



Integrating STEM and Global Citizenship in Southeast Asia: A Comparative Study of Student Character Values in Elementary Schools

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Abstract

This study aims to analyze and compare the integration of STEM (Science, Technology, Engineering, and Mathematics) education and global citizenship in the development of student character values in elementary schools across Southeast Asia. The research method employed is a descriptive comparative study, involving interviews with 18 informants, including school principals, teachers, and students from elementary schools in Indonesia, the Philippines, and Thailand. The findings indicate differences in student understanding and engagement related to STEM education and global citizenship, as well as its impact on student character values. Schools that successfully integrated both aspects showed significant improvements in student character values. The findings of this research are expected to provide recommendations for the development of educational policies in the Southeast Asian region.

Keywords: STEM education; global citizenship; student character values; elementary education in southeast asia

INTRODUCTION

The integration of STEM (Science, Technology, Engineering, and Mathematics) with global citizenship education is becoming an increasingly important topic in contemporary education, especially in Southeast Asia. Given the evolving global challenges, it is essential for students to possess not only technical skills but also a profound understanding of their social responsibilities. A good character education must include an understanding of the individual's role in the global society and the challenges faced by future generations (Herlina et al., 2024). In this context, it is important to first define what is meant by 'character' and 'values'. Character refers to the moral and behavioral qualities of individuals that determine how they act in social situations, while values are the principles or standards that guide individuals in making decisions and behaviors (Lavy, 2020). This explanation will help distinguish between the two terms and emphasize their importance in character education.

The rapid pace of societal and technological development necessitates an education system that goes beyond academic achievement. Character education, which emphasizes values such as integrity, collaboration, and social responsibility, plays a fundamental role in preparing students to face global issues with a moral and ethical compass (Balontia, 2024). In this context, integrating STEM with global citizenship is not only about enhancing technical competence but

also about cultivating well-rounded individuals who are sensitive to social issues and committed to positive societal change. While previous research highlights the engagement and relevance of interdisciplinary approaches (Mebert et al., 2020), the unique contribution of this study is analyzing how this integration specifically impacts character building at the elementary level, which is often overlooked.

In addition, integrating STEM with global citizenship education creates a more engaging and relevant learning environment for students. A holistic approach to education can increase students' engagement in the learning process and provide them with opportunities to apply knowledge in the real world (Mebert et al., 2020). When students feel engaged, they tend to be more motivated to learn and contribute in a positive way in society. For example, STEM-based projects involving global issues such as climate change or social injustice will give students hands-on experience facing real challenges, while also applying the technical knowledge they learn in class. Such a dynamic learning environment not only enriches their academic learning but also shapes students' characters to be aware of their role in the wider society.

Elementary schools play a critical role in shaping the character values of students, which will influence their future behavior. Instilling strong citizenship values at an early age can provide a solid foundation for the development of responsible individuals. The character values cultivated in elementary schools will carry forward into later life stages and contribute to building a better society (Iksal et al., 2024). Therefore, the implementation of a combination of STEM and global citizenship education at the ministry of education level is a strategic move. Integrating STEM with global citizenship education offers a way to prepare students to face future challenges. STEM skills combined with character education will create individuals who are not only academically intelligent but also possess high social awareness (Tabiin, 2020). In this context, a comprehensive educational approach has the potential to enhance the overall quality of students in Southeast Asia.

Global citizenship education not only equips students with knowledge but also encourages them to engage in positive social actions. Through global citizenship education, students are taught to understand global issues, as well as the impact of their actions in a broader context (Estellés & Fischman, 2021). Thus, students will develop into responsible citizens and contributors to society. With the advancement of innovations in learning, many schools in Southeast Asia have started adopting interdisciplinary approaches to integrate STEM and citizenship. Interdisciplinary approaches enhance student engagement and make learning more relevant to real-world contexts (Mebert et al., 2020). This signifies that this integration has the potential to create a more meaningful learning experience for students.

While the existing literature confirms the potential benefits of STEM and global citizenship integration, there remains a research gap in understanding how this synergy specifically promotes character values in Southeast Asian elementary schools, which face unique cultural and socio-economic contexts. Therefore, this study aims to present a comparative analysis of character development in students exposed to STEM-integrated global citizenship programs across different countries in Southeast Asia, marking a novel contribution to the field. Ultimately, by exploring this connection, this study seeks to provide actionable insights to policymakers and educators for designing curricula that not only boost academic performance but also foster morally grounded, socially responsible citizens. This holistic approach is vital for

preparing future generations who can navigate and address global challenges effectively, ethically, and empathetically.

METHODS

This research aims to analyze and compare how the integration of STEM and global citizenship education influences students' character development in primary schools across Southeast Asia, specifically in Indonesia, the Philippines, and Thailand. Beginning with an extensive literature review, the study examined scholarly sources and policy documents to understand each country's educational landscape, challenges, and frameworks. This process provided a strong contextual foundation, helping to refine the research questions and guiding subsequent data collection steps. To ensure meaningful cross-country comparisons, purposive sampling was used to select teachers and principals with relevant experience, while considering differences in curriculum standards and policies. Controlling for systemic and cultural variances was essential to minimize bias and enhance the study's validity, despite inherent limitations. The researchers acknowledge that cultural, systemic, and socio-economic differences may influence outcomes, and the small sample size may limit the generalizability of the findings, emphasizing the need for cautious interpretation.

Data collection involved semi-structured interviews conducted in participants' native languages, with recordings transcribed and verified for accuracy. The interviews balanced consistency with flexibility, allowing exploration of themes like curriculum integration, teacher training, student engagement, and community involvement. To increase credibility, member checking was employed, giving informants the opportunity to review and confirm their responses. These measures aimed to reduce bias and strengthen the reliability of the qualitative data. While these methods enhanced data reliability, the limitations of a small, context-specific sample highlight the need for larger, more diverse future studies. Overall, the study provides a detailed understanding of how educational systems across these countries approach integrating STEM and global citizenship, offering a strong basis for further comparative analyses.

For data analysis, a comparative descriptive approach was used, systematically coding and categorizing qualitative data into thematic areas. Code maps and matrices helped identify similarities and differences across countries, essential for distinguishing cultural and systemic factors influencing outcomes. Examining these patterns enabled identification of shared challenges and successful strategies while acknowledging contextual nuances. Despite efforts to ensure rigor, potential for cultural bias remains, as interpretative analysis may be influenced by researcher perspectives and unmeasured contextual factors. The small sample size and focus on three countries also limit broader generalizations across Southeast Asia. Nonetheless, the outcomes of this study are expected to offer valuable insights into best practices for integrating STEM and global citizenship education, considering local contexts. Policymakers and educators can use these findings to refine strategies and implement effective character development initiatives. Recognizing these methodological limitations encourages further research with larger samples and broader regional coverage, ultimately strengthening the evidence base and addressing potential biases. Addressing these challenges ensures that the results are meaningful and applicable within the complexities of Southeast Asian educational systems.

RESULT AND DISCUSSION

Result

In the context of this research, the process of coding and grouping informants from the data gathered through interviews, observations, and documentation is crucial for analysis. By grouping informants, researchers can compare and contrast information among different groups or individuals, which helps to better understand the demographic context influencing the informants' perspectives. The demographic aspects considered in this study include name of country, name, position, gender, year of admission, and duration of teaching, which are detailed in Table 1.

Table 1: Informant Data

No.	Name of Country	Name	Position	Gender	Year Entered	Duration of Teaching
1	Indonesia	MYM	Education Staff	Male	2011	11 Years
2		DHP	Principal 1	Female	1997	25 Years
3		MW	Principal 2	Female	2001	21 Years
4		TSI	Teacher	Female	1994	28 Years
5		DS	Teacher	Male	2019	6 Years
6		RK	Teacher	Female	2014	8 Years
7	Philippines	SEN	Education Staff	Female	2011	11 Years
8		SUM	Principal 1	Male	2017	5 Years
9		ZAK	Principal 2	Female	1993	29 Years
10		JAC	Teacher	Female	2014	8 Years
11		MES	Teacher	Male	2011	11 Years
12		GGD	Teacher	Female	2001	21 Years
13	Thailand	PON	Education Staff	Male	2013	9 Years
14		WAN	Principal	Female	2000	17 Years
15		NUT	Teacher	Male	2012	22 Years
16		KHA	Teacher	Female	2018	10 Years
17		RAY	Teacher	Male	2018	4 Years
18		LAY	Teacher	Female	2016	6 Years

During the analysis of interviews, observations, and documentation, key findings emerged on integrating STEM and global citizenship education in elementary schools in Indonesia, the Philippines, and Thailand. Themes were organized to highlight comparative aspects, revealing differences in approaches and their impact on student character values. This comparative study underscores the unique challenges and successes within each educational context. The research findings are summarized in Figure 1.



Figure 1. Schematic Comparative Understanding of STEM and Global Citizenship in South East Asia.

Building on the schematic overview presented in Figure 1, the tables below provide further details breakdown of how each country’s curriculum approaches STEM education.

Table 2. Comparative Understanding of STEM Concept Across Three Countries

Indonesia Merdeka Curriculum	Philippines K-12 Curriculum	Thailand Basic Education Curriculum
The Merdeka Curriculum emphasizes experiential learning, fostering students' understanding of STEM through practical applications. (I- MYM, I- TSI)	The K-12 curriculum incorporates STEM to enhance critical thinking and problem-solving skills through hands-on activities. (F-ZAK)	The Basic Education Curriculum integrates STEM principles in teaching to prepare students for future challenges. (T-PON, T-WAN)

From table 2, it is evident that the three countries Indonesia, the Philippines, and Thailand have different but complementary approaches to understanding the STEM concept. In Indonesia, the Merdeka Curriculum encourages experiential learning, allowing students to grasp STEM concepts through practical applications. Meanwhile, in the Philippines, the K-12 Curriculum emphasizes developing critical thinking and problem-solving skills through hands-on activities that actively engage students. In Thailand, the Basic Education Curriculum integrates STEM principles into teaching with the aim of preparing students to face future challenges. In other words, while their methods and focuses differ, all three countries are striving to enhance STEM understanding among students to better prepare for a brighter future.

Table 3. Comparative Awareness of Global Citizenship and Responsibilities Across Three Countries

Indonesia Merdeka Curriculum	Philippines K-12 Curriculum	Thailand Basic Education Curriculum
The curriculum encourages students to develop a sense of global citizenship and understand their responsibilities	The K-12 curriculum integrates global citizenship concepts across subjects, focusing on social responsibility and cultural understanding. (F-JAC, F-GGD)	Schools promote global citizenship through community projects and environmental awareness activities. (T-NUT)

towards their community and environment. (I-RK)

The findings (see table 3) indicate that the three countries Indonesia, the Philippines, and Thailand have different approaches to fostering awareness of global citizenship and social responsibility. In Indonesia, the Merdeka Curriculum encourages students to develop a sense of global citizenship and understand their responsibilities toward their community and environment. Meanwhile, in the Philippines, the K-12 Curriculum integrates global citizenship concepts across various subjects, emphasizing social responsibility and cultural understanding. In Thailand, schools promote global citizenship through community projects and environmental awareness activities. Overall, while each approach is distinct, all three countries demonstrate a strong commitment to educating students to become responsible global citizens.

Table 4. Comparative Engagement in STEM-related projects Across Three Countries

Indonesia Merdeka Curriculum	Philippines K-12 Curriculum	Thailand Basic Education Curriculum
Students are encouraged to participate in community projects that involve STEM concepts, promoting practical application and awareness. (I-DHP)	K-12 emphasizes project-based learning, allowing students to engage in STEM-related community initiatives to analyze real-life problems. (F-SUM)	Students participate in STEM clubs and workshops that enhance their project-based learning experiences. (T-KHA)

From the findings in table 4, it is clear that the three countries Indonesia, the Philippines, and Thailand have different strategies for encouraging student engagement in STEM-related projects. In Indonesia, the Merdeka Curriculum encourages students to participate in community projects that involve STEM concepts, enabling them to apply their knowledge practically and increase their awareness. In the Philippines, the K-12 Curriculum emphasizes project-based learning, allowing students to engage in STEM-related community initiatives to analyze real-world problems. Meanwhile, in Thailand, students actively participate in STEM clubs and workshops that enhance their project-based learning experiences. Thus, although their approaches differ, all three countries are working to improve student involvement in STEM projects for the development of their skills and knowledge.

Table 5. Comparative Familiarity with Issues of Global Significance Across Three Countries

Indonesia Merdeka Curriculum	Philippines K-12 Curriculum	Thailand Basic Education Curriculum
Students are exposed to global issues such as climate change and social justice, fostering discussions and awareness in classrooms. (I-MW)	The K-12 curriculum addresses global issues through integrated learning, promoting discussions that connect local and global contexts. (F-MES)	The curriculum includes topics on sustainability and cultural diversity to raise students' awareness of global issues. (T-RAY)

The findings in table 5, indicate that the three countries Indonesia, the Philippines, and Thailand have different yet complementary approaches to introducing global issues to students. In Indonesia, the Merdeka Curriculum equips students with an understanding of global issues such as climate change and social justice, fostering discussions and awareness in the classroom. Meanwhile, in the Philippines, the K-12 Curriculum addresses global issues through integrated learning, promoting discussions that connect local and global contexts. In Thailand, the curriculum includes topics on sustainability and cultural diversity to raise students' awareness of

global issues. Overall, although their methods and focuses differ, all three countries demonstrate a commitment to educating students to be more sensitive to issues that have significant global impacts.

Table 6. Comparative Ability to Make Connections Between Stem and Global Issues Across Three Countries

Indonesia Merdeka Curriculum	Philippines K-12 Curriculum	Thailand Basic Education Curriculum
The curriculum encourages students to see the interconnectedness of STEM with global challenges, like environmental sustainability. (I-DS, I-RK)	Students learn to connect STEM disciplines to global challenges, providing a comprehensive understanding of their impact. (F-JAC)	The Basic Education curriculum encourages students to relate STEM knowledge to real-world global challenges. awareness of global issues. (T-NUT)

The findings in table 6, indicate that the three countries Indonesia, the Philippines, and Thailand have different approaches to encouraging students to make connections between STEM and global issues. In Indonesia, the Merdeka Curriculum encourages students to understand the interconnectedness of STEM with global challenges, such as environmental sustainability. In the Philippines, the K-12 Curriculum teaches students to link STEM disciplines to global challenges, providing a comprehensive understanding of their impacts. Meanwhile, in Thailand, the Basic Education Curriculum encourages students to relate STEM knowledge to real-world global challenges, thereby increasing their awareness of these issues. Thus, while their approaches differ, all three countries strive to enhance students' understanding of the relevance of STEM in the context of global challenges.

Table 7. Comparative Participation in Community Services Related to Both Fields Across Three Countries

Indonesia Merdeka Curriculum	Philippines K-12 Curriculum	Thailand Basic Education Curriculum
The Merdeka Curriculum encourages community service that aligns with STEM and global citizenship principles, enhancing character development. (I-MYM)	K-12 requires community service projects that blend academic skills with social awareness, emphasizing real-world implications. (F-JAC, F-MES)	Schools engage students in community service activities that incorporate STEM projects and global citizenship. (T-NUT, T-PON)

The findings in table 7, indicate that the three countries Indonesia, the Philippines, and Thailand have unique approaches to encouraging student participation in community service related to STEM and global citizenship. In Indonesia, the Merdeka Curriculum promotes community service that aligns with STEM and global citizenship principles, enhancing students' character development. Meanwhile, in the Philippines, the K-12 Curriculum requires community service projects that blend academic skills with social awareness, emphasizing real-world implications. In Thailand, schools engage students in community service activities that incorporate STEM projects and global citizenship. Thus, while their methods and focuses differ, all three countries strive to develop students to be not only academically intelligent but also socially aware and caring about their communities and the environment.

DISCUSSION

Understanding of STEM concepts

Understanding the concepts of STEM among students is crucial for successfully integrating STEM education with global citizenship. In Indonesia, teachers revealed a predominant interest amongst students in STEM learning, especially when they are engaged in practical, hands-on activities (I-MYM/Education Office). This aligns with existing literature, which suggests that experiential learning significantly enhances students' grasp of STEM concepts (Thahir et al., 2020). Emphasize that experiential learning leads to deeper understanding as students interact directly with content. Thus, the findings of this research highlight the critical role of practical engagement in fostering student interest, filling a gap identified in past studies that often overlooked the effects of hands-on experiences in STEM education. In the Philippines, interview responses corroborate this notion, as teachers shared insights on the effectiveness of project-based learning methods in enhancing students' understanding of STEM concepts. F-ZAK (Principal 2) articulated, "When students are involved in environmental projects that utilize science and technology, they not only learn about theory but also how to apply it in real-life situations." This observation resonates with findings from AlAli (2024), who noted that project-based learning fosters critical thinking and problem-solving skills crucial for comprehensive STEM understanding. By embedding real-world applications into the curriculum, students can make meaningful connections between theoretical knowledge and practical use, thereby reinforcing their understanding. This combination of practical engagement and collaborative problem-solving underlines the innovative nature of this research, distinguishing it from previous studies that primarily focused on theoretical frameworks without practical application.

Conversely, data from interviews in Thailand indicated that while students possess a reasonable understanding of STEM principles, they often lack active participation in related activities. T-PON (Education Office) acknowledged this gap, stating, "There is a need to encourage students to be more actively involved in STEM activities because this can deepen their understanding." The limited active participation reflects findings from Dzaiy & Abdullah (2024), who argue that student engagement is crucial for mastering complex STEM concepts. This suggests that even when foundational knowledge exists, the absence of robust participatory methodologies can hinder comprehensive understanding. Addressing this deficiency is vital; thus, educational institutions must create environments that promote active involvement through inquiry-based and student-centered learning (Brand, 2020).

Overall, the interviews provide a clear picture of how students' understanding of STEM is significantly influenced by the teaching methods employed and the relevant experiences they acquire. As Takeuchi et al. (2020) suggest, STEM education should incorporate frameworks that recognize the social dimensions of learning, engaging students as active agents in their educational processes. Therefore, efforts to strengthen the understanding of STEM in elementary schools must encompass comprehensive teacher training programs and increasingly interactive teaching strategies (Heilporn et al., 2021). In conclusion, the findings of this research fill an important gap in the literature by emphasizing the necessity of experiential and contextual learning in STEM education, highlighting the multifaceted approach needed to truly engage students and enhance their understanding of these crucial concepts.

Awareness of global citizenship responsibilities

Awareness of global citizenship responsibilities among students is a crucial aspect of education that integrates STEM with social awareness. The interviews conducted with teachers in Indonesia revealed that many students feel engaged with both local and global issues impacting their communities. I-ARK (Teacher) explained, "Global citizenship education is essential in helping students understand their roles in a broader society." This statement aligns with findings from Zainuddin (2023), who emphasized that engaging students in discussions about global responsibilities can significantly bolster their awareness and understanding. The novelty of this research lies in its specific focus on how integrating global citizenship with STEM education can create a more comprehensive educational experience, thus filling the gap identified in previous studies that have often treated these subjects in isolation. In the Philippines, teachers are actively striving to instill global citizenship values through diverse classroom activities. F-MIC (Teacher) conveyed, "We need to teach students to view themselves as part of the global community and understand the impact of their actions." Who assert that global citizenship frameworks promote positive contributions to critical issues such as environmental sustainability and social justice (Guo-Brennan & Guo-Brennan, 2020). By incorporating discussions on these topics into their curriculum, educators not only enhance students' understanding of their social responsibilities but also encourage them to think critically about their role within a global context. The emphasis on real-world application is an essential extension of earlier research by Casmana et al. (2023), which suggested that fostering awareness of global citizenship can lead to increased empathetic engagement among students, making this study a significant contribution to the ongoing discourse.

Students in Thailand similarly exhibit an understanding of global citizenship responsibilities, albeit facing distinctive challenges in fully grasping these concepts. T-PON (Education Office) noted that "while we have seen increased student interest in global issues, there is still room to deepen their understanding." This observation is supported by Ainscow (2020), who argues that fostering ongoing dialogue about global responsibilities among students is vital for equipping them to respond effectively to contemporary challenges. Moreover, integrating project-based learning can serve as a potent vehicle for enhancing this understanding, as it provides practical contexts for students to engage with global issues directly (Chankseliani et al., 2021). Previous research by Roca et al. (2022) supports this finding, indicating that applied learning experiences significantly improve students' comprehension of global challenges.

From the interviews, it is clear that students place a high value on their involvement in social projects related to global issues. I-DIT (Teacher) shared, "Students feel more connected and responsible after participating in projects focused on community needs." This feedback aligns with findings from Afzal & Hussain (2020), who suggest that real-life experiences in community projects significantly enhance students' awareness of their social responsibilities. The active participation in service-learning initiatives facilitates a deeper understanding of their roles as global citizens and encourages a sense of ownership over their contributions to societal improvement.

Engagement in STEM-related projects

Engagement in STEM-related projects is critical for enhancing students' understanding and application of STEM concepts while simultaneously fostering character development. Interview results reveal that students in Indonesia actively participate in community-based STEM projects, which allow them to apply their knowledge in real-world situations. I-MYM (Education Office) stated, "Hands-on projects enable students to see the relevance of STEM in their daily lives and motivate them to learn more." This illustrates the effectiveness of practical engagement in improving students' comprehension and interest in STEM fields. In the Philippines, schools employ project-based learning as a central component of their curriculum, emphasizing the importance of collaboration and problem-solving. F-MIC (Teacher) mentioned, "Working together on STEM-related projects not only enhances their understanding of scientific concepts but also builds teamwork skills that are crucial in today's world." Collaboration in STEM projects cultivates critical thinking and social skills, essential for students' future success (Thornhill-Miller et al., 2023). This concurs with findings that highlight increased student engagement through collaborative efforts. Thai schools have also adopted similar practices, where STEM-related projects are used to encourage active learning. T-PON (Education Office) observed, "Students are more enthusiastic and motivated when they can participate in projects that address real-life challenges in their communities." Real-life problems provide contexts where students can apply their STEM skills, leading to deeper learning and engagement (Dare et al., 2021). Such projects not only enhance understanding but also encourage civic responsibility among students.

Despite the successes, challenges remain in fully engaging students in STEM-related projects, particularly in rural areas where resources may be limited. I-DS (Teacher) pointed out, "Access to materials and technology can hinder the implementation of effective STEM projects in less privileged schools." Equitable access to STEM resources is essential for ensuring that all students can benefit from engaging projects (Wilson, 2021). This highlights the need for targeted support and investment in resources to help facilitate rural schools' engagement in STEM initiatives. This highlights the need for targeted support and investment in resources to help facilitate rural schools' engagement in STEM initiatives. By creating partnerships between the government, private sector, and communities, we can enhance the provision of the necessary resources (Falloon et al., 2020). All these steps are expected to address the existing gaps and build a better future for students in remote areas.

Familiarity with issues of global significance

Familiarity with issues of global significance is crucial for students as it enhances their understanding of the interconnectedness of local actions and global outcomes. In Indonesia, interviews with teachers revealed that students are often introduced to topics such as climate change and social justice through integrated lessons. I-DHP (Principal 1) stated, "Highlighting global issues in our curriculum enables students to recognize their role in addressing these challenges." This aligns with findings from (Acharya, 2021) that emphasize the importance of contextual education in fostering a global perspective among students. In the Philippines, educators have reported that the K-12 curriculum effectively incorporates discussions about global issues into various subjects. F-SUM (Principal 1) shared, "We stress the importance of understanding global challenges to prepare students as responsible citizens." Addressing significant global issues related to education not only enhances students' awareness but also

motivates them to engage in problem-solving activities (Asigigan & Samur, 2021). This shows that increasing familiarity with global issues can lead to a more proactive approach among students. In Thailand, the integration of global issues into the Basic Education Curriculum has also proven effective. T-PON (Education Office) noted, "Students become more engaged when they learn about global challenges and are encouraged to propose their solutions." Linking educational content to global significance fosters critical thinking and problem-solving skills among students (Xu et al., 2023). This perspective indicates that familiarity with global issues can have a profound impact on developing essential life skills. Despite these advancements, some students still struggle to grasp the complexity of global issues due to varying levels of exposure and resources. I-RK (Teacher) pointed out, "In rural areas, students may not have as much access to information about global issues, which limits their understanding." Equitable access to quality education and information is essential for all students to engage in global citizenship effectively (Rivera & Garden, 2021). This challenge underscores the need for targeted educational initiatives that enhance resource access for all students.

This study brings several strengths to the existing literature concerning education and global citizenship. One of the primary strengths is its qualitative approach, allowing for a nuanced exploration of educators' and students' perspectives on global issues across different countries (Jones, 2023). The inclusion of diverse geographical contexts Indonesia, the Philippines, and Thailand fosters a richer understanding of how local educational practices shape global awareness. By focusing on the voices of various stakeholders, this research contributes valuable insights into the challenges and successes faced in integrating global citizenship into STEM education.

Ability to make connections between STEM and global issues

The ability to make connections between STEM (Science, Technology, Engineering, and Mathematics) and global issues is essential for students as it fosters an understanding of how their learning can impact real-world challenges. In Indonesia, interviews with teachers showed that many students are encouraged to relate STEM concepts to pressing global issues such as climate change and public health. I-RK (Teacher) mentioned, "When students can see the relevance of STEM to global challenges, it enhances their motivation to learn and apply those concepts." Connecting academic knowledge to global issues helps students understand their role in contributing solutions (Irkinovich, 2022). Similarly, in the Philippines, the K-12 curriculum emphasizes the interrelatedness of STEM and global challenges. F-ZAK (Principal 2) shared, "We incorporate discussions about environmental sustainability into our science lessons, prompting students to think critically about their actions." Education should not exist in a vacuum; it needs to engage students with real-world problems to remain relevant (Maroungkas et al., 2023). By integrating such discussions, students become more adept at recognizing how their STEM education applies to significant global issues. In Thailand, educators have also recognized the importance of making these connections clear. T-PON (Education Office) noted, "When we teach students about engineering principles, we also discuss their applications in addressing global challenges like water scarcity." Creating meaningful connections between STEM subjects and global issues is essential for equipping students with the skills necessary for future challenges (Dare et al., 2021). This approach not only enhances students' understanding of STEM but also reinforces their awareness of global responsibilities.

However, students still experience challenges in drawing connections between STEM and global issues due to varying levels of exposure and prior knowledge. I-MYM (Education Office) stated, "Many students struggle to see the relevance of what they learn in science classes to global challenges." Teachers play a crucial role in facilitating discussions that help students bridge the gap between academic content and the real world (Amerstorfer & Münster-Kistner, 2021). This highlights the need for educators to actively provide opportunities for students to explore these connections. In addition to critical thinking, fostering collaboration among students is crucial for making these connections effective. Schools in the Philippines have implemented group projects where students work together to tackle global challenges using STEM solutions (Sweet & Michaelsen, 2023). F-MES (Teacher) commented, "Collaborative projects allow students to share diverse perspectives and ideas, enriching their understanding of global issues." Teamwork within STEM contexts promotes interpersonal skills and reinforces the importance of collective efforts to solve pressing global problems (Sachmpazidi et al., 2021). This not only prepares students to work in team settings in the future but also emphasizes the role of cooperation in addressing global challenges.

Participation in community services related to both fields

Participation in community services related to both STEM and global citizenship is an essential aspect of fostering student character values. Students engaged in community service projects gain practical experience that connects their classroom learning with real-world applications. In Indonesia, I-MYM (Education Office) remarked, "Community service projects allow students to use their STEM knowledge to address local issues, enhancing their sense of responsibility." This statement underscores the importance of experiential learning in developing character and citizenship. In the Philippines, community engagement is heavily emphasized within the K-12 curriculum, which encourages students to participate in service-learning initiatives. F-SUM (Principal 1) noted, "These initiatives not only benefit the community but also instill values of empathy and cooperation in students." Service-learning provides an avenue for students to contribute to society while developing a sense of belonging and commitment to their communities (Tripon, 2024). This demonstrates the dual benefit of such projects for both students and the communities they serve. In Thailand, the Basic Education Curriculum integrates community service as a fundamental component of character development. T-PON (Education Office) explained, "Involving students in community service helps them understand their role in society and the global challenges that affect their community." Community service projects empower students to apply their STEM skills to solve real-life problems, creating a more profound impact (Huang et al., 2022). This highlights the significant connection between applying STEM knowledge and fulfilling social responsibilities.

Despite the benefits, challenges exist in facilitating student participation in community services. I-RK (Teacher) pointed out, "Schools often face logistical barriers and require additional resources to coordinate service projects effectively." Overcoming these barriers is crucial for maximizing student involvement in community service activities (Boenigk et al., 2021). Thus, addressing these challenges can lead to greater student involvement and enhance the overall impact of community service. Furthermore, the integration of global citizenship into community service initiatives fosters a broader understanding among students. I-TSI (Teacher) stated, "When students engage in global issues through community projects, they enhance their awareness of cultural diversity and social justice." Participating in community services linked to global

citizenship helps students see the relevance of their actions in a wider context (Coelho & Menezes, 2021). This connection reinforces the role of education in preparing students to become active global citizens.

This study provides important insights into the integration of STEM education and global citizenship across Indonesia, the Philippines, and Thailand, leveraging a qualitative approach that captures diverse perspectives from teachers, students, and officials. Including a range of geographical and cultural contexts enhances the richness of the findings, shedding light on how different communities incorporate global challenges into STEM curricula. However, the small sample size of 18 informants limits the generalizability of the results, and focusing solely on specific urban and rural areas restricts the applicability of findings to broader educational settings. The reliance on self-reported data also introduces potential bias, as participants might tailor their responses to what they believe is socially desirable. Future research with larger, more diverse samples and mixed methods, including quantitative surveys, is recommended to strengthen the robustness and applicability of the findings. Even with these limitations, this research underscores the urgent need for educational reform to integrate STEM with global citizenship, preparing students to be responsible global citizens in a complex, interconnected world (Sharma, 2023; Pradana et al., 2020). Policymakers and educators should focus on developing curricula that highlight global challenges and support real-world applications to foster civic responsibility and technical skills. Incorporating community service and project-based learning tied to local and global issues can produce engaged, thoughtful citizens capable of addressing both local and global challenges (Tuhuteru, 2023; Morley & Jamil, 2021). These integrated approaches are essential for developing a new generation of learners ready to meet global challenges responsibly, with future studies needed to evaluate long-term impacts and the systems that sustain such practices.

CONCLUSION

This comparative study highlights the critical importance of integrating STEM education and global citizenship in shaping the character values of elementary school students in Southeast Asia. The findings reveal that students engaged in STEM-related projects linked to global citizenship develop a deeper sense of responsibility toward their communities and the wider world. Notably, the Philippines and Thailand demonstrate more progressive approaches than Indonesia, with greater student engagement and understanding. These differences can be attributed to factors like teacher training, resources, and curricular frameworks adopted by each country. As highlighted by teachers and educational leaders, addressing these challenges is crucial for promoting a more equitable and effective educational landscape. Looking ahead, continued investment in teacher training, curriculum development, and resources is essential for successful implementation. By adopting innovative teaching practices and fostering community involvement, educators can cultivate future generations who are academically capable and committed to positive societal contributions. This study highlights the potential of integrating STEM and global citizenship education as a foundation for developing responsible, informed citizens in the region.

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