

# Challenges in Implementing STEM Education: Overview from Several Countries

Rizki Amalia Sa'adah<sup>1\*</sup>, Slamet Suyanto<sup>1</sup>, Nurul Faizah<sup>1</sup>

<sup>1</sup>Department of Biology Education, Faculty of Mathematics and Natural Sciences, Graduate School, Yogyakarta State University, Yogyakarta, Indonesia.

Received: December 10, 2024

Revised: April 08, 2025

Accepted: June 25, 2025

Published: June 30, 2025

Corresponding Author:

Rizki Amalia Sa'adah

[rizkiamalia.2024@student.uny.ac.id](mailto:rizkiamalia.2024@student.uny.ac.id)

DOI: [10.29303/jppipa.v11i6.9961](https://doi.org/10.29303/jppipa.v11i6.9961)

© 2025 The Authors. This open access article is distributed under a (CC-BY License)



**Abstract:** This study aims to identify various challenges encountered in implementing STEM education, as well as to describe the problems faced by several countries in implementing STEM education. To achieve the objectives of this study, the researcher conducted a literature review related to STEM education and learning, especially by conducting a Systematic Literature Review (SLR) study. This article is an SLR conducted by accessing the Scopus and Google Scholar databases as sources of information. Scopus and Google Scholar database exploration by entering the keywords "challenge" + "STEM education". The search results were exported in \*CSV format (to facilitate the simulation process) and \*RIS for synchronization with Mendeley. The selected articles are in the 2017-2024 period. The results of the study indicate that the challenges faced are mostly intrinsic challenges, namely the difficulty of teachers in managing learning time, as well as the lack of teachers in the STEM field who have adequate certification. Other problems were also encountered, such as the unavailability of supporting facilities for STEM education, and the lack of support from education administrators and stakeholders, which are challenges that must be considered in realizing STEM education.

**Keywords:** Barriers; Implementation challenges; STEM education

## Introduction

As time goes by, demands in the world of education have also changed. Globalization is one of the characteristics of the 21<sup>st</sup> century which is marked by technological advances and eliminating cross-border connectivity. Globalization is one of the phenomena that underlies the development of education throughout the world (Garritzmann & Garritzmann, 2023). Globalization has a crucial impact on educational standards and convergence, curriculum, educational content, and educational skills and educational qualifications. With this phenomenon, the world community is required to improve its capabilities in the field of education.

Technological progress as something that is born from globalization becomes an aspect that can be integrated into educational practices. Integration of technology in education is an important aspect of developing 21<sup>st</sup> century skills (Ali et al., 2019). Implications of 21<sup>st</sup> century skillstowards education is the need for changes in the teaching and learning approach. One of the recommended approaches is STEM (Science, Technology, Engineering, Mathematics). The STEM approach encourages the improvement of 21<sup>st</sup> century skills (Stehle & Peters-Burton, 2019; Widya et al., 2019). STEM education provides students with the experience of being able to integrate interdisciplinary educational approaches and make them a successful generation in all kinds of challenges in the 21<sup>st</sup> century.

## How to Cite:

Sa'adah, R. A., Suyanto, S., & Faizah, N. (2025). Challenges in Implementing STEM Education: Overview from Several Countries. *Jurnal Penelitian Pendidikan IPA*, 11(6), 1-6. <https://doi.org/10.29303/jppipa.v11i6.9961>

STEM (Science, Technology, Engineering, and Mathematics) education is increasingly gaining global attention along with the rapid development of technology and the need for skilled human resources in the fields of science and technology. STEM learning not only involves individual mastery of disciplines, but also emphasizes critical thinking skills, creativity, and collaborative abilities needed to solve real-world problems that are in line with the demands of 21<sup>st</sup> century learning. In the world of education, STEM has proven to be a solution in efforts to improve the quality of students (Ardianti et al., 2020; Le et al., 2023). But unfortunately there are still some problems encountered (Bentley et al., 2022; Terzieva et al., 2024; Barakabitze et al., 2019) to be able to realize effective STEM education. The problems and challenges faced include lack of facilities, differences in gender stereotypes, lack of student interest in STEM learning, and other problems.

In this article we try to identify the challenges faced by several countries in implementing STEM education. Thus, it is hoped that this research can be a reference for other researchers and as a consideration for making improvements in the implementation of STEM in education.

**Method**

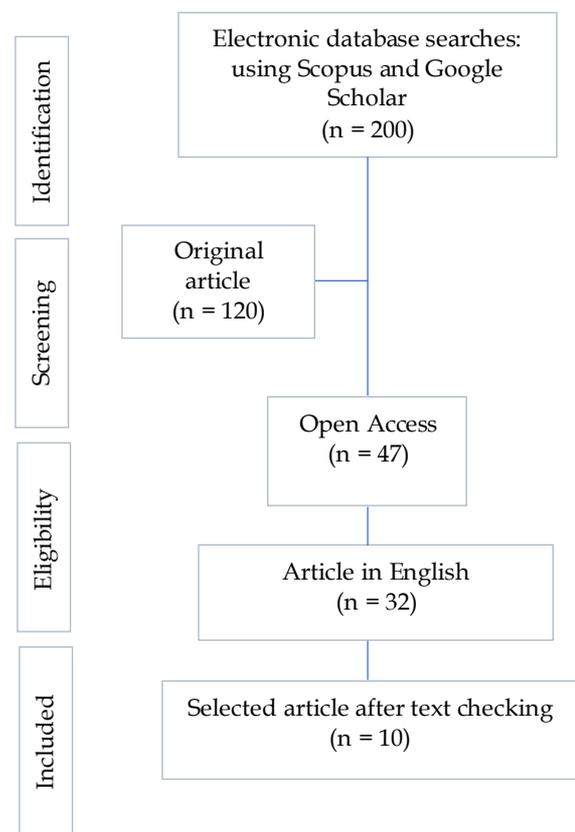
To achieve the objectives of this study, the researcher used a systematic literature review to collect information that was relevant to the topic being studied. A systematic literature review is a method which sets out a series of steps to methodically organize the review (Carrera-Rivera et al., 2022). A systematic literature review was conducted to obtain information related to “challenges in STEM implementation”.

This article is an SLR conducted by accessing the Scopus and Google Scholar databases as sources of information. Scopus and Google Scholar database exploration by entering the keywords "challenge" + "STEM education". The search is exported in \*CSV format (to facilitate the simulation process) and \*RIS for synchronization with Mendeley. The selected articles are in the year range 2017-2024.

This SLR used preferred reporting items for systematic reviews and meta-analysis (PRISMA). The model selecting articles (inclusion and exclusion of articles) so that appropriate articles were obtained. This model consists of four stages, namely identification, screening, eligibility and inclusion (Rethlefsen & Page, 2022). The selection sequence we performed is depicted in Figure 1.

Figure 1 shows that in the initial stage of the search (identification) 200 articles were obtained. In the initial screening stage, we only took original article articles the

number of which was 120, which means the number of excluded articles was 80. We excluded the types of article from book chapter, conference review, and review. Next was the selection of article based on open access and free download status that were openly accessible (open access) and obtained 47 articles, meaning 73 articles were excluded because it only accessible to those who pay a fee or have a subscription. Next, the criteria for article published in English were selected, so there were 32 articles was included and 15 articles were excluded because they were published in Spanish, Bahasa, and Malay. At the eligibility stages we used the 10 selected articles were articles that had been read and understood in their entirety and were concluded as articles that were suitable for analysis in the next stage.



**Figure 1.** Article selection flow with PRISMA model

**Results and Discussion**

After analyzing the collection of articles obtained, the final results of the selection of articles analyzed amounted to 10 articles discussing the challenges in implementing STEM from various countries. A summary of the title, country where the research was conducted and the results of the research are presented in Table 1.

In this study we adapted the grouping of the types of challenges encountered based on Hasanah & Tsutaoka (2019). Some of the challenges encountered are grouped into intrinsic challenges, extrinsic challenges, and institutional challenges.

**Table 1.** Literature about challenges in implementing STEM

Title	Research Location	Results
Context of STEM Integration in Schools: Views from In-service Science Teachers (2017)	Saudi Arabia	Teachers felt underprepared to implement STEM practices, as engineering was the least integrated discipline. Factors such as teacher self-efficacy, pedagogical content knowledge, collaborative school culture, and familiarity with STEM education among educators and school administrators were highlighted as significant factors.
The lack of STEM Vocation and Gender Gap in Secondary Education students (2024)	Spanish	Research shows that students' interest, especially female students, in science and technology subjects is generally low, with a lack of female student engagement.
Challenges to the implementation of STEM education in the Bono East Region of Ghana (2023)	Ghana	Inadequate STEM teaching and learning materials, limited number of certified STEM teachers, lack of STEM-specific infrastructure, inadequate professional development opportunities, lack of documented STEM standards and curriculum, limited access to technology, and limited time to teach STEM-related subjects.
Challenges in Implementing STEM Education: Insights from Novice STEM Teachers in Developing Countries (2023)	Pakistan	Research shows that the gap lies in the lack of educational competency among STEM teachers, poor curriculum, and lack of student engagement. Despite announcing new STEM schools, the Pakistani government has yet to implement the program.
Critical Factors that Contribute to the Implementation of the STEM Education Policy (2020)	Malaysia	The factors influencing the achievement of STEM education policies in Malaysia can be divided into four main factors, namely student factors, school factors, parent factors and administrator factors.
The Movement of Stem Education in Indonesia: Science Teachers' Perspectives (2019)	Indonesia	Research shows that in many ways, the pattern of understanding of STEM education in some areas of Java is higher than in other areas. STEM literacy in Indonesia is still low and needs to be improved to obtain adequate teacher skills in improving student skills in the 21 <sup>st</sup> century.
The Challenges of STEAM Instruction: Lessons from the Field (2019)	United States of America	Difficulties encountered include collaborating with colleagues, managing time constraints and policy issues, integrating course materials across disciplines, and effective assessment. Two other challenges include technology integration and issues related to assessment.
Moving Forward in STEM Education, Challenges and Innovations in Senior High Schools in The Philippines: The Case of Northern Iloilo Polytechnic State College (2019)	Philippines	Lack of time management for teachers to teach in class, limited science textbooks and classrooms, and unavailability of laboratories for practical activities require proper attention from the authorities to improve STEM learning.
Obstacles and Challenges in Implementing STEM Education in High Schools: A Case Study in the Northern Mountains of Vietnam (2023)	Vietnam	Teacher competence, use of time in lesson planning and guiding students to produce STEM products, teacher beliefs about STEM education, inflexible programs, inadequate facilities, exam pressure, lack of recognition and encouragement, teachers who self-fund STEM teaching, student competence, students' cultural, economic, and social backgrounds, and disapproval from students' parents.
Gender differences in high school students' interest in STEM careers: a multi-group comparison based on structural equation model (2023)	China	Male students' interest in STEM careers is significantly higher than female students' interest.

*Intrinsic Challenges*

Intrinsic barriers are the most frequently encountered barriers in the literature we analyzed. Intrinsic barriers are related to teacher personnel, such as teaching quality, educators' personal experience and awareness, attitudes, beliefs, practices or preparation,

and resistance. It can be said that these intrinsic challenges are related to the limitations of teacher pedagogy in implementing the STEM approach in schools. The idea of integrating STEM education into existing pedagogical principles can be daunting for teachers, leading some to believe that they are not ready

to implement STEM-based pedagogy in their classrooms (Thi et al., 2021).

The most frequently found intrinsic problems based on the literature reviewed are related to the limited number of certified STEM teachers and time management by teachers in STEM learning which has not been implemented properly (Bardoe et al., 2023; Aslam et al., 2023; Nugroho et al., 2019; Herro et al., 2019; Tupas & Matsuura, 2019; Thi et al., 2021). Teachers feel they need more time in designing lesson plans and need more time to guide students in completing the STEM products produced. Limited time allocation causes teachers and students to have difficulty in implementing STEM learning which requires more time allocation in completing projects and so on.

Other research also shows that teachers are not ready to implement STEM learning, which is learning that integrates across disciplines (Herro et al., 2019; El-deghaidy et al., 2017). This is in line with the findings of Margot (2019) which revealed that the lack of time management and knowledge regarding STEM disciplines is a challenge and obstacle in implementing STEM. Factors that are considered significant in influencing the implementation of STEM are teacher self-efficacy, pedagogical content knowledge, and habits with STEM education. The STEM approach is also considered a relatively new teaching style so that teachers feel they have less experience in implementing it so that these demands will be difficult to meet.

Another challenge found was that teachers found it difficult to collaborate with colleagues (Herro et al., 2019). As an interdisciplinary science, teachers from various fields of science, technology, engineering and mathematics must be able to collaborate in implementing STEM education. However, problems related to the implementation of collaboration between teachers are obstacles. Problems such as differences in time allocation, differences in students and other problems are still found so that STEM education cannot run as expected.

#### *Extrinsic Challenges*

Extrinsic barriers resulting from inadequate and/or inappropriate configuration of teacher infrastructure such as gender, race, time, access, support, resources, training for educators, and culture. Research shows that interest in science and technology subjects among female students is generally low, with female students lacking engagement. The gender gap in STEM starts early and worsens in adolescence., which is influenced by several factors, including gender stereotypes, perceptions of personal abilities, family and teacher support, lack of role models in STEM, differences between schools and socio-economic and parental

education levels (Hernández-pérez et al., 2024). This finding is also in line with Wang et al. (2023) which revealed that environmental factors can influence male students' interest in STEM careers through the mediating role of self-efficacy, and the perception of STEM careers in female students is influenced by social support and media. There are gender differences in the mediating role of STEM self-efficacy and STEM career perceptions between environmental factors and interest in STEM careers.

Most of the findings revealed that male students are more involved in STEM education compared to female students. The limited availability of STEM jobs is a concern for female students due to the fear of failure which can lead to rejection of more technical fields ((Hernández-pérez et al., 2024). Other findings reveal factors that cause male students to be more involved in STEM activities (Merayo & Ayuso, 2023) namely in the form of family and teacher encouragement. This is related to the choice of future professions where female students prefer health professions and male students choose jobs in engineering and computer science.

Findings on Aidillina et al. (2020) revealed that other external factors that can influence students' tendency to pursue STEM fields are teachers, laboratory infrastructure, and parents. The lack of infrastructure availability was also found in Tupas & Matsuura (2019), Thi et al. (2021), and Barakabitze et al. (2019). The limited availability of science textbooks and classrooms, as well as the unavailability of laboratories for practical activities require proper attention from the authorities to improve STEM learning.

#### *Institutional Challenges*

Institutional barriers, especially to curriculum, policy, technology, and organizational continuity in education. Several problems were found such as inflexible STEM education programs, lack of encouragement and activities that improve teacher competence (Thi et al., 2021). The importance of improving teacher competence as explained in Rajasekaran et al. (2024) which reveals that improving student learning outcomes is highly dependent on an effective learning process. In order to realize the expected competency improvement, a comprehensive strategy-based teacher education program is needed to foster and improve the competencies they possess.

Another challenge was also found in Nugroho et al. (2019) which reveals that STEM education is better understood by teachers in Java. While in terms of creativity, teachers from the eastern region tend to be higher compared to teachers in Java. The article also presents teachers' opinions regarding the role of the government in providing teacher training and

professional development. Most teachers consider that teacher training programs initiated by the government are effective in improving the quality of science teachers in Indonesia. While a small number of others considered that the training program provided was not related to the implementation of daily learning, and the training materials were general. Some teachers also considered that the training provided was not related to the curriculum or specific teaching problems faced by teachers. In addition, the frequency of training was not too often and tended to be done only once.

In this institutional challenge, more attention is paid to the role of the government and stakeholders in providing support to teachers in realizing STEM education as expected. Teacher need support to integrate STEM subjects into the national curriculum, educational trends and school environment.

## Conclusion

The challenges encountered in implementing STEM education include intrinsic challenges, extrinsic challenges, and institutional challenges. Intrinsic barriers related to teacher personnel, for example the quality of teaching, the educator's personal experience and awareness, attitudes, beliefs, practice or preparation, and resistance, are the most faced are difficulties for teachers in managing learning time, as well as the lack of teachers in the STEM field who have adequate certification. The challenge of the lack of supporting facilities for STEM education is an extrinsic challenge that can also hinder the implementation of STEM education. The institutional challenges encountered are the lack of support from stakeholders and education administrators to support teachers in realizing effective STEM education. Thus, stakeholders and education administrators are expected to pay more attention, especially to teachers.

## Acknowledgments

The author would like to express his deepest gratitude to Prof. Dr. Slamet Suyanto, M. Ed. as a lecturer in charge of STEM courses who has provided guidance and direction in writing this article.

## Author Contributions

Conceptualization, R. A. S, S.S, N.F; methodology, R. A. S, and S.S; validation, S.S; resources, R.A.S; writing original draft preparation, R.A.S, and N. F. All authors have read and agreed to published version of the manuscript.

## Funding

This research received no external funding.

## Conflicts of Interest

The authors declare no conflict of interest.

## References

- Aidillina, N., Ramli, M., & Awang, M. (2020). Critical Factors that Contribute to the Implementation of the STEM Education Policy Critical Factors that Contribute to the Implementation of the STEM Education Policy. *International Journal of Academic Research in Business and Social Sciences*, 10(1), 111–125. <https://doi.org/10.6007/IJARBS/v10-i1/6811>
- Ali, N. S., Ali, S. S. N. K., & D'Souza, F. C. R. (2019). Integrating Technology In 21<sup>st</sup> Century Classrooms: Pathways Towards Harmony Through Education. *IOSR Journal of Research & Method in Education (IOSR-JRME)*, 9(6), 64–68. <https://doi.org/10.9790/7388-0906036468>
- Ardianti, S., Sulisworo, D., Pramudya, Y., & Raharjo, W. (2020). The Impact of the Use of STEM Education Approach on the Blended Learning to Improve Student's Critical Thinking Skills. *Universal Journal of Educational Research*, 8(3 B), 24–32. <https://doi.org/10.13189/ujer.2020.081503>
- Aslam, S., Alghamdi, A. A., Abid, N., & Kumar, T. (2023). Challenges in Implementing STEM Education : Insights from Novice STEM Teachers in Developing Countries. *Sustainability*, 15(19), 14455. <https://doi.org/10.3390/su151914455>
- Barakabitze, A. A., Lazaro, A. W.-A., Ainea, N., Mkwizu, M. H., Maziku, H., Matofali, A. X., Iddi, A., & Sanga, C. (2019). Transforming African Education Systems in Science, Technology, Engineering, and Mathematics (STEM) Using ICTs: Challenges and Opportunities. *Education Research International*, 2019. <https://doi.org/10.1155/2019/6946809>
- Bardoe, D., Hayford, D., Bagnmen, R., & Gyabeng, J. (2023). Heliyon Challenges to the Implementation of STEM Education in the Bono East Region of Ghana. *Heliyon*, 9(10), e20416. <https://doi.org/10.1016/j.heliyon.2023.e20416>
- Bentley, B., Sieben, R., & Unsworth, P. (2022). STEM Education in Australia: Impediments and Solutions in Achieving a STEM-Ready Workforce. *Education Sciences*, 12(10). <https://doi.org/10.3390/educsci12100730>
- Carrera-Rivera, A., Ochoa, W., Larrinaga, F., & Lasa, G. (2022). How-to Conduct a Systematic Literature Review: A Quick Guide for Computer Science Research. *MethodsX*, 9, 101895. <https://doi.org/10.1016/j.mex.2022.101895>
- El-deghaidy, H., Mansour, N., Alzaghibi, M., & Alhammad, K. (2017). Context of STEM Integration in Schools: Views from In-Service Science Teachers. *Eurasia Journal of Mathematics, Science and Technology Education*, 8223(6), 2459–2484.

- <https://doi.org/10.12973/eurasia.2017.01235a>  
 Garritzmann, J. L., & Garritzmann, S. (2023). Why Globalization Hardly Affects Education Systems: A Historical Institutional View. In Paola Mattei, and others (eds), *The Oxford Handbook of Education and Globalization*.  
<https://doi.org/10.1093/oxfordhb/9780197570685.013.24>
- Hasanah, U., & Tsutaoka, T. (2019). An Outline of Worldwide Barriers in Science. *Jurnal Pendidikan IPA Indonesia*, 8(2), 193–200.  
<https://doi.org/10.15294/jpii.v8i2.18350>
- Hernández-pérez, M., Alonso-sánchez, J. A., Hernández-castellano, P. M., Quevedo-gutiérrez, E. G., & Paul, K. (2024). The Lack of STEM Vocations and Gender Gap in Secondary Education Students. *Frontiers in Education*, 9, 1–16.  
<https://doi.org/10.3389/educ.2024.1428952>
- Herro, D., Quigley, C., Cian, H., & Herro, D. (2019). The Challenges of STEAM Instruction: Lessons from the Field. *Action in Teacher Education*, 41(2), 172–190.  
<https://doi.org/10.1080/01626620.2018.1551159>
- Le, H. C., Nguyen, V. H., & Nguyen, T. L. (2023). Integrated STEM Approaches and Associated Outcomes of K-12 Student Learning: A Systematic Review. *Education Sciences*, 13(3).  
<https://doi.org/10.3390/educsci13030297>
- Margot, K. C. (2019). Teachers' Perception of STEM Integration and Education: A Systematic Literature Review. *International Journal of STEM Education*, 6(1). <https://doi.org/10.1186/s40594-018-0151-2>
- Merayo, N., & Ayuso, A. (2023). Analysis of Barriers, Supports and Gender Gap in the Choice of STEM Studies in Secondary Education. *International Journal of Technology and Design Education*, 33(4), 1471–1498. <https://doi.org/10.1007/s10798-022-09776-9>
- Nugroho, O. F., Permanasari, A., & Firman, H. (2019). The Movement of STEM Education in Indonesia: Science Teachers' Perspectives. *Jurnal Pendidikan IPA Indonesia*, 8(3).  
<https://doi.org/10.15294/jpii.v8i3.19252>
- Rajasekaran, R., Sreedevi, P. S., & Chang, C-Y. (2024). DECODE-Based STEM Workshop in Improving Academic Resilience and Teaching Competency of Pre-Service Teachers. *Eurasia Journal of Mathematics, Science and Technology Education*, 20(2), em2406.  
<https://doi.org/10.29333/ejmste/14243>
- Rethlefsen, M. L., & Page, M. J. (2022). PRISMA 2020 and PRISMA-S: Common Questions on Tracking Records and the Flow Diagram. *Journal of the Medical Library Association*, 110(2), 253–257.  
<https://doi.org/10.5195/jmla.2022.1449>
- Stehle, S. M., & Peters-Burton, E. E. (2019). Developing Student 21st Century Skills in Selected Exemplary Inclusive STEM High Schools. *International Journal of STEM Education*, 6(1), 1–15.  
<https://doi.org/10.1186/s40594-019-0192-1>
- Terzieva, V., Paunova-Hubenova, E., & Slavcheva, S. (2024). Trends, Challenges, Opportunities, and Innovations in STEM Education. *IFAC-PapersOnLine*, 58(3), 106–111.  
<https://doi.org/10.1016/j.ifacol.2024.07.134>
- Thi, L., Le, B., Thai, T., & Hai, N. (2021). Challenges to STEM Education in Vietnamese High School Contexts. *Heliyon*, 7(October), 1–7.  
<https://doi.org/10.1016/j.heliyon.2021.e08649>
- Tupas, F. P., & Matsuura, T. (2019). Moving Forward in STEM Education, Challenges and Innovations in Senior High School in the Philippines: The Case of Northern Iloilo Polytechnic State College. *Jurnal Pendidikan IPA Indonesia*, 8(3).  
<https://doi.org/10.15294/jpii.v8i3.19707>
- Wang, N., Tan, A. L., Zhou, X., Liu, K., Zeng, F., & Xiang, J. (2023). Gender Differences in High School Students' Interest in STEM Careers: A Multi-Group Comparison Based on Structural Equation Model. *International Journal of STEM Education*, 10(1).  
<https://doi.org/10.1186/s40594-023-00443-6>
- Widya, W., Rifandi, R., & Rahmi, Y. L. (2019). STEM Education to Fulfil the 21st Century Demand: A Literature Review. *Journal of Physics: Conference Series*, 1317(1). <https://doi.org/10.1088/1742-6596/1317/1/012208>