



The New Course on STEM Education and Its Implementation: What Did Students Think?

Muhammad Abd Hadi Bunyamin^a, Noorzana Khamis^a, Firmanul Catur Wibowo^b, and Binar Kurnia Prahani^c

Universiti Teknologi Malaysia^a, Universitas Negeri Jakarta, Indonesia^b, Universitas Negeri Surabaya, Indonesia^c
Corresponding Author's Email: mabhadi@utm.my

ABSTRACT

BACKGROUND & CONTEXT

Introducing a new course on Science, Technology, Engineering, and Mathematics (STEM) education for physics education students presents both opportunities and challenges. This course, introduced in 2022, was designed to equip future physics teachers with the mindset and strategies necessary for integrated STEM instruction.

PURPOSE OR GOAL

This study investigates students' perspectives on the implementation of the new course, with particular attention to teaching approaches and assessment practices. Student feedback was sought to inform iterative course refinement.

APPROACH OR METHODOLOGY

Data were collected over two semesters (October 2023–October 2024) from 44 undergraduate physics education students through written reflections. Reflections provided qualitative insights into students' experiences in the course. Data were analysed using open coding.

OUTCOMES

Findings indicate that 85% of students valued the interdisciplinary nature of the course, and 72% highlighted active learning activities such as group projects and discussions as engaging and meaningful. However, concerns were raised in three areas: unclear and inequitable assessment practices (58%), limited hands-on opportunities (43%), and the absence of community engagement components (26%).

CONCLUSIONS

Students' concerns centred less on teaching approaches and more on the fairness and clarity of assessment systems, an outcome not fully anticipated by the instructor. Addressing these concerns requires revised rubrics, structured peer and self-assessment, and expanded formative assessment opportunities.

KEYWORDS

Active learning; STEM education; course assessment.

Introduction

Teaching a new undergraduate Science, Technology, Engineering, and Mathematics (STEM) education course for physics education students offers both stimulation and challenge. University students are often trained within single disciplines, such as pure physics, with limited exposure to interdisciplinary approaches. Introducing this course creates an important opportunity to shape the pedagogical mindset needed for teaching integrated content, especially as schools increasingly emphasize real-world problem-solving and cross-curricular learning (Rodríguez et al., 2024). Future physics teachers must learn to connect scientific principles with engineering design, mathematical reasoning, and technological tools to create engaging lessons. Integrated STEM education supports the application of knowledge across domains and strengthens students' critical thinking and innovation skills (Portillo-Blanco et al., 2025). It also prepares teachers to facilitate inquiry-based, project-driven learning—an approach essential for 21st-century readiness (Wu et al., 2024).

The course is structured around three complementary frameworks. Bybee's STEM integration model highlights disciplinary connectedness and guided the use of real-world, cross-curricular tasks (Bybee, 2013). Kolb's experiential learning cycle informed the sequence of activities, moving students through concrete experience, reflective observation, abstract conceptualization, and active experimentation (Kolb, 1984). The course also reflects Boyer's scholarship of application (Boyer, 1990), emphasizing teaching that applies knowledge to consequential, school-relevant problems and community-oriented tasks with broader educational impact.

Purpose

This study examines students' views of a new STEM education course designed to promote interdisciplinary thinking among future physics teachers. Using active, collaborative learning, the instructor gathered feedback to refine assessment practices. Student-centred evaluations (Flodén, 2017) offer insights for improving alignment, effectiveness, and future course iterations in teacher education.

Methodology

Data were collected over two semesters from October 2023 to October 2024, involving a total of 44 physics education undergraduates. Each student completed the course as part of their degree requirement. Students submitted individual written reflections at the end of each semester. These reflections, ranging between 500–800 words, captured personal experiences, perceptions of teaching and learning approaches, and suggestions for improvement.

The qualitative reflections were analysed using open coding (Strauss and Corbin, 1998). Codes were developed inductively and refined through constant comparison, resulting in five overarching themes: satisfaction with interdisciplinary learning, challenges with assessment, value of active learning strategies, calls for more hands-on activities, and interest in community engagement. Representative quotes were extracted to illustrate findings.

For example, reflections such as *"It is hard to know how my contribution in group projects was graded"* were coded under "assessment fairness," while *"I enjoyed thinking beyond physics and using engineering design"* was coded under "interdisciplinary mindset."

Outcomes

Students expressed several positive perceptions about the STEM education course. A large majority, amounting to 85% of those surveyed, agreed that the course helped them think beyond traditional disciplinary silos. One student, for example, wrote, *"I now see how*

mathematics and engineering design can support physics teaching,” highlighting the value of developing an interdisciplinary mindset. In addition, 72% of students emphasized that group projects and class discussions were particularly motivating and engaging, suggesting that the active learning strategies employed in the course were effective in sustaining their interest. Beyond these aspects, many students also felt that the course was highly relevant to their future careers, noting that it prepared them for teaching in school contexts where real-world problem-solving and integrated approaches are increasingly emphasized.

Despite these positive perceptions, students also raised several concerns and offered constructive suggestions for improvement. The most frequently mentioned issue, noted by 58% of students, related to assessment practices. Many participants expressed dissatisfaction with unclear grading rubrics, the fairness of group evaluations, and the lack of recognition for individual contributions. As one student commented, *“I worked harder than my groupmates, but the group assignment grade was the same.”* These remarks point to a need for clearer and more transparent assessment mechanisms.

Another area of concern, mentioned by 43% of students, was the limited number of hands-on experiences in the course. While the theoretical components were valuable, students indicated a desire for more laboratory work, prototyping sessions, or design-based activities that could deepen their understanding and make the learning more practical and enjoyable.

Finally, 26% of the participants suggested incorporating a community engagement component. They recommended outreach projects with schools or local communities, explaining that such experiences would allow them to apply what they had learned in authentic settings, build confidence, and bridge the gap between theory and practice.

Discussion

The findings of this study show that students strongly valued the interdisciplinary nature of the STEM course while also expressing concerns about assessment and practical application. These results can be understood through the theoretical frameworks guiding the course.

Bybee’s STEM education framework (2013) helps explain students’ positive responses to interdisciplinary learning. Many students (85%) reported seeing physics, mathematics, engineering, and technology as interconnected rather than isolated disciplines, indicating meaningful progress toward integrated STEM thinking and real-world problem-solving—central aims of Bybee’s model.

Kolb’s experiential learning cycle (1984) also illuminates students’ perceptions. Their appreciation for active and collaborative learning reflects movement through the cycle’s four stages: concrete experience, reflective observation, abstract conceptualization, and active experimentation. Group projects and problem-solving tasks contributed to a 72% satisfaction rate, reinforcing the importance of experiential approaches in preparing future teachers for learner-centred practice.

At the same time, concerns about assessment reveal areas for improvement. Students felt that evaluation methods lacked transparency, clear rubrics, and fair recognition of individual contributions. Because assessment supports reflection in Kolb’s cycle, strategies such as peer feedback, individual reflections, and hybrid grading models would strengthen alignment between assessment and learning goals.

Students also requested more hands-on experiences, echoing Bybee’s emphasis on authentic, real-world tasks. While design-based projects were included, additional laboratory activities, prototyping, and STEM kits would provide deeper concrete experiences and help bridge theory and practice.

Finally, suggestions for community outreach or service-learning align with Boyer’s scholarship of application (1990), which calls for teaching and research that address societal needs.

Incorporating school-based or community STEM engagement would deepen relevance, enhance teaching competencies, and expand the course's social impact.

In sum, the course has effectively cultivated interdisciplinary and experiential thinking among physics education students. Strengthening assessment practices, expanding practical activities, and embedding community engagement will further align the course with its guiding frameworks and enhance its educational and societal value.

Conclusion

This study shows that the new STEM education course is shifting physics education students toward more integrated, engaging teaching practices. Students value interdisciplinary learning and experiential activities but call for improved assessment, more hands-on work, and authentic engagement beyond the classroom. Bybee's framework highlights students' growing ability to see STEM domains as interconnected, though assessment and limited lab activities require stronger practical integration. Kolb's experiential cycle supports the need for clearer feedback and expanded practical components. Boyer's scholarship of application reinforces adding community outreach. Strengthening assessment, practical experiences, and community engagement will enhance the course's impact and relevance.

References

- Boyer, E. L. (1990). *Scholarship reconsidered: Priorities of the professoriate*. New Jersey: Princeton University Press.
- Bybee, R. W. (2013). *The case for STEM education: Challenges and opportunities*. Arlington: NSTA Press.
- Flodén, J. (2017). The impact of student feedback on teaching in higher education. *Assessment & Evaluation in Higher Education*, 42(7), 1054-1068. <https://doi.org/10.1080/02602938.2016.1224997>
- Kolb, D. A. (1984). *Experiential learning: Experience as the source of learning and development*. New Jersey: Prentice-Hall.
- Portillo-Blanco, A., Guisasola, J., & Zuza, K. (2025). Integrated STEM education: addressing theoretical ambiguities and practical applications. *Frontiers in Education*. <https://doi.org/10.3389/feduc.2025.1568885>
- Rodríguez, C. M. A., González-Reyes, R. A., Ballen, A. B., Merchán, M. A. M., & Barrera, E. A. L. (2024). Characterization of STEM teacher education programs for disciplinary integration: A systematic review. *Eurasia Journal of Mathematics, Science and Technology Education*, 20(3), em2408. <https://doi.org/10.29333/ejmste/14280>
- Strauss, A., & Corbin, J. (1998). *Basics of qualitative research: Techniques and procedures for developing grounded theory* (2nd ed.). Thousand Oaks: Sage Publications.
- Wu, X., Yang, Y., Zhou, X., Xia, Y., & Liao, H. (2024). A meta-analysis of interdisciplinary teaching abilities among elementary and secondary school STEM teachers. *International Journal of STEM Education*, 11(1), 38. <https://doi.org/10.1186/s40594-024-00500-8>

Acknowledgements

The authors would like to thank Ministry of Higher Education of Malaysia (MOHE) and Universiti Teknologi Malaysia (UTM) for sponsoring the project under Fundamental Research Grant Scheme (FRGS) with the reference code of FRGS/1/2024/SSI09/UTM/02/1 and the cost centre of R.J130000.7801.5F722.

Copyright Statement

Copyright © 2025 Muhammad Abd Hadi Bunyamin, Noorzana Khamis, Firmanul Catur Wibowo, and Binar Kurnia Prahani: The authors assign to the Research in Engineering Education Network (REEN) and educational non-profit institutions a non-exclusive licence to use this document for personal use and in courses of instruction provided that the article is used in full, and this copyright statement is reproduced. The authors also grant a non-exclusive license to REEN to publish this document in full on the World Wide Web (prime sites and mirrors), on portable media and in printed form within the REES and RCEE & RHed 2025 proceedings. Any other usage is prohibited without the express permission of the authors.