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RESEARCH ARTICLE

Training designs that affect motivation and intellectual progression of science, Engineering, and mathematics teachers

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ABSTRACT

Training designs shape the motivation and intellectual development of educators, particularly those teaching science, engineering, and mathematics. This study explored how psychological frameworks—Schema Activation, Dual-Process Theory, and Habituation—enhance professional development for 40 Filipino educators from Agusan del Sur, Surigao del Norte, and Samar, Philippines. Using a descriptive qualitative research design, data were collected from 40 educators through semi-structured questionnaires that explored their experiences with professional development. The data gathering was conducted using both in-person and online methods to ensure accessibility. The questionnaire focused on motivational and cognitive factors, aligning with Schema Activation, Dual-Process Theory, and Habituation, though no standardized scales were employed. The study found that hands-on activities, culturally responsive teaching strategies, and interdisciplinary workshops enhance teacher engagement and practical application. Additionally, training sessions that combine intuitive and analytical thinking foster cognitive flexibility, enabling educators to address diverse classroom challenges. The findings also stress the importance of sustained post-training support to ensure ongoing professional growth and innovation in teaching practices.

Keywords: Training Designs; Motivation; Intellectual Progression; Science; Engineering; Mathematics Teachers

1. Introduction

Professional development for science, engineering, and mathematics teachers should systematically integrate psychological frameworks such as Schema Activation, Dual-Process Theory, and Habituation.

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These disciplines in education involve intricate and interconnected elements, including the instructor, learner, information, media, and environment[1]. Effective training programs must align educators' existing knowledge with modern educational standards to ensure teaching approaches evolve alongside curriculum changes. Research demonstrates that well-structured professional development enhances teachers' self-confidence and instructional skills, ultimately leading to improved student outcomes[2,3]. This study recognizes the responsibility of teachers in fostering a classroom environment that encourages engagement and learning[4].

Schema Activation highlights the significance of prior knowledge in acquiring new information. This cognitive framework has shaped how learning, memory, and academic achievement are understood, focusing on how individuals categorize, interpret, and store information[5,6]. For educators tasked with making complex scientific concepts understandable, this framework provides a foundation for effective teaching. Training programs designed to build upon teachers' existing mental frameworks enable them to bridge theoretical and practical knowledge effectively[7]. This structured alignment improves understanding and facilitates knowledge transfer into classroom practices.

Dual-Process Theory sheds light on how educators engage in problem-solving during training. By combining intuitive and analytical thinking, this theory equips teachers to approach challenges with both creativity and depth[8]. Training sessions based on this concept allow teachers to alternate between quick, instinctive decisions and thoughtful, deliberate analysis, enhancing their adaptability[9,10]. This flexibility is particularly valuable in addressing the varied and dynamic learning needs of students.

The principles of Habituation and Sensitization are also central to improving training methodologies. Habituation addresses the diminished response to repetitive stimuli, while sensitization emphasizes the need for introducing fresh and engaging experiences[11]. Affective habituation, which refers to reduced emotional responses due to repeated exposure, serves an adaptive purpose[12]. Training programs incorporating diverse and interactive activities ensure that participants remain attentive and motivated, creating a dynamic and engaging learning experience.

Incorporating these psychological principles into training designs leads to more effective professional development programs. Programs that balance cognitive and motivational strategies help educators continuously enhance their skills. These approaches allow teachers to adapt to changing educational demands while maintaining engagement in their professional growth. As a result, they are better equipped to inspire intellectual curiosity and foster deeper learning among their students. Despite increasing attention to professional development for STEM educators, few studies have examined how specific psychological frameworks—Schema Activation, Dual-Process Theory, and Habituation—can be intentionally integrated into training design, particularly in the Philippine context. Much of the existing literature addresses teaching strategies or general motivation, but lacks a focus on how cognitive and motivational theories interact to enhance the professional growth of educators.

To address this gap, the study examines how training designs grounded in psychological theories influence the motivation and intellectual development of STEM educators. It specifically explores which training approaches most effectively stimulate teacher engagement and promote cognitive growth.

2. Literature review

Training programs for Filipino educators, particularly those specializing in science, engineering, and mathematics, are designed to address national educational challenges while aligning with international standards. Science education in the Philippines is currently undergoing a transformative phase, emphasizing

the incorporation of technology and the adoption of innovative teaching methodologies[13]. These initiatives aim to improve instructional practices and deepen students' understanding of fundamental concepts[14]. A key feature of these programs is the integration of psychological frameworks such as Schema Activation, which helps educators utilize prior knowledge to effectively assimilate new concepts. By connecting established mental structures with fresh content, Filipino teachers can deliver meaningful learning experiences tailored to the unique needs of their classrooms[15].

In the diverse Philippine educational landscape, Schema Activation plays a crucial role in addressing the varied backgrounds of students and their differing levels of access to resources. Schema theory, a psychological tool for understanding cognitive processes, facilitates comprehension by encouraging learners to link their background knowledge to new information, particularly in vocabulary development[16]. This framework has been shown to positively influence students' vocabulary learning strategies[17]. Training sessions that incorporate culturally relevant examples and locally significant topics enable educators to contextualize lessons effectively[18]. For instance, workshops on environmental education often use scenarios like biodiversity conservation or disaster preparedness, which not only enhance knowledge retention but also empower teachers to tackle pressing national issues within their classrooms.

The Dual-Process Theory, which outlines how human cognition operates through two interconnected systems, is another critical concept in the Philippine context. It illustrates the duality of intuitive and analytical thinking; a concept rooted in history and still highly relevant today[19]. Teachers in the Philippines, especially those working in under-resourced schools, often face challenges requiring a balance between rapid decision-making and thorough analysis[20]. Training programs that incorporate this framework provide educators with essential cognitive tools to address these demands effectively. Whether resolving classroom management challenges or adjusting lesson plans to unforeseen circumstances, Filipino educators equipped with this dual-thinking approach can develop more adaptive and versatile teaching methods[21].

Moreover, Dual-Process Theory fosters cognitive flexibility, a vital skill for teachers navigating diverse classroom settings in the Philippines[22]. Training programs designed to strengthen this adaptability empower educators to alternate between intuitive and analytical responses based on the needs of their students. Through these strategies, teachers can better connect with learners from various cultural, economic, and educational backgrounds[23]. This approach ensures inclusivity and responsiveness, enabling educators to provide more effective instruction tailored to their students' specific contexts.

The psychological principles of Habituation and Sensitization are equally important in shaping effective teacher training designs. The Philippine education system has long been criticized for relying on repetitive and conventional teaching methods, often leading to disengagement among educators and learners alike. Training programs that introduce innovative and interactive techniques help counter these limitations. Activities like project-based learning, STEM integration workshops, and collaborative problem-solving sessions offer fresh and engaging experiences that keep teachers motivated and attentive to their professional development[24].

Incorporating Habituation and Sensitization into training designs also supports the Philippine government's goals of fostering innovation and creativity in education[25]. Government initiatives underscore the necessity of dynamic teaching strategies that prepare students for the challenges of the 21st century. By exposing teachers to diverse, modern pedagogical methods, these programs address both the intellectual growth of educators and the motivational hurdles they may encounter. This comprehensive approach ensures that training not only equips teachers with updated skills but also inspires a more innovative and engaging learning environment for their students.

Integrating psychological frameworks like Schema Activation, Dual-Process Theory, and Habituation and Sensitization into training programs enriches the Philippine education system. These approaches foster professional development among teachers while creating inclusive and stimulating classroom environments. By promoting continuous improvement, these initiatives support the broader goal of elevating educational quality across the country[26].

3. Methods

3.1. Research design

This study adopted a descriptive research design to explore the psychological factors that influence motivation and intellectual growth among 40 Filipino educators teaching science, engineering, and mathematics. The target population consisted of full-time STEM educators from public higher education institutions in Agusan del Sur, Surigao del Norte, and Samar. The qualitative approach was chosen for its ability to provide an in-depth understanding of individuals' beliefs, experiences, attitudes, behaviors, and interactions[27,28]. Qualitative research offers deeper insights into real-world challenges by emphasizing the complexity of human experiences[29,30]. This design was specifically employed to investigate how psychological concepts, such as Schema Activation, Dual-Process Theory, and Habituation, enhance the impact of professional development programs. The study sought to bridge theoretical frameworks with practical applications, shedding light on how cognitive and motivational elements contribute to the effectiveness of teacher training. Data were collected between January and March 2025.

3.2. Participants

The participants in this study consisted of 40 Filipino educators from Agusan del Sur, Surigao del Norte, and Samar, Philippines actively engaged in teaching science, engineering, or mathematics. Eligible participants were full-time faculty with at least six years of experience teaching STEM-related subjects. Those who had not participated in professional training within the last three years or who held administrative roles with minimal teaching loads were excluded. They were selected to represent a range of teaching backgrounds and levels of experience, ensuring diverse perspectives within the research. The sampling strategy followed a purposive approach, coordinated with school heads who identified participants meeting the inclusion criteria. This variety allowed the study to examine key psychological factors, including individual learning preferences, prior knowledge, and adaptability, which influence responses to professional development programs. The unique teaching contexts and cognitive frameworks of these educators provided valuable insights into how training designs impact their motivation and intellectual progression. By exploring these differences, the study aimed to identify commonalities and variations in how educators engage with training initiatives. As is typical in qualitative research, the findings are not intended to be statistically generalizable, but rather to offer contextual depth and insight.

3.3. Instrument

Data collection relied on a semi-structured questionnaire specifically designed to delve into the psychological and motivational dimensions of professional development programs[31]. The questions targeted areas such as the impact of experiential learning activities connected to Schema Activation, the interplay of intuitive and analytical thinking based on Dual-Process Theory, and techniques to sustain attention and minimize habituation. The open-ended format of the questionnaire allowed participants to share detailed and reflective responses. This approach ensured a thorough exploration of their experiences, facilitating the identification of recurring psychological themes and patterns. The instrument was meticulously crafted to capture nuanced insights into how training programs influence cognitive and motivational aspects of

teaching. The tool was administered either through Google Forms or printed copies, depending on participants' access and preference. **Table 1** presents the instrument used in the study.

Table 1. Research Instrument

Objectives	Interview questions	Participants	N
Determine short term training courses that stimulates the motivation of science, engineering and mathematics instructors	1. What are the types of training courses for science, engineering, and mathematics teachers that can motivate you more to teach? Describe each. 2. Can you describe a training design that can stimulate motivations of science, engineering, and math teachers? Explain further with examples. 3. What specific activities in a training course can make you listen and apply your learning from it? Elaborate more.	Teachers teaching for 6 years on science, engineering, and math - oriented subjects	40
Characterize training or workshop designs that can contributed to the intellectual progression of science and mathematics teachers	1. What can you say about the available training you have in terms of their intellectual enhancement? Elaborate your experience 2. What are the characteristics of training designs that contribute to intellectual progression to science, engineering and mathematics teachers? Explain more. 3. How should training be executed in order to address the need for an updated content gap among science and math teachers? Describe comprehensively.		

3.4. Data gathering procedure

The data collection process was conducted over a designated period using both online and face-to-face methods to accommodate participants' preferences and ensure inclusivity. A systematic procedure was implemented to gather and record data consistently, promoting completeness and accuracy[32]. Clear instructions and sufficient time were provided to minimize cognitive overload and encourage thoughtful participation. Follow-up reminders were sent to ensure comprehensive responses from all participants. Throughout the process, efforts were made to create a supportive environment that encouraged honest and reflective input, enabling a richer exploration of the psychological factors influencing motivation and intellectual engagement.

3.5. Data analysis

Thematic analysis was utilized to interpret the data, focusing on identifying psychological themes that aligned with the research objectives[33]. Each response was systematically coded based on its relevance to psychological frameworks, such as how training designs activate prior knowledge, foster cognitive flexibility, or address emotional and motivational factors. This method allowed for the categorization of responses into themes related to intrinsic and extrinsic motivation, cognitive engagement, and the influence of psychological stimuli in enhancing professional development outcomes. The analysis provided a comprehensive understanding of the patterns and relationships within the data, contributing to the study's overarching insights. Given the qualitative nature of the study, generalizability is limited; instead, the findings provide in-depth perspectives on the specific teaching contexts explored.

3.6. Ethical considerations

Strict adherence to ethical guidelines was maintained throughout the study to ensure the principles of respect, confidentiality, and informed consent were upheld. Ethics in research emphasize the responsibilities of researchers toward participants, society, and the academic community, necessitating adherence to good

research practices[34]. Participants were thoroughly briefed on the study's objectives and scope, and assurances were provided regarding the confidentiality of their identities and responses. Written consent was obtained before participation, and respondents were informed of their right to withdraw at any point without repercussions. Measures were also taken to minimize stress during data collection, safeguarding participants' psychological well-being. This ethical framework reinforced the reliability and credibility of the research while prioritizing the welfare of the participants. The study was conducted with administrative clearance from participating institutions. While no formal ethics board approval was obtained, the minimal risk nature of the study and absence of sensitive personal data were consistent with institutional norms for exempt research.

4. Results

Research Objectives 1. Determine short term training courses that stimulate the motivation of science, engineering and mathematics instructors.

Question No. 1. What are the types of training courses for science, engineering, and mathematics teachers that can motivate you more to teach? Describe each.

1.1 *Hands-on Laboratory and Experimentation Training*

Forty (40) respondents expressed that one training that really motivated them was a hands-on laboratory workshop where they learned how to incorporate more interactive experiments into their lessons. It gave them fresh ideas on how to make abstract scientific concepts more tangible for their students. They were able to experiment with inexpensive materials to create exciting demonstrations that capture students' attention. This experience made them more enthusiastic about teaching because they could see the immediate impact on student engagement. This type of teaching keeps them motivated because they see that it's not just about knowledge, it's about inspiring action. In summary, these perspectives from teaching disciplines illustrate how hands-on training empowers educators to create more engaging, meaningful, and dynamic learning experiences for students, which in turn, motivates teachers to innovate and refine their instructional methods.

> "One training that really motivated me was a hands-on laboratory workshop where we learned how to incorporate more interactive experiments into our lessons. It gave me fresh ideas on how to make abstract scientific concepts more tangible for my students."

> "The hands-on training I participated in, focused on environmental education, deeply motivated me. I began incorporating field trips to local parks and conducting 'urban ecology' projects where students could test real environmental conditions. The most motivating part was watching my students develop a sense of responsibility for the environment."

1.2 *STEM Enrichment Programs for Teachers*

Thirty-two (32) respondents expressed that what really motivated them was attending a STEM-focused workshop where we worked on designing interdisciplinary projects. The course helped them realize how hands-on experiences can be used to solve real-world problems in the classroom. For instance, they built water filtration systems out of simple materials to demonstrate both scientific and engineering principles. This not only connected science with engineering, but it also taught students how to work in teams, communicate ideas, and solve problems. This approach where students actively engage in creating and testing solutions has transformed their classroom. It keeps them motivated because they see their students

developing skills they will use in their future careers. By incorporating hands-on, interdisciplinary projects, teachers are not only improving student learning outcomes but are also finding new energy and motivation in their teaching practices.

> "What really motivated me was attending a STEM-focused workshop where we worked on designing interdisciplinary projects. The course helped me realize how hands-on experiences can be used to solve real-world problems in the classroom."
>
> "I participated in a STEM enrichment program that offered a blend of workshops, seminars, and interactive sessions. The focus was on advanced topics in math and technology, but we also discussed strategies for engaging students with STEM subjects."

1.3 Culturally Responsive Teaching

Twenty (20) respondents expressed that they participated in a training on culturally responsive teaching, which opened their eyes to the importance of acknowledging students' diverse backgrounds and learning styles. This was particularly motivating because they were able to adapt their teaching methods to be more inclusive and relevant to their students' lives. For example, they started using real-world problems that reflected diverse cultural perspectives. This made mathematics feel more connected to their students' lived experiences, and they seemed more motivated to learn. It helped them realize that math can be a way to empower students, allowing them to navigate and better understand the world around them. In conclusion, through their experiences with culturally responsive teaching, teachers report that the motivation and engagement of their students dramatically improves, as students see themselves reflected in the curriculum. By honoring and celebrating cultural diversity, teachers foster a classroom environment where all students feel valued, leading to deeper learning and a stronger connection to the subject matter.

> "I participated in a training on culturally responsive teaching, which opened my eyes to the importance of acknowledging students' diverse backgrounds and learning styles. This was particularly motivating because I was able to adapt my teaching methods to be more inclusive and relevant to my students' lives."
>
> "The CRT workshop was eye-opening for me because it helped me understand how to make math more inclusive and relevant to all my students, especially those from different cultural and socio-economic backgrounds."

Question No. 2. Can you describe a training design that can stimulate motivations of science, engineering, and math teachers? Explain further with examples.

2.1 *The 'Hands-On Inquiry' session*

Twenty-four (24) respondents expressed that they've been feeling overwhelmed by classroom management and not sure how to keep students engaged in science. The 'Hands-On Inquiry' session was amazing. They now have new ideas to make science fun, like building mini solar panels or experimenting with simple chemistry reactions. Plus, hearing from an engineer in the keynote about how they use science every day made them realize just how important their role is in shaping future innovators. This workshop has renewed their excitement for teaching and given them real tools to connect with their students. To create a training design that stimulates the motivations of science, engineering, and math (STEM) teachers; they must first understand the factors that drive them and the challenges they face. In summary, teachers in these disciplines are often motivated by the desire to inspire students, foster critical thinking, and prepare them for

future careers, but they can also feel bogged down by administrative demands, limited resources, or student disengagement.

> "As a first-year teacher, I've been feeling overwhelmed by classroom management and not sure how to keep students engaged in science. The 'Hands-On Inquiry' session was amazing. I now have new ideas to make science fun, like building mini solar panels or experimenting with simple chemistry reactions."

> "This training design combines inspiration, practical application, and community building to stimulate STEM teachers' passion and drive, ultimately benefiting their students."

2.2 *Training that focuses on STEM integration*

Ten (10) respondents expressed that they enjoy training that focuses on STEM integration because it helps them connect their subjects better. It's always exciting to see how math, science, and engineering fit together in the real world. One workshop they attended focused on teaching students the engineering design process while also incorporating physics and math concepts. It helped them see how to create an interdisciplinary curriculum that's both engaging and informative for their students. That sort of holistic approach really motivates them to continue innovating in their classroom. A well-designed STEM teacher training program that incorporates hands-on learning, real-world application, collaboration, and personalized development can significantly boost motivation. In general, by recognizing the different needs and experiences of STEM teachers, such a program fosters an environment where teachers feel empowered, inspired, and equipped to bring new energy and ideas into their classrooms.

> "I enjoy training that focuses on STEM integration because it helps me connect my subjects better. It's always exciting to see how math, science, and engineering fit together in the real world. It helped me see how to create an interdisciplinary curriculum that's both engaging and informative for my students. "

> "Cross-disciplinary training that shows how science, technology, engineering, and mathematics intersect can increase motivation by helping us understand the power of an integrated curriculum. For example, a professional development session could focus on how to teach the engineering design process using math concepts, or how technology can enhance science experiments in the classroom."

2.3 Personalized Professional Development

Twenty (20) respondents mentioned that they've always found that hands-on activities are what keep their students engaged in math, but they often feel like they don't get enough opportunities to explore new techniques by themselves. They appreciate when training focuses on applying new technology and tools that they can bring back to their classroom. One memorable PD session they attended involved using coding to solve real-world math problems, which helped them see how to make abstract concepts more accessible. It was exciting to learn and really motivating to apply it right away. Designing a training program that stimulates the motivation of science, engineering, and math (STEM) teachers requires an approach that is both engaging and responsive to their professional needs and personal aspirations. In summary, to achieve this, the training design should focus on fostering a growth mindset, providing practical tools, and creating opportunities for teachers to collaborate and innovate in ways that are relevant to their teaching contexts.

> "I've always found that hands-on activities are what keep my students engaged in math, but I often feel like I don't get enough opportunities to explore new techniques myself. I appreciate when training focuses on applying new technology and tools that I can bring back to my classroom."

> "Teachers have varying levels of experience and expertise, and personalized training opportunities can address these differences. Offering flexible pathways within the training program, where we can select areas of focus allows us to feel in control of our learning and ensures that their professional growth aligns with our needs and interests. "

Question No. 3. What specific activities in a training course can make you listen and apply your learnings from it? Elaborate more.

3.1 *Hands-on Experiments and Simulations*

Twenty-seven (27) respondents expressed that from their experience, students truly engage when they can actively experiment. In science, theories can feel abstract, but when students perform hands-on experiments or engage in virtual simulations, the concepts come to life. For example, when teaching physics or chemistry, they find that students apply their learning best when they conduct experiments where they hypothesize, test, observe, and adjust their theories. The process of trial and error gives them deeper insight into how science works in real life, making the learning feel relevant and impactful. These activities give immediate feedback, so students can adjust their understanding on the spot.

> "From my experience, students truly engage when they can actively experiment. In science, theories can feel abstract, but when students perform hands-on experiments or engage in virtual simulations, the concepts come to life."

> "Hands-on activities and simulations require students to think critically and solve problems in a structured yet creative way. In science, this means predicting outcomes and testing hypotheses. In engineering, it involves applying theoretical knowledge to solve design challenges."

3.2 *Collaborative Problem-Solving Sessions*

Twenty-three (23) respondents expressed that in mathematics, abstract concepts can sometimes be challenging for students to grasp, especially when it comes to higher-level topics like calculus or linear algebra. One technique they find effective is conducting collaborative problem-solving sessions, where students work in small groups to tackle complex problems. This promotes active discussion, allows students to explain their reasoning to peers, and offers the opportunity to see different approaches to the same problem. When students explain concepts to each other, they often gain a deeper understanding of the concepts themselves.

> *"In mathematics, abstract concepts can sometimes be challenging for students to grasp, especially when it comes to higher-level topics like calculus or linear algebra. One technique I find effective is conducting collaborative problem-solving sessions, where students work in small groups to tackle complex problems."*

> *"One of the most valuable aspects of collaborative problem-solving sessions is the opportunity for students to teach each other. When students explain a concept to their peers, they are forced to organize and clarify their understanding."*

3.3 Project-Based Learning (PBL)

Twenty (20) respondents expressed that they focus on problem-solving and application of theory to real-world scenarios. In their courses, students are often assigned group projects where they design, build, or troubleshoot something relevant to engineering. Whether it's creating a small prototype or developing a software solution, students apply mathematical models, physics principles, or engineering design processes to solve complex problems. This not only reinforces learning but encourages collaboration and critical thinking. It also makes the theoretical knowledge they gain in class feel more tangible.

> "As an engineering instructor, I focus on problem-solving and application of theory to real-world scenarios. In my courses, students are often assigned group projects where they design, build, or troubleshoot something relevant to engineering."

> "Project-based learning allows students to make direct connections between theory and practice. It encourages critical thinking and innovation. By working on real-world problems, students see the practical value of what they're learning, which makes them more motivated to pay attention and deeply engage with the material."

Research Objectives 2. Characterize training or workshop designs that can contributed to the intellectual progression of science and mathematics teachers

Question No. 1. What can you say about the available training you have in terms of their intellectual enhancement? Elaborate your experience.

1.1 Workshops on Cross-Disciplinary Approaches

Twenty-four (24) respondents expressed that a workshop they attended that focused on cross-disciplinary teaching connecting math and science was one of the most intellectually enriching experiences they've had. By working with teachers from both fields, they learned how mathematical concepts can be applied to scientific inquiry and vice versa. This holistic approach not only enhanced their own understanding but also gave them strategies for teaching their students how these subjects are interconnected. In one session, for example, they explored how mathematical modeling can predict physical phenomena, which was exciting both as a learner and as a teacher. They've since found that their students are more engaged when they see how math and science intersect.

> "A workshop I attended that focused on cross-disciplinary teaching—connecting math and science—was one of the most intellectually enriching experiences I've had. By working with teachers from both fields, I learned how mathematical concepts can be applied to scientific inquiry and vice versa."

> "One of the most intellectually enriching aspects of cross-disciplinary workshops was the opportunity to collaborate with my colleagues from both math and science backgrounds. We worked together to design interdisciplinary lessons that were not only aligned with the standards but also deepened students' understanding of both subjects."

1.2 Integration of Technology and Modern Tools

Fifteen (15) respondents expressed that in their experience, workshops that integrate technology are essential for keeping up with current trends in education. For example, learning how to use interactive simulations in a physics class or mathematical modeling software in algebra was a game changer. These

tools are not just add-ons but are deeply connected to enhancing the conceptual understanding of topics. When they learned to use graphing software in workshops, it made complex mathematical ideas more visual and accessible to their students. It also challenged them to think in new ways about teaching. For instance, now they can instantly generate graphs and visual representations to explain abstract concepts, which significantly deepens their students' comprehension.

> "When I learned to use graphing software in workshops, it made complex mathematical ideas more visual and accessible to my students. It also challenged me to think in new ways about teaching. For instance, now I can instantly generate graphs and visual representations to explain abstract concepts, which significantly deepens my students' comprehension. "
>
> "The ability to visualize these ideas made them more concrete and easier to understand. I can now apply this same approach to my classroom, and I've seen a noticeable increase in student engagement and comprehension."

1.3 Workshops Focused on Pedagogical Strategies and Content Knowledge

Ten (10) respondents expressed that the workshops they've attended that focus on developing both content knowledge and pedagogical strategies have been extremely beneficial. For example, when they learned about inquiry-based learning, they were able to apply the ideas in their own science classroom. The key is having a clear connection between theory and practice. They had the chance to work on lesson plans that were directly tied to the curriculum they teach, which made the concepts easy to implement. Moreover, the training helped them deepen their understanding of core mathematical concepts, which in turn made it easier for them to explain difficult topics to their students. In essence, the feedback highlights that when professional development is rooted in practical, directly applicable strategies, it not only enhances teachers' content knowledge but also transforms how they engage students in learning.

> "The workshops I've attended that focus on developing both content knowledge and pedagogical strategies have been extremely beneficial. For example, when we learned about inquiry-based learning, I was able to apply the ideas in my own science classroom. The key is having a clear connection between theory and practice."
>
> "One of the most impactful experiences was when we were introduced to problem-based learning (PBL), where we were asked to tackle real-world problems using mathematical concepts. This made me realize how important it is for students to see the practical applications of what they are learning."

Question No. 2. What are the characteristics of training designs that contribute to intellectual progression to science, engineering and mathematics teachers? Explain more.

2.1 Focus on Critical Thinking and Inquiry-Based Learning

Thirty-three (33) respondents expressed that training emphasizing critical thinking and inquiry-based learning is incredibly beneficial. When the training design challenges them to approach problems as a researcher formulating hypotheses, testing them, and drawing conclusions it directly enhances my teaching. This way of thinking translates into the classroom, where I can guide students through similar processes, encouraging them to be more curious and investigative. By encouraging students to ask questions and experiment, they can guide them to formulate their own hypotheses, collect data, and analyze results—skills they will use not only in science but in every area of life.

> "I find that training that emphasizes critical thinking and inquiry-based learning is incredibly beneficial. When the training design challenges me to approach problems as a researcher—formulating hypotheses, testing them, and drawing conclusions—it directly enhances my teaching."

> "The inquiry-based approach in training helps me shift away from traditional lecture-based teaching. Instead, it allows me to create student-centered environments where they explore and discover on their own."

2.2 Personalized Learning and Growth

Thirty (30) respondents expressed that one of the things they value most in training is the opportunity for personalized learning. The pace, depth, and content of the training should be flexible enough to accommodate teachers with varying levels of expertise. As someone who has been teaching for several years, they appreciate when they can choose more advanced modules or focus on areas where they feel they need growth. Tailoring the experience makes it feel more valuable. Whether focusing on specialized topics, advanced strategies, or addressing immediate classroom needs, personalized training fosters continuous professional development, enhances teacher confidence, and ultimately benefits student learning outcomes.

> "One of the things I value most in training is the opportunity for personalized learning. The pace, depth, and content of the training should be flexible enough to accommodate teachers with varying levels of expertise."

> "Personalized training can also play a key role in career advancement. I've been able to tailor my professional development toward areas that align with leadership roles I want to take on—like mentoring other teachers or creating curriculum."

2.3 Incorporation of Latest Research and Innovations

Twenty (20) respondents expressed that professional development should always include exposure to the latest research in STEM fields. New materials, techniques, or digital tools are constantly emerging, and it's vital that training stays up-to-date. They've found that when training is informed by the latest trends and innovations, it inspires them to incorporate these new developments into their lessons and make their teaching more relevant to modern practices in STEM industries. By understanding how students best retain information, they can adjust their teaching methods to be more effective. This keeps their approach fresh and aligned with modern educational research.

> "I've found that when training is informed by the latest trends and innovations, it inspires me to incorporate these new developments into my lessons and make my teaching more relevant to modern practices in STEM industries."

> "Incorporating the latest research in my professional development has allowed me to refine my teaching practices. For example, learning about recent studies on active learning strategies or flipped classrooms has helped me rethink how I approach lectures and student engagement."

Question No. 3. How should training be executed in order to address the need for an updated content gap among science and math teachers? Describe comprehensively.

3.1 Content-Specific Knowledge Enhancement

Twenty-six (26) respondents expressed that the biggest challenge they face now is staying current with new scientific discoveries and the technology that supports learning. It would be extremely helpful if training focused on specific updates in the field of science, such as the latest research on climate change, advancements in biotechnology, or the development of new scientific tools. These sessions need to be regularly updated, ensuring that teachers have the most relevant knowledge to bring to the classroom.

> "I've been teaching science for over 15 years, and over the years, the curriculum has changed significantly. The biggest challenge I face now is staying current with new scientific discoveries and the technology that supports learning."

> "One challenge I face is finding current, quality resources for teaching subjects like robotics or coding. These fields are evolving at a rapid pace, and existing textbooks or materials often become outdated very quickly. We need more training on how to identify, evaluate, and use resources that are relevant and up to date."

3.2 Ongoing Support and Reflection

Twenty-five (25) respondents expressed that one-time workshops or training sessions aren't enough. They need sustained support. After attending training, they sometimes struggle to apply what they've learned because they don't have time to reflect on it or discuss it with others. What would be helpful is a follow-up system where they get opportunities to revisit concepts they learned and receive feedback on how they're implementing them. Ongoing access to experts or facilitators who can provide guidance would be essential for their continued growth. In summary, to ensure lasting impact, training should be ongoing, with regular follow-up sessions, peer observations, and opportunities for self-reflection. A system of coaching or support from instructional leaders can also help reinforce what teachers have learned and help them refine their practices over time.

> "One-time workshops or training sessions aren't enough. We need sustained support. After attending training, I sometimes struggle to apply what I've learned because I don't have time to reflect on it or discuss it with others."

> "I've had to adapt to different curricula in different schools, and each time I need to learn new content and strategies quickly. It would be helpful if training could be consistent across schools, so there's a common understanding and approach to teaching core concepts in math and science."

3.3 Pedagogical Strategies for Implementing New Content

Twenty (20) respondents expressed that content is constantly changing, but they find it challenging to integrate new material into their lessons in a way that makes sense for their students. Sometimes, they struggle with how to balance teaching the fundamentals while also including these new concepts. They need training on how to update their teaching strategies and how to make this new content engaging and accessible to a diverse classroom. Ultimately, training should not only focus on content but also on pedagogy on how to adapt and present that content in ways that engage all students, including those with different learning styles and abilities. Teachers should also receive practical strategies for incorporating inquiry-based learning, project-based learning, and technology into lessons, especially for complex subjects like science and math.

"Content is constantly changing, but I find it challenging to integrate new material into my lessons in a way that makes sense for my students. Sometimes, I struggle with how to balance teaching the fundamentals while also including these new concepts."

"My students have different learning needs, and while the content is important, how I teach it matters just as much. I would appreciate training on differentiated instruction techniques and how to adapt the new math and science content for students with learning disabilities."

5. Discussion

A key finding emphasizes the importance of hands-on and experiential training methods in enhancing engagement and practical application[35]. Programs incorporating real-world activities, such as laboratory experiments and interdisciplinary STEM projects, effectively connect theoretical knowledge with actionable skills[36]. These approaches align with Schema Activation Theory, which highlights the significance of linking new information to existing cognitive frameworks. Educators involved in hands-on sessions expressed heightened enthusiasm and a renewed sense of purpose, as they observed the immediate applicability of their knowledge in classroom settings. This insight is particularly valuable in addressing the challenge of fostering student engagement, which often proves elusive[37].

The findings also underscore the necessity of integrating Dual-Process Thinking into the design of training programs. By blending intuitive and analytical approaches, educators are better prepared to handle complex teaching scenarios and cater to diverse student needs[38]. For instance, STEM workshops that combined creative problem-solving with structured analysis enabled participants to develop adaptable and effective instructional strategies. This dual approach enhances educators' ability to encourage critical thinking in their students, an essential competency for navigating the demands of 21st-century education.

The study further highlights the significance of culturally responsive teaching in motivating educators. Training programs that incorporate diverse cultural contexts and relatable scenarios foster a sense of inclusivity and relevance, addressing intrinsic motivational drivers[39]. This aligns with the psychological principles of Habituation and Sensitization, which suggest that novel and meaningful experiences sustain attention and prevent disengagement. The integration of culturally aligned teaching examples demonstrates how motivation can be cultivated through relevance and emotional connection, ultimately inspiring educators to engage more deeply with their professional roles.

In terms of intellectual progression, cross-disciplinary workshops and technology-driven sessions play a transformative role. These programs stimulate intellectual curiosity by introducing innovative tools and collaborative methodologies[40]. For example, training that integrates mathematical models with real-world phenomena illustrates the power of inquiry-based learning in deepening understanding. Such methods also address psychological needs for competence and mastery, as articulated in Self-Determination Theory, by equipping educators with the skills required to adapt to evolving curricular expectations. The theory further underscores how satisfying these needs can drive sustained engagement[41].

The findings also identify a critical gap in the provision of ongoing support and follow-up after training sessions. While initial motivation and engagement are often achieved, maintaining these outcomes necessitates continuous opportunities for reflection, feedback, and refinement. This underscores the importance of reflective practice, a process essential for reinforcing learning and fostering long-term

professional growth. Programs designed to provide structured post-training support can ensure that the benefits of professional development are not only achieved but sustained over time.

6. Conclusion

This study highlights how well-designed training programs improve motivation and intellectual growth among science, engineering, and mathematics educators. Psychological frameworks such as Schema Activation, Dual-Process Theory, and Habituation demonstrate the importance of aligning training with educators' cognitive processes while introducing strategies that enhance engagement and classroom application. Approaches such as hands-on experiments, culturally relevant teaching, and interdisciplinary methods allow teachers to connect theory to practice effectively. Training that incorporates intuitive and analytical thinking prepares educators to adapt to diverse classroom needs and evolving curricular challenges. Cross-disciplinary workshops and technology-focused sessions further support intellectual progression by introducing tools and approaches that encourage collaboration and inquiry-based learning. However, the study emphasizes the need for continuous follow-up and support to reinforce learning and sustain professional development. Based on these findings, we recommend that training programs for STEM educators integrate psychological frameworks into their design, prioritize hands-on and culturally relevant approaches, and include sustained follow-up support to reinforce long-term professional growth.

Conflict of interest

The authors declare no conflict of interest.

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