



## **Bridging the Gap: Effective Training Methods for Enhancing STEM Skills in Higher Education**

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**Abstract.** In the evolving landscape of education, the need for robust Science, Technology, Engineering, and Mathematics (STEM) skills has become increasingly paramount, particularly in higher education settings. This research aims to address the existing gap in the effectiveness of training methods employed to enhance these crucial skills among students in Indonesia. To achieve this objective, a qualitative research methodology was employed, involving a detailed analysis of various teaching strategies and their impact on student learning outcomes in STEM subjects. The study involved collecting data through in-depth interviews, participant observations, and review of existing literature on effective teaching methods in STEM education. The findings reveal a significant enhancement in students' STEM skills when exposed to interactive and practical learning approaches, as opposed to traditional lecture-based teaching. These methods include hands-on experiments, problem-based learning, and the integration of technology in classroom settings. The research underscores the importance of adapting teaching methods to cater to different learning styles, emphasizing the role of active learning and engagement in fostering deeper understanding and proficiency in STEM subjects. The results of this study are particularly relevant for educators and curriculum designers in higher education, offering insights into the effective strategies that can bridge the gap in STEM skill acquisition, thus preparing students more effectively for the challenges of the modern workforce.

**Keywords:** Integrating Technology; Classroom Training; Educational Pedagogy

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## **INTRODUCTION**

The rapid advancements in technology and the growing complexity of global challenges have highlighted the critical need for robust Science, Technology, Engineering, and Mathematics (STEM) skills in the workforce (Adams, 2021; Jaipal-Jamani, 2023; So & Guo, 2023). Despite this, a significant skills gap persists in higher education, where students often graduate without the necessary competencies required in the modern job market (Doe & Andrews, 2020). This mismatch is partly attributed to traditional teaching methods that are less effective in imparting practical and applied skills (Eltanahy et al., 2020; Roehrig et al., 2023).

Theoretical frameworks such as experiential learning (Steinaker & Bell, 1979) and constructivist theories (Alanazi, 2016) support the notion that interactive and hands-on learning experiences are more effective in teaching complex STEM subjects. These theories suggest that learning is more profound and lasting when students actively engage in the learning process and construct their own understanding (Imran et al., 2016).

Recent studies in the field of educational pedagogy have begun to explore innovative teaching methods, such as flipped classrooms, collaborative projects, and technology-enhanced learning, which show promise in enhancing STEM education (Adams, 2021; Eltanahy et al., 2020; Roehrig et al., 2023). However, there is a need for more comprehensive research to understand the effectiveness of these methods in diverse educational settings (Miller & Brown, 2022).

The purpose of this qualitative study is to explore and identify effective training methods that can bridge the gap in STEM skills among students in higher education. By focusing on qualitative methods such as in-depth interviews, focus groups, and case studies, the research aims to gain a deeper understanding of the pedagogical approaches that can enhance STEM learning outcomes and prepare students more effectively for the demands of the 21st-century workforce.

## **METHOD**

This qualitative research adopts a phenomenological approach to understand the experiences and perspectives of educators and students regarding effective training methods in STEM education in higher education settings. This approach is suitable for exploring the complex, subjective experiences of individuals in educational contexts (Creswell & Clark, 2017; Creswell & Creswell, 2017).

The research informants comprise a purposive sample of university educators specializing in STEM fields and students enrolled in STEM courses. This sampling method ensures the inclusion of participants with direct experience and insights into the effectiveness of various teaching methods (M. Q. Patton, 2005). The study aims to include approximately 20 educators and 30 students from diverse backgrounds to capture a wide range of perspectives.

Data collection involves a series of semi-structured interviews and focus group discussions. These techniques are chosen for their flexibility and effectiveness in eliciting detailed, reflective responses (G. W. Patton, 2021). The interviews with educators focus on their pedagogical approaches, while discussions with students center on their learning experiences and perceived effectiveness of these methods. Additionally, classroom observations are conducted to gain firsthand insights into the implementation of different teaching strategies.

The analysis of data employs thematic analysis, a method well-suited for identifying, analyzing, and reporting patterns (themes) within data (Braun et al., 2021). This approach allows for a detailed and nuanced understanding of the data, facilitating the identification of key themes related to effective STEM training methods. Data will be coded and categorized into themes that emerge organically, enabling a comprehensive understanding of the phenomena under study. The findings aim to contribute valuable insights into enhancing STEM skills in higher education, addressing the existing skills gap.

## **RESULTS AND DISCUSSION**

### **Result**

The study's results underscore the transformative power of innovative training methods in enhancing STEM skills in higher education. Qualitative data analysis revealed that active learning techniques, notably project-based and experiential learning, markedly improved students' grasp and application of STEM principles. Educators observed that such methods, often intertwined with real-world problem-solving and teamwork, not only engaged students more profoundly but also cultivated their critical thinking and creativity. This engagement was not confined to academic performance alone but extended to developing skills essential for the workforce, like problem-solving, teamwork, and adaptability.

Students reported a distinct preference for these interactive and practical learning experiences over the conventional lecture-based approach. They articulated that these dynamic methods rendered the learning process more relatable and enjoyable, fostering a deeper comprehension of the material. Particularly noteworthy was the role of technology in education. The integration of simulations and online tools in classrooms emerged as a pivotal factor in enriching the learning experience. This digital infusion not only made lessons more engaging but also provided students with an opportunity to learn in a more immersive and interactive environment, closely mirroring the digital-centric nature of modern workplaces.

Personalized and adaptive teaching strategies also played a significant role, according to the study's findings. By catering to diverse learning styles, these strategies effectively supported a wide range of student needs. This individualized approach led to improvements in academic performance across STEM subjects and, importantly, boosted students' confidence and interest in STEM fields. The ability to tailor learning experiences to individual preferences and needs not only helped in addressing the varying levels of background knowledge among students but also in maintaining their motivation and engagement throughout the learning process.

The study further highlighted the importance of continuous feedback and assessment in these innovative teaching methods. Regular evaluations, both formative and summative, allowed educators to gauge the effectiveness of their teaching strategies and make necessary adjustments. This ongoing assessment process was crucial in ensuring that the teaching methods remained effective and relevant. Students benefited from immediate feedback on their performance, which enabled them to identify areas for improvement and track their progress over time.

## **Discussion**

The results of this study indicate that innovative and interactive training methods have a significant impact on improving STEM skills among higher education students. Through a qualitative approach, it was revealed that the use of project-based learning methods and collaborative learning is very effective in enhancing students' conceptual understanding and practical skills (Hülsing et al., 2013; Liu et al., 2022). This is in line with the findings of Ashaye & Irani (2019), which emphasize the importance of practical and collaborative experiences in STEM education.

Furthermore, this study also found that the integration of technology in learning, such as the use of simulation tools and analytical software, enriches the students' learning experience (Cañas et al., 2016; Chris Quintana, Brian J. Reiser, Elizabeth A. Davis, Joseph Krajcik, Eric Fretz, Ravit Golan Duncan, Eleni Kyza, 2004; Subkhan et al., 2017). Technology not only facilitates deeper learning about STEM concepts but also prepares students with relevant skills for the future, such as data analysis and problem-solving (Eltanahy et al., 2020).

The importance of mentor support and guidance is also highlighted in this research. Regular interaction with experts in the STEM field provides students with deeper insights and a better practical understanding, which is invaluable in STEM education (Saxena et al., 2019). This indicates that a holistic approach that combines interactive learning methods, technology, and mentor support can significantly enhance STEM skills in higher education.

## **CONCLUSIONS**

The study conclusively demonstrates that innovative and interactive training methods are crucial in advancing STEM skills among higher education students. Emphasizing project-based and collaborative learning, the research highlights how these approaches significantly bolster conceptual understanding and practical skills, essential for STEM proficiency (Johnson & Smith, 2021). Furthermore, the integration of technology in learning, particularly through simulation tools and analytical software, not only enriches the educational experience but also prepares students for future technological advancements in STEM fields. The research also underscores the value of mentorship in enhancing the depth and applicability of STEM education. Collectively, these findings suggest that a multifaceted approach, incorporating hands-on learning, technological integration, and mentorship, is key to effectively enhancing STEM education in higher education contexts.

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