, job-embedded learning, while Mishra and Koehler^[20] advocated for integrating technological and content knowledge to address evolving student needs. Each perspective highlights different dimensions of effectiveness in professional growth. In this context, professional development for science and technology educators is indispensable for preparing both teachers and students to meet contemporary educational challenges.

2.2. Social facilitation in education

Social facilitation is a psychological concept that describes improved task performance in the presence of others, particularly for familiar or well-practiced tasks^[21]. In education, engaging with industry professionals exemplifies this phenomenon by helping teachers gain insights and practical skills to enhance their teaching practices^[22]. Collaborations with experts in the field provide a unique opportunity for teachers to grasp the nuances of complex concepts, enabling them to deliver lessons with greater clarity and relevance. This is particularly important in higher education, where facilitating student engagement during transitional years can set the foundation for sustained academic interest^[23].

Mentorship programs that connect educators with industry professionals equip them with up-to-date knowledge and specialized expertise^[24]. Observing the application of advanced tools or methodologies in real-world settings helps teachers link theoretical principles to practical scenarios. These opportunities allow educators to develop more engaging and interactive instructional methods for their students. Furthermore, the sharing of insights during professional development activities fosters the creation of innovative teaching practices, ensuring that students are well-prepared for future workplace challenges^[25].

Collaborative engagements with industry experts also enhance teachers' confidence in their abilities. Such programs empower educators to approach lessons with increased competence, encouraging innovative teaching methods aligned with modern industry demands^[26]. Research shows that these exchanges of knowledge enrich educational environments by bridging the gap between academic theories and their practical applications. Students benefit from lessons that connect their studies to real-world contexts, which motivates them to pursue opportunities aligned with their aspirations^[27].

2.3. Schema modification in professional development

Schema modification, a psychological process involving the restructuring of mental frameworks, helps individuals adapt their understanding based on new experiences. Schemas, which are mental representations of the self, others, and the world, shape how people interpret and organize information^[28,29]. These frameworks, derived from personal experiences, play a critical role in guiding thoughts, behaviors, and decisions. Understanding how schemas are formed and modified has far-reaching implications for cognitive development and well-being. In the context of education, schema modification allows teachers to adapt their knowledge and methodologies to align with evolving scientific advancements^[30].

Industry-based experiences challenge educators to rethink their instructional approaches. Exposure to real-world applications often leads teachers to incorporate practical scenarios into their curriculum, offering students a clearer understanding of the relevance of their studies. For instance, examples from industries like biotechnology or renewable energy can illustrate how classroom lessons translate into workforce applications. This integration not only enhances student engagement but also transforms instruction into a more meaningful and purposeful experience^[31,32].

Additionally, schema modification fosters continuous professional growth among educators. Professional development programs encourage teachers to remain open to new knowledge and flexible in adapting their practices to stay relevant in rapidly advancing fields^[33]. Embracing this process, educators ensure their teaching remains effective and aligned with the skills students need to succeed in an ever-evolving world. This adaptability is particularly crucial in science and technology education, where staying current with advancements is a constant requirement.

3. Methodology

3.1. Research design

This study implemented a descriptive cross-sectional research design to assess the impact of industry-based professional development on science and technology educators' confidence and mindset. The purpose of this design was to collect data at a single point in time, capturing the existing relationships and dynamics among variables relevant to the study. Descriptive cross-sectional research is instrumental in providing a detailed "snapshot" of the current state of phenomena, allowing researchers to evaluate the participants' experiences and perceptions without manipulating variables^[34]. This design facilitated a systematic exploration of how exposure to industry practices influences teaching methods, curriculum planning, and educators' professional growth.

3.2. Purposive sampling

To ensure alignment with the research objectives, this study employed purposive sampling to select 25 participants from Visayas, Philippines. The sample consisted of experienced science teachers from the Philippines with at least six (6) years of teaching practice. This sampling approach was chosen because it allows researchers to focus on individuals who have specific characteristics relevant to the study^[35]. Teachers with industry-based professional development experience were prioritized, as they could offer valuable insights into how such training affects their teaching confidence and instructional methods. By carefully selecting participants who met these criteria, the study ensured the collection of highly relevant and focused data.

3.3. Research instrument

The primary research instruments used in this study were a structured interview guide and an open-ended survey questionnaire. Structured interviews are a systematic way to obtain precise responses to preformulated questions, making them effective for qualitative research^[36]. The **Table 1** in the interview guide aimed to gather specific details about the participants' experiences, including changes in teaching confidence, integration of industry knowledge, and classroom strategies. Meanwhile, the open-ended survey allowed participants to elaborate on their responses in their own words, providing additional context and depth to the data. Both tools were reviewed and pilot-tested to ensure clarity and effectiveness in addressing the research questions, as well as their reliability for gathering comprehensive and meaningful insights.

Table 1. Instrument of the study

Objectives	Interview questions	N
Determine the added value of science industry-based professional development for science and tech faculty.	1. What is the importance of exposing the sci tech teachers in science-industry based settings? Elaborate further. 2. Can the science-industries contribute to the teaching confidence of the teachers? Elaborate more. 3. What is it in the science-industries that the teachers can learn from the most? Cite specific learnings.	25
Determine the effects of industry-based training to the mindset of the sci tech teachers.	1. What perspectives can change if a teacher is exposed or trained by the industry players themselves? Elaborate further. 2. What mindset in teaching can change when teachers experience the real-life applications of their lessons? Explain through examples. 3. Can you compare the difference between teachers who were not trained by the industry players and by teachers who were not exposed to the industries in terms of confidence?	

3.4. Data gathering procedure

The data collection process was carried out in two distinct stages to ensure a thorough understanding of the participants' experiences. First, individual virtual interviews were conducted using secure communication platforms. This format allowed participants to share detailed accounts of their experiences while ensuring privacy and convenience. The sessions were recorded with their consent for accurate transcription and analysis. Second, an open-ended survey was distributed to enable participants to reflect further and provide detailed, written insights. This dual-method approach ensured that the study captured both immediate, conversational responses and well-thought-out reflections. All collected data were anonymized to maintain confidentiality and securely stored to protect participant privacy.

3.5. Data analysis

A content configuration analysis approach was utilized to analyze the data systematically. This method enabled the researchers to identify key themes, recurring patterns, and meaningful variations in participant responses^[38]. Categorizing data into thematic clusters, the analysis provided insights into how professional development programs influenced educators' confidence and teaching methodologies. The data were cross validated through triangulation, comparing interview responses with survey data to ensure consistency and reliability. Additionally, Interview and focus group responses were analyzed by identifying recurring themes, validating insights through triangulation, and documenting both patterns and contradictions. This analytical framework ensured a comprehensive and unbiased understanding of the findings, directly addressing the study's objectives.

4. Results

Research Objectives 1. Determine the added value of science industry-based professional development for science and tech faculty.

Question No. 1. What is the importance of exposing the sci tech teachers in science-industry based settings? Elaborate further.

1.1 Bridging Theory and Application

Twenty (20) respondents expressed that they often deliver concepts theoretically, but firsthand experience in industry settings helps them understand how these ideas are applied in real-world scenarios. This makes their teaching more relatable and relevant to students. After experiencing how science is applied in practical settings, they can develop labs, projects, or experiments that reflect industry practices. Additionally, they mentioned that many students don't know how classroom science connects to real jobs.

Their industry exposure can confidently explain how roles like biomedical researchers, environmental engineers, or data scientists use the concepts they're learning. This guidance helps students see the value in their studies and identify pathways that align with their interests. Exposure to ever-evolving industry practices reminds teachers of the importance of continuous learning. This mindset can inspire their students to value ongoing education.

" Teachers often deliver concepts theoretically, but first hand experience in industry settings helps them understand how these ideas are applied in real-world scenarios. This makes their teaching more relatable and relevant to students."

" A teacher with industry exposure can confidently explain how roles like biomedical researchers, environmental engineers, or data scientists use the concepts they're learning. This guidance helps students see the value in their studies and identify pathways that align with their interests. "

1.2 Enhancing Curriculum Development

Twenty-two (22) respondents expressed that industry exposure equips them with insights into current trends and emerging technologies. This allows them to integrate contemporary examples into their lessons, ensuring students receive up-to-date knowledge. They gain awareness of current technologies, such as renewable energy systems, autonomous vehicles, or genome sequencing. This allows them to explain how textbook principles underpin these technologies, making lessons more engaging and relatable. Additionally, they mentioned that exposure to industries highlights fields with growing demand, such as data science, robotics, or climate science. They can emphasize these areas in lessons and even create electives or club activities, preparing students for the job market of the future. This concludes, industries often operate at the intersection of disciplines. A teacher exposed to this approach might integrate lessons that connect physics with computer science or chemistry with environmental sustainability.

" This allows them to integrate contemporary examples into their lessons, ensuring students receive up-to-date knowledge. They gain awareness of current technologies, such as renewable energy systems, autonomous vehicles, or genome sequencing. "

" My exposure to industries highlights fields with growing demand, such as data science, robotics, or climate science. Teachers can emphasize these areas in lessons and even create electives or club activities, preparing students for the job market of the future."

1.3 Developing a Future-Ready Mindset

Thirteen (13) respondents expressed that industry experiences reveal the skills and competencies companies' value, such as collaboration, adaptability, and digital proficiency. Teachers can align their teaching methods to nurture these qualities in students. For them leveraging insights from industry experiences to cultivate essential skills in students can significantly enhance their readiness for future careers. Additionally, they mentioned that industries face rapidly evolving challenges, such as adapting to new technologies or market demands, requiring employees to be flexible and open to change. Finally, by aligning classroom practices with these industry-valued competencies, teachers empower students with skills that extend beyond academics, preparing them for success in diverse, dynamic career paths.

" Industry experiences reveal the skills and competencies companies' value, such as collaboration, adaptability, and digital proficiency. Teachers can align their teaching methods to nurture these qualities in students."

"Industries face rapidly evolving challenges, such as adapting to new technologies or market demands, requiring employees to be flexible and open to change."

Question No. 2. Can the science-industries contribute to the teaching confidence of the teachers? Elaborate more.

2.1 Professional Development and Training

Twenty-one (21) respondents expressed that Science industries often pioneer cutting-edge advancements, and their involvement in teacher training can provide up-to-date, real-world knowledge. Workshops or webinars led by professionals in fields like biotechnology, renewable energy, or space exploration can deepen their content mastery. Knowing they're equipped with accurate, contemporary information builds confidence in classroom delivery. They could participate in internships or lab visits. Experiencing real-world applications of theoretical concepts helps them relate better to the material, making lessons more impactful. In essence, the partnership between science industries and educators must focus on mutual empowerment. Industries benefit by fostering a future workforce passionate about STEM, while teachers gain the confidence, resources, and inspiration to deliver impactful lessons that spark curiosity and innovation in students.

"Knowing they're equipped with accurate, contemporary information builds confidence in classroom delivery. We could participate in internships or lab visits. Experiencing real-world applications of theoretical concepts helps us relate better to the material, making lessons more impactful."

"Engaging with real-world processes, like DNA extraction in a biotechnology lab or studying solar panel efficiency in renewable energy facilities, allows them to build confidence in conducting similar experiments with students"

2.2 Mentorship and Networking

Eighteen (18) respondents expressed that partnering with industry professionals as mentors can be transformative. Those who know they have a network to consult can approach new topics or challenging student questions with less fear of "getting it wrong." Exposure to industry networks also allows them to stay current, boosting credibility and confidence. Additionally, they mentioned that they often encounter advanced or niche topics that are outside their formal training. Having industry professionals as mentors ensures they have a reliable source of accurate and practical insights. They gain confidence knowing they can consult an expert when students ask challenging, cutting-edge questions. This reassurance reduces the anxiety of being "caught off guard." Ultimately, the mentorship dynamic is a win-win for teachers and industry professionals. Teachers gain confidence, credibility, and content expertise, while industries benefit from a better-prepared future workforce inspired by well-equipped educators.

"Partnering with industry professionals as mentors can be transformative. Those who know they have a network to consult can approach new topics or challenging student questions with less fear of "getting it wrong."

"Teachers often encounter advanced or niche topics (e.g., nanotechnology, quantum computing, or renewable energy systems) that are outside their formal

training. They gain confidence knowing they can consult an expert when students ask challenging, cutting-edge questions."

2.3 Resource Provision

Ten (10) respondents believe in offering modern laboratory tools or virtual simulation software for schools. Being familiar with advanced technology helps them conduct experiments or demonstrations effectively, boosting their confidence. Providing lesson plans, kits, or real-world case studies tied to industrial innovations. They can lean on these materials to build engaging and accurate lessons. Additionally, they mentioned that many of them feel intimidated by new tools or software. Hands-on training sessions provided alongside the tools ensure teachers are comfortable and competent in using them. Access to industrial-grade tools and up-to-date lesson resources helps them stay aligned with the latest trends and technologies, enhancing their professional credibility because when they are confident in their tools, they are more likely to encourage students to experiment independently, fostering a collaborative and inquiry-driven classroom environment. In summary, this combination of technology and support not only enhances teaching confidence but also transforms classrooms into vibrant hubs of innovation and exploration.

"Being familiar with advanced technology helps me conduct experiments or demonstrations effectively, boosting my confidence. Providing lesson plans, kits, or real-world case studies tied to industrial innovations."

"Access to industrial-grade tools and up-to-date lesson resources helps them stay aligned with the latest trends and technologies, enhancing their professional credibility because when they are confident in their tools, they are more likely to encourage students to experiment independently."

Question No. 3. What is it in the science-industries that the teachers can learn from the most? Cite specific learnings.

3.1 Real-World Relevance and Application

Twenty-three (23) respondents expressed that they learned to link theoretical concepts like chemical reactions to industrial processes like polymer production. It helps students see the value of what they're learning in everyday life. Industries often focus on applying scientific concepts to solve practical problems, such as developing new materials, medicines, or technologies. They can incorporate these real-world examples into lessons to make the subject more engaging and relatable. Additionally, they mentioned that linking theoretical concepts to industrial processes is one of the most impactful ways to demonstrate the real-world value of science to students. For example, when they shared a case study on how green chemistry principles are applied to reduce waste in industrial manufacturing. This sparked a conversation on sustainability and inspired students to think critically about eco-friendly solutions. Integrating these approaches into science teaching, educators can effectively bridge the gap between theoretical knowledge and practical application, inspiring students to view science as not just a subject but a gateway to understanding and shaping the world around them.

"I learned to link theoretical concepts like chemical reactions to industrial processes like polymer production. It helps students see the value of what they're learning in everyday life. I can incorporate these real-world examples into lessons to make the subject more engaging and relatable."

“I shared a case study on how green chemistry principles are applied to reduce waste in industrial manufacturing. This sparked a conversation on sustainability and inspired students to think critically about eco-friendly solutions.”

3.2 Emphasis on Innovation and Critical Thinking

Twelve (12) respondents expressed that observing the iterative processes in biotech companies taught them to emphasize resilience and adaptability in their teaching. Students now approach failure in experiments as opportunities to learn. They prioritize innovative thinking and problem-solving wherein they can encourage these skills in their students through project-based learning and inquiry-driven experiments. Additionally, they mentioned that fostering innovative thinking and problem-solving in students mirrors the approach scientists in the industry take to tackle real-world challenges. For example, when students brainstorm their methods for filtering water, they engage with trial and error. It's fascinating to see their creativity as they test different materials like sand, charcoal, and fabric. Integrating these methods, teachers not only help students understand scientific concepts but also equip them with critical skills for innovation and problem-solving that resonate with industry practices. This approach inspires students to think like scientists, ready to tackle challenges creatively and collaboratively.

“Observing the iterative processes in biotech companies taught me to emphasize resilience and adaptability in my teaching. Students now approach failure in experiments as opportunities to learn.”

"Fostering innovative thinking and problem-solving in students mirrors the approach scientists in the industry take to tackle real-world challenges. For example, when students brainstorm their methods for filtering water, they engage with trial and error.”

3.2 Ethical Considerations and Responsibility

Ten (10) respondents expressed that industries grapple with ethical questions (e.g., genetic engineering, AI). They can incorporate these discussions into the curriculum to foster critical thinking and a sense of responsibility. Their interaction with professionals in environmental sciences made them realize the importance of discussing ethical dilemmas, like climate change policies, in class. It sparks deep, meaningful debates among students. Additionally, they mentioned that incorporating discussions about ethical dilemmas into lessons is essential for fostering critical thinking and preparing students to tackle complex global issues.

“My interaction with professionals in environmental sciences made me realize the importance of discussing ethical dilemmas, like climate change policies, in class. It sparks deep, meaningful debates among students.”

“We examined the ethical concerns surrounding geoengineering solutions like solar radiation management. Students debated whether such interventions could cause more harm than good, highlighting how science intersects with societal values.”

Research Objectives 2. Determine the effects of industry-based training to the mindset of the sci tech teachers.

Question No. 1. What perspectives can change if a teacher is exposed or trained by the industry players themselves? Elaborate further.

Enhanced Real-World Context

Twenty-five (25) respondents expressed that much of their lesson planning and teaching focused on the theoretical frameworks of science, often tied to standardized curricula. Exposure to industry professionals has opened their eyes to how these theories are applied in cutting-edge technologies and real-world scenarios. For example, seeing how principles of physics are integral to developing renewable energy solutions makes the subject far more relatable and engaging for students. Additionally, they mentioned that exposure to industry professionals deepened their understanding of the practical application of science in ways they had previously only touched upon. For example, while they always taught the laws of physics and their principles, industry training allowed them to see how these laws directly influenced innovations such as wind turbine design, energy-efficient construction, and electric vehicle technologies. This broader perspective made them realize that students often struggle to see how abstract formulas and theories translate into tangible solutions that impact society. In essence, this has encouraged me to incorporate collaborative projects in my teaching, mirroring the teamwork necessary in the real world.

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1.2 Awareness of Emerging Trends

Fourteen (14) respondents expressed that before the exposure, their understanding of certain scientific fields felt static rooted in textbooks. Industry training updated their perspective on dynamic advancements like AI in healthcare, biotechnology, or sustainable materials. Knowing what's "next" in science means they can prepare students for future career landscapes, rather than simply for exams. Additionally, they mentioned that it made them realize that their role as a teacher is not just to impart existing knowledge but to anticipate the skills and understanding students will need for the jobs of tomorrow. Industry exposure helps them present science as a living, evolving field one where today's students will contribute to tomorrow's solutions. It encourages them to integrate future-forward topics like bioinformatics, renewable energy technologies, and the Internet of Things into their curriculum, giving students a competitive edge in their career aspirations. In conclusion, staying informed about these advancements has shifted their teaching focus from rote memorization to fostering innovation and critical thinking. It's no longer about "teaching to the test" but about preparing students to navigate and thrive in a rapidly evolving scientific and technological landscape.

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1.3 Empathy Toward Industry Needs

Twenty-one (21) respondents expressed that they now better understand the skills gaps industries face in fresh graduates. This perspective has helped them encourage students to develop transferable skills like communication, data analysis, and adaptability. It's no longer just about "teaching science" but about equipping students to be employable in STEM fields. It made them appreciate the interplay between academic knowledge and practical application, ultimately enriching their teaching philosophy and preparing students not just to learn, but to thrive in a rapidly evolving world. Additionally, they mentioned that industry exposure gave them valuable insight into the skills gaps employers often observe in fresh graduates, even those with strong academic backgrounds. While technical knowledge is essential, industry professionals emphasized that the ability to apply knowledge creatively, communicate effectively, and work collaboratively in diverse teams often matters just as much, if not more. This understanding has significantly influenced how they approach teaching science. In essence, my teaching philosophy has shifted from simply "teaching science" to "teaching scientists in the making." By prioritizing these transferable skills, they're equipping students not only to excel academically but also to thrive in their future STEM careers, making them well-rounded, industry-ready professionals.

"I now better understand the skills gaps industries face in fresh graduates. This perspective has helped me encourage students to develop transferable skills like communication, data analysis, and adaptability."

"While technical knowledge is essential, industry professionals emphasized that the ability to apply knowledge creatively, communicate effectively, and work collaboratively in diverse teams often matters just as much, if not more.."

Question No. 2. What mindset in teaching can change when teachers experience the real life applications of their lessons? Explain through examples.

2.1 From Separate Disciplines to Interconnected Realities

Twenty (20) respondents expressed that before subjects often feel isolated, with clear boundaries between biology, physics, and chemistry but after experiencing it they see how interconnected the sciences and other disciplines are in solving real-world problems. For example, during a collaborative project with an NGO on renewable energy, they realized that physics (solar panels), chemistry (battery storage), and economics (cost-benefit analysis) work together. They started designing lessons that combined these perspectives, such as challenging students to plan a sustainable energy solution for their homes. Additionally, they mentioned that experiencing these interconnected realities help them realize that teaching isn't just about preparing students for exams, it's about equipping them with the tools and mindset to understand and address the complexities of the world. This shift not only enriches their teaching but also helps students see the purpose and power of what they're learning. Experiencing the real-world application of lessons reshaped their mindset. They now see themselves not just as a science teacher but as someone preparing students to think critically and make meaningful contributions. In sum, it fosters a sense of responsibility, curiosity, and possibility that extends far beyond the classroom.

"During a collaborative project with an NGO on renewable energy, I realized that physics (solar panels), chemistry (battery storage), and economics (cost-benefit analysis) work together. I started designing lessons that combined these perspectives, such as challenging students to plan a sustainable energy solution for their homes."

"As science teachers, experiencing these interconnected realities helps us realize that teaching isn't just about preparing students for exams—it's about equipping them with the tools and mindset to understand and address the complexities of the world."

2.2 From Content-Delivery to Skill-Building

Twenty-five (25) respondents expressed that before, they focused on ensuring students understood scientific concepts thoroughly. However, when they observed how understanding circuits helped students repair broken gadgets or apply chemical knowledge in baking experiments, they realized the value of teaching transferable skills. Now, they design lessons that emphasize problem-solving and creativity, rather than just rote memorization. Example, instead of only teaching the laws of motion, they now challenge students to design and test a simple machine using household materials. This encourages innovation and shows them how physics operates in everyday engineering. Additionally, they mentioned that many students grasp concepts better when they see their real-world implications. For instance, teaching electricity through lectures alone doesn't resonate with all students. When they introduced activities like building simple circuit boards or repairing small appliances, students became more engaged and confident in their understanding. In summary, integrating such real-life applications, they've seen students become more motivated and confident. They no longer see science as abstract facts to memorize but as a toolkit for solving problems and making meaningful contributions to their communities.

"I focused on ensuring students understood scientific concepts thoroughly. However, when I observed how understanding circuits helped students repair broken gadgets or apply chemical knowledge in baking experiments, I realized the value of teaching transferable skills."

"For instance, teaching electricity through lectures alone doesn't resonate with all students. When I introduced activities like building simple circuit boards or repairing small appliances, students became more engaged and confident in their understanding."

2.3 From Instructor to Facilitator

Fifteen (15) respondents expressed that they used to see themselves as the primary source of knowledge. However, real-life applications taught them that students can often teach themselves when given the right tools and encouragement. This realization transformed their role from a "sage on the stage" to a "guide on the side." They encouraged students to independently explore science. They surpassed their expectations, creating machines far more advanced than anything they had done in class. This reinforced their belief in empowering students to lead their own learning. Additionally, they mentioned that when they stopped viewing themselves as the sole authority in the classroom, they noticed students became more invested in their learning. By providing tools like lab equipment, online resources, and problem scenarios, they created opportunities for them to explore and discover on their own. This shift reminded them that students are naturally curious. When they trusted them to take ownership of their learning, they often exceeded their expectations. In summary, by transitioning to a "guide on the side," teachers witnessed how much more engaged and capable students became. They learned not just the subject matter but also essential life skills like critical thinking, collaboration, and independence.

"Used to see myself as the primary source of knowledge. However, real-life applications taught me that students can often teach themselves when given the right tools and encouragement. They surpassed my expectations, creating machines far more advanced than anything we had done in class. This reinforced my belief in empowering students to lead their own learning."

"When I stopped viewing myself as the sole authority in the classroom, I noticed students became more invested in their learning. By providing tools like lab equipment, online resources, and problem scenarios, I created opportunities for them to explore and discover on their own."

Question No. 3. Can you compare the difference between teachers who were not trained by the industry players and by teachers who were not exposed to the industries in terms of confidence?

3.1 Industry-Exposed Training

Seventeen (17) respondents expressed that Being trained by industry professionals gave me a lot of confidence. I can provide real-world examples and guide students on how science is applied in the workplace. My interactions with industry partners also equipped me with insights into what employers expect, which I share with my students to better prepare them for future careers. It feels empowering to connect theory to practice in a meaningful way. Additionally, they mentioned that learning about the tools and techniques used in industries has transformed their teaching. They now incorporate discussions about technologies like spectrometry, genetic engineering, and AI in scientific research. When students hear about these cutting-edge methods, they're more engaged. This makes them feel like they're truly preparing them for modern scientific challenges. In sum, teachers feel empowered when they can link classroom concepts to real-world applications. Students benefit from lessons that emphasize practicality and career readiness. Industry-trained teachers experience greater engagement and satisfaction in their teaching roles.

" I can provide real-world examples and guide students on how science is applied in the workplace. My interactions with industry partners also equipped me with insights into what employers expect, which I share with my students to better prepare them for future careers."

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3.2 Self-Trained on Industry Concepts

Nineteen (19) respondents expressed that they weren't trained directly by industry players, but they took it upon themselves to learn about industry applications through workshops and research. This has helped them confidently discuss how science applies to real life. While their confidence is decent, they sometimes feel like they're missing the hands-on insights that come from actual exposure. Additionally, they mentioned that while they didn't get direct industry training, they attended several professional development workshops and online courses on topics like renewable energy and pharmaceutical advancements. This gave them the ability to speak with confidence about the importance of these fields. However, they still feel there's a gap when students ask for more hands-on experience or ask questions that they can't fully answer due to their lack of direct exposure. It's something they're always trying to improve on. In summary, Teachers who haven't had direct exposure to industry sometimes feel limited by their lack of hands-on experience, which

may make it challenging to answer more technical or specific questions from students. Confidence is built through the effort to make science relevant and practical, even if the exposure to actual industry work is limited.

"I feel more valued when I see the institution is investing in their professional development. I wasn't trained directly by industry players, but I took it upon myself to learn about industry applications through workshops and research. This has helped me confidently discuss how science applies to real life."

"While I didn't get direct industry training, I attended several professional development workshops and online courses on topics like renewable energy and pharmaceutical advancements. This gave me the ability to speak with confidence about the importance of these fields."

3.3 Academically Focused Training

Sixteen (16) respondents expressed that they were trained in a more academic-focused setting without much emphasis on industry. Their confidence lies in their ability to explain concepts thoroughly and handle curriculum requirements. However, they feel a gap when students ask how their learning translates into real-world careers. It makes them less confident in addressing those questions compared to colleagues with industry exposure. Additionally, they mentioned that their academic training makes them feel confident in the way they explain scientific theories, but they often find it difficult to explain how students can apply what they're learning in the real world. They try to connect the dots by talking about general career paths in science, like lab technicians or teachers, but it often feels like they are giving textbook answers. In summary, they sometimes wish they had more first-hand knowledge about industry needs to better inform their students' future choices. Teachers trained in academic settings feel confident in explaining scientific concepts, managing the curriculum, and preparing students for exams.

"I was trained in a more academic-focused setting without much emphasis on industry. My confidence lies in my ability to explain concepts thoroughly and handle curriculum requirements. It makes me less confident in addressing those questions compared to colleagues with industry exposure."

"My academic training makes me feel confident in the way I explain scientific theories, but I often find it difficult to explain how students can apply what they're learning in the real world. I try to connect the dots by talking about general career paths in science, like lab technicians or teachers, but it often feels like I'm giving textbook answers."

5. Discussion

The findings underscore the transformative effects of professional development rooted in industry-based experiences on educators' teaching methods and cognitive frameworks. Teachers reported substantial gains in their instructional confidence, relevance of curricula, and their ability to understand and integrate interdisciplinary connections. Teachers' beliefs significantly influence their approach to student learning and content delivery^[39]. These outcomes reflect moderately original insights, especially in the Philippine educational context where little research has been conducted on integrating social facilitation and schema change into science education.

The integration of real-world experiences into educational practices played a crucial role in helping educators bridge the divide between theoretical knowledge and practical applications. Teachers learned to connect classroom concepts with industry-relevant scenarios, such as illustrating how renewable energy systems apply principles of physics and chemistry. The impact of field-based teaching experiences on professional development has been recognized^[40]. Experiential learning encourages active engagement by enabling students to apply classroom lessons to industry scenarios, such as the integration of physics and chemistry in renewable energy systems^[41]. This shift in teaching strategies fosters a more dynamic and engaging learning environment, making it easier for students to see how their studies are connected to future career opportunities. Furthermore, the incorporation of technological advancements and cutting-edge examples into lessons reflects the changing demands of science education and ensures students are prepared for the evolving professional landscape^[42].

From a psychological standpoint, the study emphasizes the role of social facilitation, whereby interactions with skilled industry professionals boost educators' confidence and expertise. Exposure to advanced tools, methodologies, and professional networks enhanced teachers' ability to provide high-quality, accurate instruction^[43]. These resources contributed to the development of a growth mindset, promoting the value of adaptability and ongoing learning, both for educators and their students. This mindset is essential for cultivating resilience and fostering innovation in educational settings, particularly in fields that are rapidly evolving, such as science and technology. Suggestions and strategies for cultivating a mindset of resilience in students have been provided^[44].

The professional development experiences also triggered cognitive restructuring, a process guided by schema modification theory. As educational institutions aim to prepare future educators for the dynamic demands of the 21st-century classroom, integrating technology into teacher education programs has become an essential focus^[45]. Teachers adjusted their cognitive frameworks to incorporate new knowledge and methodologies, enabling them to align their instructional practices more closely with industry standards. This shift was particularly evident in the interdisciplinary nature of their teaching, as educators began to integrate subjects such as biology, physics, and economics to address real-world challenges. This holistic teaching approach not only enriched classroom instruction but also helped students gain a deeper understanding of the interconnections between various scientific disciplines. Holistic education embraces a broad range of philosophical orientations and pedagogical practices, focusing on wholeness and seeking to encompass all significant aspects of the human experience^[46,47].

Additionally, the study highlights the ethical aspect of science education. By engaging with industry practices, teachers incorporated discussions on sustainability and responsible innovation into their lessons. These discussions encouraged students to critically examine the societal and environmental impacts of scientific advancements, promoting ethical responsibility alongside academic achievement.

6. Conclusion

The findings of this research demonstrate the significant impact of industry-based professional development on science and technology educators. Teachers who participated in these programs reported substantial gains in their confidence, ability to connect classroom concepts to real-world applications, and understanding of interdisciplinary connections. This study revealed that industry immersion brought about substantial changes in teachers' perspectives, teaching confidence, and curriculum design practices. These shifts were facilitated by exposure to real-world applications and collaboration with professionals. Social facilitation and schema change theories helped explain these behavioral and cognitive transformations. Given these insights, curriculum planners and policymakers should institutionalize similar immersion programs as

part of long-term teacher development strategies. It is recommended that policy-making bodies prioritize contextualized, industry-linked teacher training, particularly in under-resourced educational sectors. Institutionalizing such efforts, teacher confidence, curriculum relevance, and student engagement can be sustainably improved. This research underscores the importance of continued investment in industry-based professional development programs to empower educators and enhance the quality of science and technology education.

Furthermore, the study highlights the importance of collaboration between educational institutions and industry partners to create meaningful learning experiences for teachers. The results suggest that exposure to industry professionals not only enhances teachers' knowledge and skills but also fosters a sense of purpose and relevance in their teaching. This, in turn, leads to greater student engagement and a more effective learning environment. The research also points to the need for ongoing professional development opportunities for science and technology educators to ensure they remain current with the latest advancements in their fields. Embracing a culture of continuous learning, educators can better prepare students for the ever-evolving landscape of science and technology.

Conflict of interest

The authors declare no conflict of interest.

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