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The Professionalism of Mathematics Teachers in the SDGs Era: A Comparative Study of Indonesia and Singapore

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Abstract

Background of study: The differences in education quality between Indonesia and Singapore, particularly in numeracy skills and the effectiveness of mathematics learning, highlight a gap in teacher professionalism and the implementation of SDG-based learning. Although both countries have improved access to education, significant differences remain in the quality of the learning process and achievement of mathematics competencies.

Aims and scope of paper: This study aims to analyze the understanding and implementation of mathematics teachers' professional competencies in SDG-based learning, identify strategies for improving these competencies, and compare teacher professional development practices in Indonesia and Singapore. The scope of the study includes education policies, curriculum, teacher training, and mathematics teaching practices in both countries.

Methods: The research employed a qualitative approach through literature and comparative studies, using data from policy documents, curricula, PISA and SDGs reports, and related research. Analysis was conducted descriptively through data reduction, presentation of findings, and drawing conclusions.

Result: Indonesia has sought to improve teacher professionalism through the Merdeka Curriculum, PPG, and PKB, but implementation has been uneven and teachers' understanding of SDG integration remains limited. In contrast, Singapore has a more structured professional development system through the Teacher Growth Model, NIE, and PLCs, making it more effective in integrating SDGs into mathematics learning. This difference is reflected in the PISA results, where Singapore outperforms Indonesia by a wide margin.

Conclusion: Teacher professionalism is a key factor in improving the quality of SDG-based mathematics learning. Indonesia needs to strengthen contextual training, infrastructure support, and learning communities. Relevant and sustainability-oriented mathematics learning supports increased numeracy literacy and the achievement of SDG 4.

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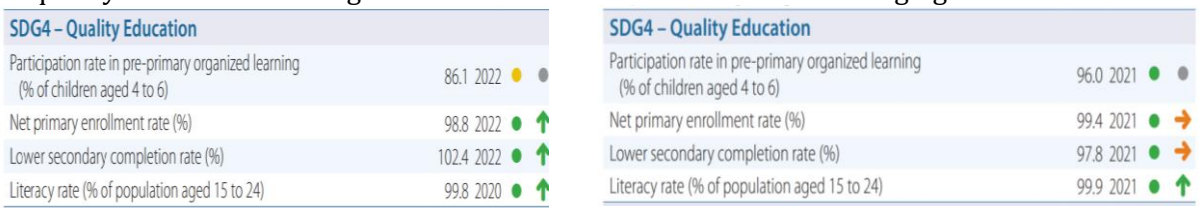
INTRODUCTION

Education is the main foundation for building an educated society, having social awareness, and having a high competitive spirit, which also contributes to the achievement of the Sustainable Development Goals (SDGs)(Rasyid and Alfareza, 2024). Of the 17 SDGs, SDG 4 is the main supporter in the development of the education sector because it emphasizes the importance of equal, quality, and accessible access to education for all groups and encourages lifelong learning opportunities (Anggraini, 2023). Inadequate education will hinder the abilities and behavior of its people. Conversely, countries with good education systems will be better able to adapt and compete globally (Kurniawati, 2022).

Based on the SDGs Index achievement report, a comparison of SDG 4 indicators between Indonesia and Singapore shows that both countries have succeeded in expanding access to education and graduation rates. However, these indicators do not fully reflect the effectiveness of learning and the quality of student learning outcomes. This can be seen in the following figure.



Indonesia Singapore

Figure 1. SDG4 Indicator Achievement Data for Indonesia and Singapore

Based on Figure 1, Indonesia and Singapore show progress in access to primary education, completion of secondary education, and adolescent literacy, which are essential foundations for mathematics learning. However, these achievements emphasize affordability and participation, and therefore do not fully reflect the quality of the mathematics learning process itself, such as students' conceptual understanding, logical thinking skills, and mathematical reasoning (Sukmawati & Puri Sukadasih, 2014). This low ability result is supported by the Program for International Student Assessment (PISA) data released by the Organization for Economic Co-operation and Development (OECD) in 2022. This report compares the abilities of students from various countries, including Indonesia and Singapore, in reading literacy, numeracy (mathematics), and science, as shown in Figure 2 (Afra Hanifah Prasastiswi, 2024).

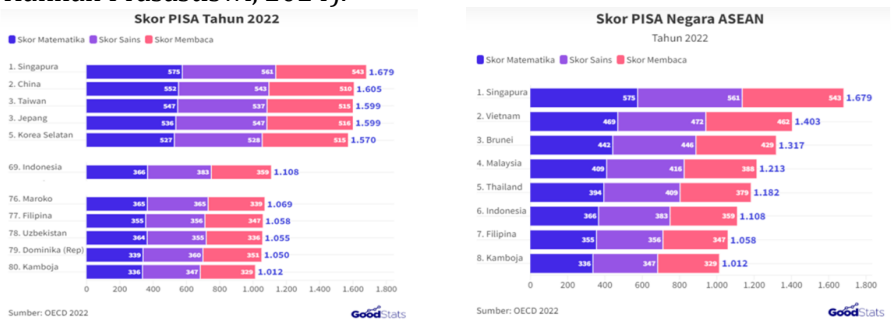


Figure 2. Diagram of Global and ASEAN Country PISA Score Rankings in 2022

Based on Figure 2, the data shows that Singapore consistently excels in all tested aspects, while Indonesia remains at the bottom of the rankings, both globally and regionally. Indonesia's low score indicates challenges in the effectiveness of learning and the quality of student learning outcomes, particularly in mathematics. This situation emphasizes the importance of improving the quality of mathematics learning as part of numeracy literacy and problem-solving, which are key elements in SDG-based learning (Mahmud & Pratiwi, 2019). Teachers play a central role in this process, so that professional competencies including pedagogical, professional, social, and personality are very important (Ramadina & Hariyati, 2024). This is in line with indicator 4.c.1 of SDG 4 which emphasizes the importance of qualified and trained teachers (Farihin, 2022). The Independent Curriculum implemented in Indonesia supports the integration of the SDGs through the freedom to design learning and various teacher development programs such as PPG, PKB, IKTE, and

the Independent Teaching Platform (Ministry of Education, Culture, Research and Technology, 2025).

On the other hand, the national curriculum implemented in Singapore has been implemented effectively, and has made Singapore a country with an advanced education system in the world, especially in ASEAN countries (Nasution, 2022). Teachers in Singapore receive specialized training from the National Institute of Education (NIE) and are facilitated by ongoing programs such as the Academy of Singapore Teachers (AST), the Teacher Growth Model (TGM), and Professional Learning Communities (PLCs). (Dina Yasmin and Animatul Chisbiyah, 2024) This reflects a strong collaboration between government policies and training institutions.

Several previous studies show a different point of view (Nurfatimah & Rostika, 2022) emphasizes that the quality of education in Indonesia is influenced by policy, access, curriculum, and equity, but has not explicitly highlighted the role of teacher professionalism. In contrast, research (Al Mustaqim, 2023) emphasizes that teacher professionalism through the PPG policy is key to achieving the SDGs. However, these studies have not explicitly linked teacher professional competency to curriculum implementation, student achievement, or how teachers incorporate sustainability values into classroom mathematics learning as a contribution to the SDGs agenda.

This study aims to examine the application of teacher professional competencies in SDG-based mathematics learning in Indonesia and Singapore, highlighting curriculum implementation and student competencies within a sustainability context. By comparing practices in both countries, particularly the factors that contribute to Singapore's excellence in numeracy according to PISA, this study is expected to fill the gap in understanding how teacher professionalism supports quality and sustainable mathematics learning. The research findings are expected to provide recommendations for strengthening teacher professionalism in Indonesia to optimally support the achievement of SDG 4.

METHOD

Research Design

This research employed a qualitative approach, employing literature reviews and comparative studies. This approach was chosen because it allowed the researcher to conduct an in-depth analysis of various relevant information sources to assess teacher professional competence in SDG-based mathematics learning in Indonesia and Singapore.

Participant

Because this study did not involve primary data collection from individuals, there were no direct human participants. The data sources consist of secondary documents, including national education policies, curriculum documents, PISA reports (particularly PISA 2022), SDGs progress reports published between 2015 and 2024, and peer-reviewed journal articles related to mathematics teacher professionalism and SDG-based learning in Indonesia and Singapore.

Population and sampling

In the context of document-based research, the study population encompasses all literature, policy documents, education reports, and research findings addressing teacher professionalism and SDG-based learning. To obtain relevant and high-quality data, a purposive sampling technique was used, selecting sources based on their thematic relevance, publisher credibility, and contribution to the research objectives. This technique allowed researchers to focus on the most significant sources for comparing conditions in Indonesia and Singapore.

Instrument

To support the analysis process, this study uses an instrument in the form of a document analysis sheet which is used for:

1. Identify themes related to teacher professional competence,
2. Examining the implementation of SDGs in mathematics learning,
3. Comparing education policies and practices between Indonesia and Singapore. This instrument is used in the process of data reduction, coding, and categorization of literature findings.

Procedures and time frame

The implementation of the research follows a series of steps designed in a structured manner as follows (Nursapi Harahap, 2020).

1. Data collection from Google Scholar, SINTA, Scopus, official OECD-PISA reports, SDGs Index, national curriculum, and various education policy documents.
2. Source selection based on relevance and quality.
3. A comparative analysis between Indonesia and Singapore regarding teacher professionalism and the implementation of SDGs-based learning.
4. Synthesis of findings to produce research conclusions and recommendations. The research implementation time is adjusted to the duration of the literature search and document analysis stage.

Analysis plan

To process the collected data, this study adopted a qualitative descriptive analysis approach (Metwally et al., 2024).

1. Data reduction to filter important information.
2. Presentation of data in the form of comparisons between countries.
3. Drawing conclusions based on patterns, gaps, and thematic findings regarding teacher professional competency and the implementation of SDGs-based mathematics learning

Scope and limitations

The scope of this research is limited to the analysis of documents and literature related to mathematics teacher professionalism and the implementation of SDG-based learning. It does not include field observations or empirical data collection from schools. Therefore, the study has several limitations, primarily related to the reliance on available literature, the potential limitations of the perspectives of the sources used, and the descriptive nature of the analysis, which makes it difficult to generalize comprehensively. Nevertheless, the study provides a comprehensive picture of the practices and challenges faced by both countries.

RESULTS AND DISCUSSION

Result

A literature review shows that Indonesia has attempted to implement teacher professional competencies in SDG-based mathematics learning through the Independent Curriculum and various teacher development programs such as Teacher Professional Education (PPG) and Continuous Professional Development (PKB). However, implementation remains uneven due to limited training and technical support, resulting in suboptimal teacher understanding of SDG integration in mathematics learning. Other challenges include low pedagogical and professional competencies in developing numeracy literacy and mathematical reasoning, as well as limited resources and collaboration among teachers. In contrast, Singapore has successfully implemented high levels of teacher professionalism through ongoing training and mentoring systems such as the Teacher Growth Model and Professional Learning Communities. Singapore's curriculum emphasizes contextual learning and numeracy reinforcement through a problem-based approach, as reflected in its significantly higher PISA scores than Indonesia's.

Figure 3. Comparison Diagram of PISA Mathematics Scores in 2022

Based on Figure 3, the results of the literature study and comparative analysis between Indonesia and Singapore show a significant gap in the quality of mathematics learning, as reflected in the PISA 2022 scores. Singapore scored 575, while Indonesia only achieved 366. This large difference in scores

not only reflects students' cognitive abilities but also indicates fundamental differences in learning strategies and the quality of teacher professionalism.

Discussion

Teacher Competencies and Professional Development Models

The findings of this study confirm that teacher professionalism is a key factor in improving the quality of mathematics learning based on Sustainable Development Goals (SDGs). These results are in line with (Dirgantoro, 2018), who states that teachers' pedagogical and professional competencies greatly determine students' abilities in mathematical reasoning and problem solving. Furthermore, (Surahman & Wang, 2023)emphasize that contextual, reflective, and practice-oriented continuous professional development plays an important role in helping teachers adapt their learning strategies to curriculum requirements and global educational goals, including sustainable education. This condition explains the research findings that the limitations of applicable and continuous training in Indonesia are one of the factors hindering the integration of SDG values into mathematics learning. Furthermore, evidence from national and international reports indicates that Indonesia still faces significant challenges in terms of teacher quantity and quality when compared to Singapore.

The teacher-to-student ratio in Indonesia is still far from ideal compared to the UNESCO standard (17:1), with some areas even experiencing extreme ratios, such as 1:10, due to small schools in rural areas. This results in low teacher placement and learning effectiveness (Sekar Purbarini Kawuryan et al., 2021). The teacher-to-student ratio in Indonesia is relatively high, which results in a heavy workload and reduced opportunities for effective interaction between teachers and students. In contrast, Singapore has managed to maintain a very ideal teacher-to-student ratio, namely 15:1 for Elementary School, 12:1 for Middle School, and 11:1 for Middle School (MOE, 2019). This figure is comparable to many OECD countries, which allows for personalized attention and optimal development of students' potential.

Teacher competency standards also show a significant gap. In Indonesia, approximately 81% of teachers have not met the minimum standards set by the Teacher Competency Test (UKG), indicating the need for massive professional quality improvement. In contrast, over 90% of teachers in Singapore meet high competency standards, a result of a structured and ongoing teacher training system (Index Mundi, 2019).

Professional training in Singapore is conducted intensively and systematically through models such as the Teacher Growth Model (TGM) and Professional Learning Communities (PLCs) (Vijayadevar et al., 2019). This model emphasizes reflective learning, collaboration between teachers, and continuous development focused on student needs. This is reinforced by the role of the National Institute of Education (NIE) as the central body that maintains national teacher training standards.

Meanwhile, professional training in Indonesia remains limited and uneven. Programs such as the Teacher Professional Education (PPG), the Freedom to Teach Platform, and Continuous Professional Development (PKB) have been initiated, but their implementation tends to be administrative and does not optimally support reflective and collaborative learning(Basri et al., 2021). This condition limits teachers' ability to comprehensively integrate SDG values into mathematics learning.

In addition, the integration of SDGs values in mathematics learning in Singapore has been carried out regularly and structured, which strengthens the relevance of learning to global issues such as climate change and social welfare (Dawn, 2011). In contrast, Indonesia is still in the early stages of implementing SDG integration, with the main obstacle being the uneven distribution of understanding and supporting resources among teachers (Hana et al., 2024). These findings indicate that differences in mathematics learning quality between Indonesia and Singapore are closely related to the structure and sustainability of teacher professional development systems. This comparison highlights teacher professionalism as a key factor in achieving SDG 4, particularly in supporting numeracy literacy and contextual problem-solving skills. In the Indonesian context, this finding implies that strengthening teacher training programs and expanding professional learning communities are essential strategies to improve the quality of sustainable mathematics learning and to ensure more effective integration of SDG values into classroom practice.

Implementation of Teacher Professional Competencies in SDGs-Based Learning

The development of teacher professionalism cannot be separated from the implementation of four basic teacher competencies, namely pedagogical, professional, social and personality competencies (Sulastri, 2023). In the context of SDGs-based learning, these four competencies must be integrated so that teachers can become agents of change oriented toward sustainability.

Table 1. Teacher Professional Competence in SDGs-Based Learning (Indonesia and Singapore)

Competence	Implementation (SDGs)	Obstacle (Indonesia)	Practice (Singapore)
Pedagogy	Contextual, collaborative, reflective learning on SDGs issues	The method is not yet innovative, integrative training is still limited	ESD-based projects, interdisciplinary approach
Professional	Mastery of materials, technology, and self-development	Unequal access to training, minimal practical research	Strengthening through NIE and mentoring programs
Social	Communication and networking with students and communities	Minimum soft skills and social literacy training	Regular leadership and collaboration training
Personality	Exemplary values of ethics, responsibility and sustainability	Character development is not yet systemic	The value of professionalism is instilled from the beginning of teacher education.

Singapore's teacher professional development system has been systematically and comprehensively designed, but several challenges remain. Teachers in Singapore face a high workload due to numerous administrative responsibilities, performance evaluations, and the demands of data-driven learning. The pressure to continuously innovate can also lead to professional burnout, especially for teachers who must balance teaching and personal development (Gkontelos, 2023). In addition, the formal evaluation systems used as the basis for career promotion and training are sometimes considered too rigid, thus limiting teachers' flexibility in exploring more creative and contextual learning approaches.

Implementation of the Curriculum and Integration of SDGs Values in Mathematics Learning

The application of Sustainable Development Goals (SDGs) values in mathematics learning is a crucial indicator in assessing the success of 21st-century education. These values address not only knowledge but also social, environmental, and economic dimensions that students need to internalize through a contextual, reflective, and problem-solving-based learning approach. Therefore, the curriculum used in a country plays a key role in encouraging or hindering the integration of these values (Budikusuma et al., 2024).

The Independent Curriculum (Curriculum Merdeka) has been gradually implemented in Indonesia since 2022. This curriculum promotes student-centered learning, providing teachers with the opportunity to innovate and adapt to local contexts. One of its key features is a project to strengthen Pancasila student profiles, which is closely aligned with the principles of the SDGs (Putri et al., 2024). For example, project themes such as sustainable lifestyles, entrepreneurship, and local wisdom provide opportunities to integrate mathematics topics with issues such as energy consumption, environmental statistics, and budget planning. However, a regional study found that over 65% of junior high school teachers in West Java had never received specific training on integrating sustainability education into the curriculum. This reflects the limited availability of training relevant to global issues such as the SDGs and indicates the need for further support in the form of learning resources and examples of good practices to enable teachers to effectively link teaching materials to the context of sustainability (Salwa A et al., 2025).

In contrast, Singapore has long implemented a competency-based and sustainability-based National Curriculum. The latest version of Singapore's mathematics curriculum, released by the

Ministry of Education (MOE) in 2021, explicitly integrates numeracy skills, problem-solving, and sustainability issues. For example, in statistics lessons, students are invited to analyze population trends, water and energy consumption, and household income distribution to assess social inequality. This approach is not merely theoretical but grounded in real-world data, and teachers are given specialized training to link contextual data to mathematical competencies. The MOE also mandates Professional Learning Communities (PLCs), which bring together teachers from across disciplines to develop cross-curricular learning units that emphasize the link between mathematics and global sustainability.

Mathematics learning strategies in Singapore tend to adopt more progressive approaches, such as project-based learning, inquiry-based learning, and experiential learning. These approaches encourage students to engage directly in problem-solving that is contextual and relevant to global issues, including those related to the Sustainable Development Goals (SDGs). In Singaporean mathematics classes, students are often given challenges such as designing a rainwater harvesting system at school, considering volume and cost, or modeling energy consumption reduction using percentages and graphs.

In contrast, in Indonesia, the integration of SDG values into mathematics learning has not yet become a common and systematic practice. Many teachers still teach mathematics separately from real-life contexts, so mathematics' potential as a tool for understanding and finding solutions to social and environmental problems has not been optimally utilized. Concepts such as statistics, measurement, and data analysis are often taught abstractly, without linking them to issues such as water consumption, household waste, or air quality. Limited practice-based teacher training, a lack of contextual teaching resources, and minimal collaboration between teachers are factors that widen this gap. As a result, mathematics learning in Indonesia does not fully support the development of critical thinking and global awareness in students as expected in the SDGs framework.

Challenges in Developing Teacher Professionalism

The main challenge in developing SDG-based mathematics teacher professionalism in Indonesia lies in the limited availability of applicable and sustainable training. Only a small proportion of teachers receive specific guidance on integrating the SDGs into the learning process. As a result, pedagogical competencies for linking mathematical concepts to sustainability issues are underdeveloped. The general and non-contextual nature of training materials makes it difficult for teachers to transform SDG values into concrete and meaningful learning activities (Surahman & Wang, 2023).

Furthermore, Indonesia's teacher evaluation system remains predominantly administrative and lacks constructive feedback that could encourage reflection and improvement of teaching strategies. Assessments focus more on document fulfillment and credit points than on improving teaching quality. This situation undermines teachers' efforts to innovate in line with SDG principles, as there is no support system that recognizes or rewards contextual and creative learning.

Inequality in access to digital infrastructure is also a significant obstacle, particularly in the 3T (underdeveloped, frontier, and outermost) regions. The limited availability of internet connections, technological devices, and interactive digital teaching materials makes it difficult for teachers in remote areas to implement SDG-based learning approaches that rely on digital resources. This inequality widens the professional gap between regions and complicates the equitable delivery of quality education (Sabrina Nur Syifa et al., 2024).

Meanwhile, Singapore's experience demonstrates a more structured approach to teacher professional development. Continuous, data-driven evaluation, training focused on contextual learning, and a strong feedback culture are the foundations for improving teacher competency there. However, the pressure to achieve high learning standards also poses a challenge, as it can limit teachers' exploration and flexibility in developing SDG-based approaches.

Implications

The implications of these differences point to the need for comprehensive reform of Indonesia's teacher development system. Training programs must be contextually designed, practice-oriented, and relevant to local needs. Teacher evaluation mechanisms also need to be refined to provide constructive feedback and stimulate pedagogical improvement. Furthermore, equitable distribution of technological infrastructure and strengthening communities of practice among teachers need to be prioritized to create a collaborative ecosystem that supports the

sustainable growth of teacher professionalism. Through these steps, SDG-based improvements in mathematics learning can be achieved more effectively and positively impact student learning outcomes.

Research contribution

This research contributes to a comprehensive understanding of the relationship between teacher professionalism and the quality of SDG-based learning, particularly in the context of mathematics. This comparative study between Indonesia and Singapore offers important insights into best practices that can serve as a reference for improving the quality of education and developing teacher competencies in Indonesia.

Limitations

This research is limited to literature analysis and does not involve direct empirical data from schools or teachers. Furthermore, the availability of documents and the quality of literature sources may influence the depth of the analysis. The findings are descriptive in nature and therefore cannot be generalized to all educational contexts.

Suggestions

Further research is recommended to incorporate field data through observations or teacher interviews to gain a more in-depth understanding. Governments and educational institutions are encouraged to strengthen SDG-based practical training, provide more contextual learning resources, and expand collaborative programs and teacher learning communities.

CONCLUSION

This study shows that the professionalism of mathematics teachers plays a strategic role in improving the quality of mathematics learning based on Sustainable Development Goals (SDG 4). A comparative study between Indonesia and Singapore reveals that differences in mathematics learning outcomes are mainly influenced by the effectiveness of the teacher professional development system. In Indonesia, the implementation of the Merdeka Curriculum and the PPG and PKB programs has not been fully optimized due to limitations in contextual training, infrastructure disparities, and the uneven ability of teachers to integrate SDG values into mathematics learning. In contrast, Singapore has a structured and sustainable professional development system through the Teacher Growth Model and Professional Learning Communities, enabling teachers to link mathematical concepts to sustainability issues in an applicable manner and have an impact on improving student numeracy. These findings imply the need to strengthen the professional development of mathematics teachers in Indonesia through practice-based training, teacher collaboration, reflective evaluation, and equitable access to learning resources so that mathematics learning can contribute more effectively to improving numeracy literacy and achieving SDG 4.

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AUTHOR CONTRIBUTION STATEMENT

NKR was responsible for the research concept development, literature collection, and comparative analysis between Indonesia and Singapore. SL contributed to the theoretical review, content validation, and refinement of the discussion and conclusions. Both authors contributed equally to the preparation, review, and approval of the final manuscript prior to publication.

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