CHAPTER V
CONCLUSION

This study aimed to investigate and compare the teaching beliefs of STEM teachers in Indonesia and Taiwan. Through a mixed-methods approach, including questionnaires, lesson plan analysis, and teacher interviews, valuable insights were gained into their perspectives and practices.

In Indonesia, a majority of teachers indicated that their schools' instructional practices aligned closely with the Project-based approach, emphasizing interdisciplinary tasks. Some teachers mentioned implementing the STEM Quartet as an alternative teaching approach. In Taiwan, teachers selected the Synchronized approach, which focused on explicit cross-curricular connections, reflecting the instructional practices in their schools. A majority of teachers in both Indonesia and Taiwan have a strong preference for adopting the Project-based approach in their classrooms without any constraints. This indicates a growing inclination among teachers in both countries to prioritize discipline integration for enhanced student learning experiences. In Indonesia, teachers had chosen the Project-based approach for STEM instruction to integrate knowledge, engage students actively, assess comprehensively, develop critical thinking and creativity, and prepare students for real-world challenges. In Taiwan, teachers had adopted the Synchronized approach due to the exam-oriented education system, which emphasizes structure, well-defined learning objectives, and parallel instruction of shared skills and knowledge.

The findings revealed that both Indonesian and Taiwanese teachers prioritize the development of 21st-century skills, with a focus on technological and scientific literacy. However, there were slight variations, as Indonesian teachers placed relatively less emphasis on mathematical literacy than their Taiwanese counterparts. Differences were also observed in interdisciplinary problem-solving, with Indonesian teachers emphasizing logical thinking and reflection, while Taiwanese teachers highlighted logical thinking but rated prediction and analysis as less significant.

Regarding implementing STEM learning, Indonesian teachers showed high self-efficacy in explaining learning objectives and facilitating student understanding but expressed lower confidence in creating well-structured learning contexts. Taiwanese teachers lacked confidence in analyzing student learning outcomes. Both groups expressed commitment to implementing STEM teaching activities, but Indonesian teachers displayed the lowest commitment to the profession, while Taiwanese teachers demonstrated the lowest sense of responsibility.

When designing STEM learning experiences, Indonesian teachers showed high confidence in designing effective activities but had the lowest agreement in constructing alternative activities tailored to students' needs. Taiwanese teachers exhibited higher self-efficacy in designing STEM activities but scored lowest in confidence regarding assessment creation. Both groups committed to designing STEM teaching activities but needed a stronger professional identity and sense of responsibility.

As disseminators of STEM learning, Indonesian teachers felt most confident explaining how STEM activities support student learning, while Taiwanese teachers exhibited higher confidence in discussing STEM activities and design concepts. Indonesian teachers were highly committed to disseminating STEM learning, driven by their desire to become professionals in STEM education, but required more support and recognition. Taiwanese teachers highly valued sharing STEM teaching activities but expressed low commitment to their professional obligations.

The t-test analysis revealed significant differences between Indonesian and Taiwanese teachers in their STEM teaching beliefs, self-efficacy, and commitment to various aspects of STEM education. Indonesian teachers emphasized 21st-century skills, STEM literacy, and interdisciplinary problem-solving more than Taiwanese teachers. Indonesian teachers also demonstrated higher self-efficacy and commitment to implementing, designing, and disseminating STEM education.

Indonesian lesson plans included engagement and career choice with multidisciplinary integration, while Taiwanese lesson plans predominantly adopted transdisciplinary integration and consistently included interdisciplinary problem-solving. Indonesian lesson plans dominantly used Project-based Learning and Taiwanese lesson plans dominantly used Inquiry-based Learning.

Teachers' perception of STEM education, including their definition of STEM, factors that motivate them to implement STEM, and their perception of curriculum support, along with their beliefs and understanding of STEM abilities development, play a vital role in providing quality STEM education and integrating STEM into teaching practices. Both Taiwanese and Indonesian teachers perceive STEM as focusing on problem-solving and subject integration. An interesting aspect that emerged was the frequent mention of authentic practices by Indonesian teachers. Indonesian and Taiwanese teachers are driven to adopt STEM instruction by a sense of purpose and curiosity. Personal interest in STEM education was noted as an additional incentive by Taiwanese teachers, while some in Taiwan cited governmental mandates as a reason for promoting STEM instruction. Collaboration was also mentioned as a reason for introducing STEM instruction by some Taiwanese teachers. Both groups of teachers mention the importance of support in terms of clear and comprehensive standards, as well as flexible content and time allocation. Interestingly, Indonesian teachers emphasized the curriculum support of providing recommended teaching methods and assessment strategies.

Teachers' instructional knowledge of STEM encompasses understanding students, selecting appropriate teaching approaches and media, and employing effective assessment methods. Taiwanese teachers prioritize the planning, building, and testing phases of the engineering design process, in addition to questioning. Indonesian teachers design STEM activities that involve questioning, detecting difficulties, designing, building, and testing. Taiwanese teachers mostly utilize digital media and traditional teaching methods to support their STEM teachings, while Indonesian teachers generally cite the use of natural and recycled materials in their STEM teaching and learning activities. In terms of assessments, Taiwanese teachers use formative, summative, and self-assessments in their STEM teachings, whereas Indonesian teachers primarily use formative and summative assessments.

STEM teacher readiness encompasses a teacher's preparedness and willingness to integrate STEM activities into their teaching practices, with self-efficacy and commitment being crucial factors influencing their readiness. Examining teachers' understanding of professionalism in STEM education provides valuable insights into their self-efficacy as STEM educators, which can be influenced by factors such as educational background, training, and experience. Taiwanese teachers perceive professionals in STEM education as individuals who possess pedagogical and content knowledge, demonstrate enthusiasm in their work, are willing to learn, and excel in communication and collaboration skills. Indonesian teachers perceive professionals in STEM learning as individuals who possess pedagogical and content knowledge, are willing to learn, and demonstrate creativity. Taiwanese teachers plan for their professional development by participating in formal and informal training and engaging in self-reflection. Indonesian teachers plan for their personal professional development by participating in formal professional development, collaborating with colleagues, and staying up-to-date with the latest research in STEM education.

The study's findings suggest several revisions to enhance the effectiveness of the STEM-TTBIQ questionnaire, coding schemes for lesson plans, and teacher interviews in capturing STEM teaching beliefs. These modifications may improve the understanding of STEM teaching practices and resulting in more comprehensive and nuanced research outcomes.

To address the room for improvement for STEM-TTBIQ, it is recommended to expand the questionnaire by incorporating non-cognitive aspects to provide a more comprehensive understanding of teachers' attitudes, motivations, and emotional dispositions towards STEM education. This can be achieved by including items that explore variables such as previous experience, motivation, interest, confidence, and commitment to professional development. Incorporating these additional dimensions will enhance the validity of the questionnaire and contribute to a more holistic assessment of STEM teaching beliefs.

The limitation pertains to the self-reported nature of the STEM-TTBIQ questionnaire, which can be mitigated by integrating additional data collection methods, such as classroom observations and student feedback. By triangulating data from multiple sources, researchers can enhance the validity of the findings and minimize potential biases associated with self-reporting.

Another limitation of the study relates to the limited number of participants recruited for the STEM-TTBIQ. To overcome this limitation, future research endeavors should strive to recruit a larger and more diverse sample of STEM teachers, considering different types of schools and regions within each country. Increasing the sample size and diversifying the participant pool will enhance the statistical power and generalizability of the findings, enabling a more comprehensive understanding of STEM teaching beliefs and practices across various educational contexts.

Utilizing an inductive coding process when analyzing lesson plans and teacher interviews will enable the identification of new themes and patterns that may emerge from the data. This inclusive approach acknowledges the diverse and intricate nature of STEM lesson plans and teacher interviews, ensuring that the analysis captures the richness of instructional strategies and disciplinary integration embedded within teachers' plans and also the rich information from the teachers. Furthermore, in teacher interviews, member checking can enhance the trustworthiness and credibility of the study. Member checking involves sharing preliminary findings with participating teachers and inviting their feedback and validation. This collaborative process allows teachers to clarify any potential misinterpretations, provide context-specific information, and ensure the accuracy of the research findings.

The study's implications highlight the importance of teacher professional development, curriculum design and support, collaboration and knowledge sharing, and policy considerations in STEM education. Targeted professional development programs can address teachers' self-efficacy and commitment to STEM education, while clear standards and flexible curriculum designs can support effective integration. Collaboration among teachers and knowledge-sharing platforms can foster a collaborative culture and disseminate effective STEM teaching strategies. Policymakers can use the findings to develop evidence-based policies that support the integration of STEM education and address the specific needs and challenges STEM teachers face in different contexts.

In terms of future research suggestions, firstly, conducting longitudinal studies would provide insights into the stability and development of STEM teaching beliefs over time. Secondly, video-based observations offer valuable insights into the alignment between teachers' beliefs and their enacted lesson plans. Video-based observations allow researchers to understand how teachers translate their beliefs into action, identify specific instructional strategies employed, and assess the alignment between beliefs and classroom practice. Thirdly, investigating the impact of STEM teaching beliefs on students' learning processes and outcomes would provide evidence of the effectiveness of specific STEM pedagogies and integration approache In addition, a stratified sampling design in future research could also ensure a more representative sample, considering factors such as school types, geographic regions, and grade levels.

In conclusion, the study's findings provide valuable insights for revising assessment tools, addressing limitations, suggesting future research directions, and identifying implications for STEM pedagogy, teacher professional development, curriculum design, collaboration, and policy-making in STEM education. By acknowledging and addressing these considerations, researchers can contribute to advancing STEM education and improving the quality of teaching and learning experiences in STEM.