Journal on Mathematics Education
Volume 15, No. 2, 2024, pp. 661-682

LEPscO: Mathematical literacy learning environment for the *Guru Penggerak* program

Tria Gustiningsi, Ratu Ilma Indra Putri*, Zulkardi, Hapizah

Department of Mathematics Education, Universitas Sriwijaya, South Sumatera, Indonesia
*Correspondence: ratuilma@unsri.ac.id

Received: 17 July 2023 | Revised: 15 February 2024 | Accepted: 20 March 2024 | Published Online: 3 April 2024

Abstract

Mathematical literacy stands as a critical skill imperative for navigating the complexities of the 21st century. Enhancing students' mathematical literacy necessitates comprehensive engagement across the educational landscape. This aligns with the *Guru Penggerak* (GP) initiative, established by the government to serve as educational leaders, propelling the entire educational system forward. Nonetheless, the current GP program needs more specific provisions addressing mathematical literacy, and the existing learning environments for mathematical literacy remain constrained. Consequently, there is a pressing need to develop a dedicated mathematical literacy learning environment within the GP framework. This study endeavors to create a mathematically literate learning environment that is both valid and practical, potentially impacting the GP program significantly. Employing a design research approach, the study progresses through three key stages: preliminary, prototyping, and assessment. Seven teachers participated as subjects, using data collection methodologies including walkthroughs, observations, questionnaires, and interviews, which were analyzed descriptively. Findings indicate the development of a model for a mathematical literacy learning environment termed D-C-C with the LEPscO framework, which is deemed valid due to its alignment with the PISA framework, Indonesian educational curriculum, and unambiguous language. Moreover, the model proves practical for implementation within the GP program, exhibiting potential effects such as enhanced teacher satisfaction, learning, organizational support, and utilization of new knowledge, alongside improved student outcomes reflecting heightened mathematical literacy proficiency. This research contributes to educational discourse by introducing the LEPscO Framework, encompassing a Digital-Class-Community learning environment, structured learning processes encompassing training, classroom implementation, knowledge sharing, and community development, and targeted learning outcomes focusing on teachers' comprehension and reinforcement of mathematical literacy in education.

Keywords: Design Research, *Guru Penggerak*, Learning Environment, LEPscO, Mathematical Literacy

How to Cite: Gustiningsi, T., Putri, R. I. I., Zulkardi, & Hapizah. (2023). LEPscO: Mathematical literacy learning environment for the *Guru Penggerak* program. *Journal on Mathematics Education, 15*(2), 661-682. http://doi.org/10.22342/jme.v15i2.pp661-682

In the framework of the Program for International Student Assessment (PISA), mathematical literacy stands as a pivotal domain under scrutiny (OECD, 2023). Along with this global trend, Indonesia incorporates mathematical literacy as a significant component within its Minimum Competency Assessment, serving as a replacement for the National Examination (Kemendikbudristek, 2022). This underscored emphasis on mathematical literacy across diverse educational assessments underscores its paramount importance for students universally.

PISA findings highlight a persistent challenge in Indonesia's mathematical literacy, as evidenced by consistently low rankings (OECD, 2016; OECD, 2019). Previous PISA surveys in 2003 and 2012 underscored this issue, with Indonesia ranking 38th out of 41 countries in 2003 and 64th out of 65 countries in 2012 (OECD, 2003; OECD, 2014; Stacey & Turner, 2015; Widjaja, 2011). More recent data from the 2022 PISA assessment reveal a further decline, positioning Indonesia at 70th out of 81 countries, with a mean score of 366 compared to the OECD average of 472 points (OECD, 2023). Numerous studies corroborate these findings, indicating persistent deficiencies in students' abilities to tackle PISA-style mathematical questions (Dewantara et al., 2015; Gustiningsi, 2015; Lestari et al., 2021; Wijaya, 2016). Stacey (2011) noted that nearly 70% of Indonesian students scored below level 2 across all assessed topics. Further analysis by Zulkarnain et al. (2021) revealed that only 21.84% of students achieved a "high" category, while 35.63% and 42.53% fell into the "moderate" and "low" categories, respectively. Ekawati et al. (2020) explored mathematical literacy in Surabaya and found that students' proficiency levels varied significantly, with average scores for solving high, medium, and easy-level questions below desirable thresholds.

Enhancing students' mathematical literacy necessitates a concerted effort to bolster teachers' roles and competencies in mathematical instruction (Hwang et al., 2018; Supriyati & Muqorobin, 2021; Nortvedt & Wiese, 2020; Susanti & Syam, 2017). Research by Meroni et al. (2015) underscores the significant correlation between teacher quality and students' PISA outcomes, highlighting the pivotal influence of teachers on mathematical literacy development. Effective pedagogy entails designing instructional approaches seamlessly integrating formal knowledge with practical mathematical applications (Höfer & Beckmann, 2009). The success stories of Finland and Singapore in PISA elucidate the pivotal role of teacher education and curriculum emphasis on real-world problem-solving (Sahlberg, 2011; Boman, 2020; OECD, 2019; Atase Pendidikan dan Kebudayaan KBRI Singapura, 2021; Tonga et al., 2022). Chung (2016) further asserts that teaching excellence and continuous professional development are paramount in achieving success in international assessments like PISA. Thus, the quality of teaching practices within classrooms significantly impacts students' mathematical literacy attainment.

Nevertheless, various studies highlight persisting areas for improvement in implementing instructional strategies to enhance mathematical literacy, contributing to the perpetuation of low proficiency levels among students. Key issues include teacher-centered pedagogical approaches that fail to adequately support students in engaging with contextualized tasks (Wijaya et al., 2015b; Gustiningsi et al., 2022b), a dearth of instructional practices specifically designed to bolster mathematical literacy skills (Gustiningsi et al., 2022a), and limited availability of learning materials that afford students opportunities to tackle real-world mathematical challenges (Wijaya et al., 2015a; Gustiningsi & Somakim, 2021; Putri & Zulkardi, 2020). These findings underscore the urgent need for pedagogical reforms and resource enhancements to address the root causes of inadequate mathematical literacy development among students.

Improving comprehension and implementing learning strategies are crucial for fostering students' mathematical literacy, and they necessitate addressing several vital factors. Preliminary study findings reveal constraints such as limited access to training sessions, online resources, communal spaces dedicated to mathematical literacy, and instructional materials among teachers (Gustiningsi et al., 2022a). Indeed, Piper et al. (2018) assert the significance of teacher training, student textbooks, and teacher guides in augmenting mathematical literacy levels. Components of the learning environment, including coaching, educational literature, online platforms, and instructional guides, are pivotal in facilitating mathematical literacy development (Perkins, 2013; Phillips et al., 2010; Phillips et al., 2019). It can be inferred that teachers' insufficient understanding and application of learning strategies stem from a deficient learning environment, thereby emphasizing the critical role of a conducive learning environment in nurturing mathematical literacy.

The requisite learning environment for fostering mathematical literacy encompasses a holistic approach, addressing all pertinent aspects (Fianto, 2018). This aligns with the LEPO framework, which aims to enhance the design of learning and teaching environments by encompassing all facets of learning. By focusing on the comprehensive spectrum of learning, educational designers can tailor specific strategies to suit diverse learning contexts effectively. Moreover, the LEPO framework is a guiding principle for evaluating and researching educational innovations (Phillips et al., 2010). This framework delineates the interplay among the learning environment, learning processes, and learning outcomes (Msimanga, 2020; Phillips et al., 2019; Wong et al., 2021), thereby facilitating a comprehensive approach to fostering mathematical literacy.

Studies such as Msimanga's (2020) investigation into multi-grade classroom instruction and Wong et al.'s (2021) examination of medical student learning amidst the COVID-19 pandemic have utilized the LEPO framework to delineate pertinent learning environment characteristics and students' perceptions of learning, respectively. These studies underscore the utility of the LEPO framework in guiding educational practices and informing pedagogical solutions. However, despite the widespread application of the LEPO framework in various educational contexts, no research has yet been conducted utilizing this framework to develop a specific learning environment tailored for mathematical literacy.

Previous research efforts have indeed focused on developing mathematics literacy learning environments for teachers, employing diverse methodologies such as integrating research-based principles into teaching practices (Swan & Swain, 2010), implementing a comprehensive three-way approach encompassing training, practice, and mentoring (Wium & Louw, 2012), and providing targeted training sessions (Piper et al., 2018). However, there has yet to be an endeavor to construct a mathematical literacy learning environment utilizing the LEPO framework. Moreover, existing initiatives have predominantly concentrated on mathematics teachers rather than addressing mathematical literacy across broader educational contexts. Thus, the current research endeavors to fill this gap by aiming to devise a mathematical literacy learning environment specifically tailored for teachers.

To enhance teacher competence, the Minister of Education, Culture, Research, and Technology of the Republic of Indonesia has initiated the *Guru Penggerak* program, designating these educators as learning leaders responsible for catalyzing student-centered education across schools and regions (Mansyur, 2021). This initiative aligns closely with the imperative of mathematical literacy, as fostering such literacy necessitates the involvement of all educational stakeholders (Kemendikbud, 2017a; Fianto, 2018). Furthermore, the *Guru Penggerak* program not only equips teachers to lead within their schools but also prepares them for roles as school principals, supervisors, and trainers in educational programs (Satriawan et al., 2021). Effective school leadership, a crucial component of educational success, notably influences the attainment of goals, including advancing students' mathematical literacy skills (Soh, 2014; Atase Pendidikan dan Kebudayaan KBRI Singapura, 2021). This underscores the interconnectedness between the *Guru Penggerak* program and its endeavors to elevate mathematical literacy. However, despite these efforts, prior research has yet to focus on developing a mathematical literacy learning environment tailored explicitly for *Guru Penggerak*. Therefore, this study addresses this gap by formulating a validated, practical, and efficacious mathematical literacy learning environment for *Guru Penggerak*. By adapting principles from the LEPO framework, this research endeavors to offer a comprehensive framework that not only addresses the learning environment but also provides insights into the learning process and outcomes, thus contributing to educational advancement.

METHODS

This study adopts a design research methodology, following the development study model outlined by Bakker (2019). It aims to create a valid, practical, and potentially effective learning environment tailored for mathematical literacy teachers. The research process unfolds through three distinct stages: preliminary, prototyping, and assessment, adhering to established frameworks proposed by Van den Akker et al. (2007) and Zulkardi (2002). Through this structured approach, the study endeavors to systematically design, refine, and evaluate the proposed learning environment, thereby enhancing teachers' mathematical literacy instruction.

In the preliminary stage, an exhaustive analysis of the LEPO framework and the stages of mathematical literacy guidance for teachers was conducted, serving as the foundational step toward prototype development. Subsequently, the prototyping phase ensued, adhering to a formative evaluation flow comprising self-evaluation, expert review, one-to-one, small-group, and field-test stages.

During the self-evaluation phase, the researcher refined the initial draft of the mathematics literacy mentoring program for teachers in alignment with the LEPO framework, forming Prototype I. This prototype underwent scrutiny in the expert review stage, where experts assessed its content, construct, and language validity. Simultaneously, Prototype I underwent one-to-one testing with two non-participant teachers, focusing on practicality within a mathematical literacy learning environment.

Feedback from both the expert review and one-to-one stages informed the revision process, resulting in Prototype II. Prototype II was then subjected to small-group testing involving four additional teachers, gauging its practicality and efficacy. Subsequent revisions led to the development of Prototype III, which underwent testing with the study's seven *Guru Penggerak* subjects during the field test stage.

At the assessment stage, the potential effects of the developed product were evaluated based on Guskey's (2016) development-level framework, encompassing participants' reactions, learning outcomes, organizational support and change, utilization of new knowledge and skills, and students' learning outcomes. This comprehensive assessment aimed to determine the impact and effectiveness of the mathematical literacy learning environment prototype developed for *Guru Penggerak*.

The study involved 7 *Guru Penggerak* selected through simple random sampling. Data collection was facilitated by integrating Learning Management Systems (LMS) with Zoom meetings. Multiple methods were employed, including walk-throughs, questionnaires, and observations. Walk-throughs were conducted during the expert review stage to validate the prototype's content, construction, and language. Experts received the prototype and assessment instrument via email, providing comments and suggestions for further refinement.

Questionnaires were administered during the one-to-one, small-group, and field-test stages using Google Forms. These questionnaires aimed to gather teachers' feedback on the prototype's practicality and assess *Guru Penggerak* satisfaction with the developed mathematical literacy learning environment. Furthermore, observations were conducted during the one-to-one, small-group, and field-test stages to evaluate the implementation of learning activities. Researchers directly observed teachers' implementation using observation sheets to assess the practicality of the developed prototype.

In analyzing the walk-through data, scores are computed based on validation sheets completed by experts, evaluating the prototype's alignment with the stages of mathematical literacy assistance according to the LEPscO framework and LMS stages. Additionally, suggestions and comments from experts are thoroughly described to inform revisions to the prototype. For questionnaire analysis, scores on the questionnaire sheet are tabulated and examined. Subsequently, suggestions and comments obtained from the questionnaire data are summarized, providing insights into the practicality and effectiveness of the prototype. Lastly, observation data is analyzed by computing scores on the observation sheet, assessing how teachers effectively implement learning activities. The observation data is then described comprehensively, elucidating the practical implications of the prototype's implementation in real-world settings.

RESULTS AND DISCUSSION

In the preliminary stage of developing a mathematical literacy learning environment for *Guru Penggerak*, the researcher conducted a comprehensive review of the LEPO framework and analyzed the stages involved in guiding mathematical literacy for teachers. Additionally, to ensure the creation of a robust learning environment conducive to enhancing mathematical literacy, an examination and adoption of the teacher program implemented in Singapore were undertaken. Singapore's educational system has garnered acclaim as a global exemplar, particularly in OECD countries, due to its consistent top performance in international assessments such as the Program for International Student Assessment (PISA), Trends in International Mathematics and Science Study (TIMSS), and Progress in International Reading Literacy Study (PIRLS) (Bautista et al., 2015; Boman, 2020). Singapore introduced the 21st-century teacher education program, Values, Skills, and Knowledge (V3SK), to cultivate quality educators in 2009 (Atase Pendidikan dan Kebudayaan KBRI Singapura, 2021). Given its success and compatibility with contemporary educational frameworks, V3SK is a foundational model for developing Indonesia's mathematical literacy learning environment. Furthermore, the inherent compatibility and synergies between V3SK and the LEPO framework underscore the potential for fruitful integration, as elucidated in Table 1. This strategic alignment ensures the incorporation of best practices and internationally recognized standards into the development process, enhancing the efficacy and relevance of the proposed learning environment.

Table 1. Relationship between LEPO Framework and V3SK Model

LEPO *Framework*	V3SK Model
Learning Environment: Paying attention to student factors and teacher factors.	*Value 1: Learner-Centered Values* *Value 2: Teacher identity*
Learning Process: *Learning and mentorship program (discussion, interaction, adaptation, and reflection).*	*Value 3: Service to the Profession and Community:* *1) Collaborative Learning and Practice* *2) Building apprenticeship and mentorship* *3) Social responsibility and engagement* *4) Stewardships*
Learning Outcome: *Learning outcomes in the form of knowledge, skills, and attitudes.*	*Skills,* *Knowledge*

Table 1 illustrates the similarities and differences between the learning environments and processes outlined in the LEPO framework and the V3SK program. Indeed, the comparison between the LEPO framework and the V3SK program reveals distinctive aspects of the learning process within each framework. In the LEPO framework, learning and mentoring activities revolve around interaction, adaptation, discussion, and reflection among teachers and students. Conversely, the V3SK program emphasizes learning activities, collaborative practices, apprenticeships, and guidance to facilitate effective learning. While the LEPO framework predominantly emphasizes the transmission of material between teachers and students, the V3SK program underscores the importance of additional elements, such as social responsibility involvement and management, beyond teacher-student interaction alone (Phillips et al., 2010). This highlights the comprehensive nature of the V3SK program, which recognizes the multifaceted aspects of the learning process and aims to cultivate a more holistic educational experience.

The emphasis on social responsibility and involvement in the V3SK program aligns with the Australian Institute for Teaching and School Leadership (AITSL) teacher standards, particularly in fostering engagement and linkages with colleagues, parents, and the community (Goos et al., 2020). As outlined by the Ministry of Education and Culture (Kemendikbud), one of the key strategies to bolster the mathematical literacy movement is to integrate it into various settings, including homes, schools, parenting activities, and broader societal contexts (Kemendikbud, 2017a). Recognizing that mathematical literacy is nurtured through the collective efforts of all educational ecosystems, this approach underscores the importance of community involvement and collaboration in promoting mathematical literacy (Fianto, 2018; Kemendikbud, 2017a). By fostering connections and partnerships across diverse stakeholders, educators can create a more supportive and inclusive environment for developing mathematical literacy skills among learners.

Indeed, fostering the involvement of all relevant stakeholders is crucial for advancing mathematical literacy initiatives. Knowledge sharing emerges as a fundamental aspect of creating engagement, as highlighted by Juan et al. (2018). Mu et al. (2008) further underscores the significance of knowledge sharing as a social process wherein individuals willingly exchange information and knowledge with others. This act of social involvement through knowledge sharing also serves to manage knowledge effectively (Mu et al., 2008). Therefore, within the context of learning mathematical literacy for teachers, promoting social responsibility and involvement entails actively sharing knowledge with fellow educators, parents, and the wider community. By facilitating knowledge exchange and collaboration, educators can enrich the learning environment and enhance the collective understanding and application of mathematical literacy principles across diverse contexts.

Based on Table 1, value 3's fourth point, stewardship, or management, aligns with organizational aspects (Pasaloran, 2019). Smith et al. (2017) emphasized the importance of teams integrating mathematical literacy into their work, highlighting the collaborative nature of mathematical literacy efforts. Kemendikbud (2017a) also advocated for forming literacy teams as part of the mathematical literacy movement. Consequently, within the context of teachers' learning of mathematical literacy, establishing a community or team is essential to support mathematical literacy endeavors. Thus, stewardship is defined as establishing or forming a community to support mathematical literacy efforts.

Furthermore, Table 1 illustrates that the LEPO framework and the V3SK model share similar learning outcomes, including attitudes, knowledge, and skills-based learning outcomes. This alignment underscores the importance of cultivating not only the necessary knowledge and skills but also fostering positive attitudes toward mathematical literacy among educators.

In its integration with the LEPO framework and V3SK, the learning process implemented in the mathematical literacy learning environment in this study incorporates the additional elements of sharing knowledge and fostering a community of mathematical literacy (building community). Consequently, the LEPO framework was adapted and modified to the LEPscO (Learning Environment, Learning Process (knowledge sharing, community building), and Learning Outcome) framework. This modified framework introduces special features represented by the letters "s" and "c," which denote "sharing" in the phrase "knowledge sharing" and "community" in the phrase "community building." By incorporating these elements, the LEPscO framework provides a comprehensive approach to fostering a supportive and collaborative learning environment conducive to developing mathematical literacy among educators.

The activity stages were meticulously devised by referencing the LEPscO framework and aligning them with the AITSL Professional Standards for teachers, specifically focusing on mathematical literacy. Table 2 illustrates the seamless integration of these frameworks, ensuring that the activity stages are grounded in sound educational principles and tailored to address the specific needs and competencies outlined in the professional standards for teachers. Through this strategic alignment, the activity stages are designed to effectively enhance educators' proficiency in mathematical literacy while adhering to established professional standards and best practices in teaching.

Table 2. Linkage Between the LEPscO Framework and the AITSL Professional Standards for Teachers

No	Stages of the LEPscO framework	AITSL Professional Standards for Teacher	Activity
1.	*Learning Environment*	Learning environment adapted to the needs of teachers.	Providing a suitable learning environment and supporting the learning process.
2.	*Learning Process*		
a.	Internship and Tutoring	1. Get to know students and how students learn 2. Knowing the content and how to teach it	1) Training: Delivery of materials regarding mathematical literacy and activities design to strengthen it 2) Training: Delivery of material on learning media that can be used to support the implementation of activities that strengthen mathematical literacy.
b.	Collaborative learning and practice	3. Planning and implementing effective learning. 4. Creating and maintaining a safe and supportive learning environment. 5. Conducting assessments, providing feedback and reporting on student learning	3) Training or discussion: Preparation of student worksheet, lesson plan, and evaluation questions. 4) Implementing classroom learning: implementing lesson plans and worksheets for students. 5) Implementing learning in class: giving evaluation questions to students.
c.	*Sharing knowledge*	6. Attachment to professional learning.	6) Sharing: Sharing with other teachers, parents, and the community
d.	*Building Community*	7. Professional engagement with colleagues, parents or	7) Building a community: Creating

No	Stages of the LEPscO framework	AITSL Professional Standards for Teacher	Activity
		guardians of students, and the community.	a math literacy community and getting registered on the independent teaching platform
3.	*Learning Outcome*	Learning outcomes	Teacher's understanding of mathematical literacy and its reinforcement in the classroom. Activity: Collecting teaching materials created by teachers to strengthen mathematical literacy.

Based on Table 2, the teacher activities within the learning process can be categorized into training, implementation in the classroom, knowledge sharing, and community building. To facilitate training for the research subjects, who were located in various locations, a digital learning environment was employed, utilizing a Learning Management System (LMS) and Zoom meetings.

Subsequently, for implementation activities in the classroom, the learning environment utilized was the respective classrooms of each teacher in their assigned schools. As for knowledge-sharing and community-building activities, a communal setting was chosen as the learning environment, as it provided a space conducive to accommodating numerous individuals to share knowledge.

The detailed design of the learning environment, structured according to the LEPscO framework, is elaborated in Table 3. This meticulous planning ensures that each stage of the learning process is appropriately supported by the designated learning environment, fostering effective engagement and collaboration among teachers participating in the mathematical literacy program.

Table 3. The Design of a learning environment with the LEPscO framework

Learning Environment	Learning Process	Learning Outcome
Digital	Training: *1)* Training on materials to strengthen Mathematical literacy. *2)* Training on materials that inspire learning activities that strengthen mathematical literacy. *3)* Focus Group Discussion (FGD) teaching materials	The *Guru Penggerak* understanding of mathematical literacy, Output: lesson plan, student worksheet, evaluation questions
Class	Implementation in the classroom: Implementation learning in the classroom	Understanding of *Guru Penggerak* implement in the classroom, Output: implementation results, student answers.
Community	***Knowledge Sharing:*** Share knowledge about mathematical literacy with other teachers	Understanding other teachers' or other communities, understanding mathematical literacy, Output: learning activity design or

Learning Environment	Learning Process	Learning Outcome
		math literacy questions.
	Building Community: Creating a mathematical literacy community	Understanding community goals. Output: A math literacy community is formed

The initial design of the learning environment, structured according to the LEPscO framework, was refined and progressed during the prototyping stage. Initial adjustments were made during the self-evaluation phase, leading to the development of Prototype I. Prototype I underwent validation during the expert review stage and was simultaneously piloted in parallel during the one-to-one stage with two teachers. Feedback received from both the expert review and one-to-one sessions highlighted several key suggestions, including the appropriateness of topic sequencing, the incorporation of a session on utilizing the Learning Management System (LMS), and the addition of materials focusing on learning media that support the strengthening of mathematical literacy. In response to this feedback, Prototype I was revised accordingly, creating Prototype II. It underwent further testing with four teachers, as depicted in Figure 1. This iterative process of refinement and testing ensures that the learning environment evolves to effectively meet the needs and expectations of teachers participating in the mathematical literacy program, ultimately enhancing its overall efficacy and relevance.

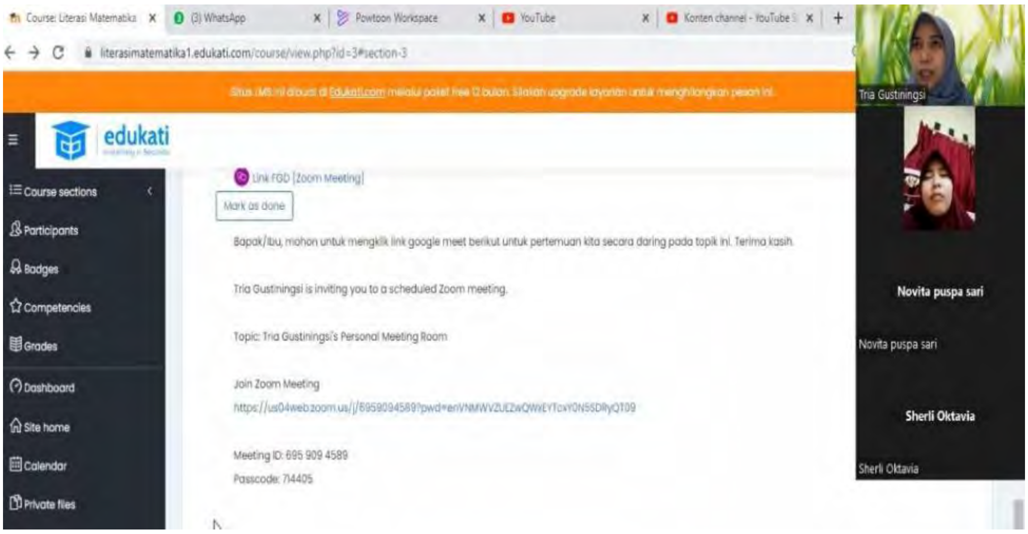


Figure 1. Training for Four Teachers

Based on Figure 1, teachers received briefings on utilizing the Learning Management System (LMS) and underwent training on mathematical literacy concepts. The implementation of Prototype II proceeded smoothly, with teachers actively engaging in activities within the mathematical literacy learning environment and generating teaching materials to reinforce students' mathematical literacy skills in the classroom. However, suggestions were proposed for enhancing the knowledge-sharing process. It was recommended that teachers conduct knowledge-sharing activities through online webinars, allowing for open participation by all teachers across Indonesia. This approach aims to disseminate mathematical literacy knowledge gained by teachers more broadly and effectively. The small group stage suggestions were embraced and utilized as revision material to develop Prototype III. Prototype III, which encompasses the learning environment structured according to the LEPscO framework, is detailed. This iterative process of refinement and adaptation ensures that the learning environment continually evolves to meet educators' evolving needs and aspirations, ultimately fostering a more robust and impactful approach to enhancing mathematical literacy across educational settings in Indonesia, summarized in Table 4. Finally, Prototype III was tested at the field test stage with seven *Guru Penggerak*.

Table 4. Learning Environment with the LEPscO Framework

Learning Environment	Learning Process	Learning Outcome
Digital	Training through Zoom meetings and LMS consists of:	
	1. Introduction to LMS	Teachers' understanding of how to use the LMS.
	2. Strengthening mathematical literacy in learning and assessment	Teachers' understanding of mathematical literacy and its reinforcement in learning
	3. Inspiration for learning activities that strengthen mathematical literacy	Teachers' understanding of how to determine learning activities that strengthen mathematical literacy.
	4. Learning media that support mathematical literacy	Teachers' understanding of media or tools that can be used to support the reinforcement of mathematical literacy.
	5. *Focus Group Discussion*	Teachers' understanding of and experience in finding different contexts for strengthening mathematical literacy.
Classroom	Implementation in classroom	Teachers' understanding in implementing in class.
Community	Sharing knowledge	Understanding of mathematical literacy of other teachers or other communities by *Guru Penggerak*
	Building Community	Understanding of community goals and maximization of the role of the community in strengthen mathematical literacy.

Digital: Training and Focus Group Discussion

The training and FGD were conducted through Zoom meetings in the LMS, as can be seen in Figure 2 and Figure 3.

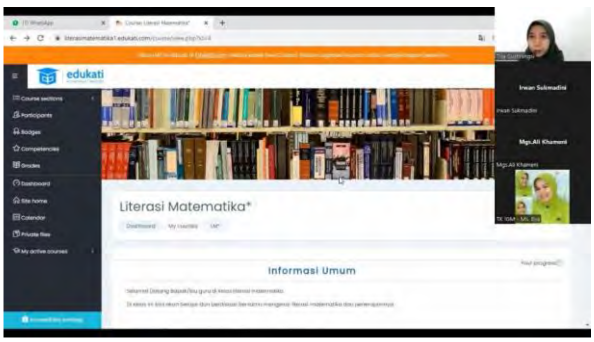


Figure 2. LMS used by Teachers

Zoom and LMS constitute integral components of a digital learning environment. The training activities facilitated teachers' comprehension of mathematical literacy concepts and strategies to enhance it within their teaching practices. Concurrently, Focus Group Discussion (FGD) sessions yielded valuable suggestions and feedback from fellow educators aimed at refining teaching materials geared towards bolstering mathematical literacy. One of the outcomes derived from teachers' discussions during the FGD is showcased in Figure 4.

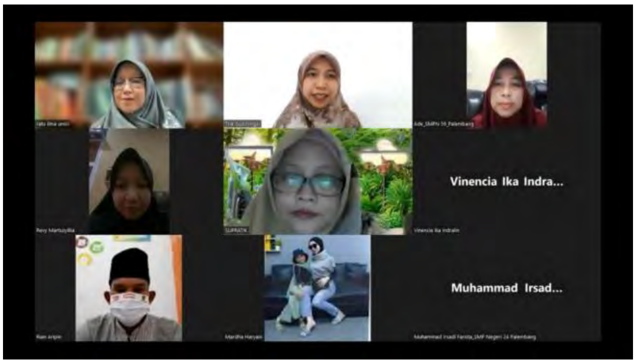


Figure 3. Training via Zoom Meeting

In the word problem depicted in Figure 4, students are tasked with assessing whether Mr. Beni's assertion regarding the rise of the roof framing of his house, exceeding 2 meters, is accurate. To address this inquiry, students must gather data by conducting trigonometric comparisons. Within the PISA framework, the content of this question encompasses concepts related to space and shape.


Perhatikan Gambar 1.

Gambar 1. Kerangka atap rumah
(Sumber: https://www.kibrispdr.org/detail-47/rangka-atap-rumah-kayu.html)

Pak Beni sedang merenovasi atap rumahnya. Lebar rumah Pak Beni (yang ditunjukkan oleh garis merah) adalah 6 meter. Tukang yang mengerjakan atap rumah Pak Beni mengatakan bahwa sudut kemiringan atap rumah Pak Beni sebaiknya dibuat 30^0 agar air hujan dapat mengalir dengan baik ke bawah. Pak Beni menyetujui sudut kemiringan tersebut. Kemudian, Pak Beni berpendapat bahwa dengan sudut kemiringan 30^0 maka tinggi atap rumahnya (yang ditunjukkan oleh garis biru) yang harus dibuat adalah lebih dari 2 meter. Apakah pendapat Pak Beni benar? Uraikan alasanmu.

Translation:
Mr. Beni was renovating the roof of his house. The width of the span of the roof framing (shown by the red line) was 6 meters. The builder who was working on the roof of Mr. Beni's house said that the angle of the roof framing of Mr. Beni's house should be made 30^o so that rainwater could run off properly. Mr. Beni agreed with the angle of inclination. Then, Mr. Beni thought that with a slope angle of 30^o, the rise of the roof framing of his house (shown by the blue line) should be more than 2 meters. Was Mr. Beni's opinion, correct? Explain your reasons.

Figure 4. Questions Made by the Teacher

Class: Implementation in the Classroom

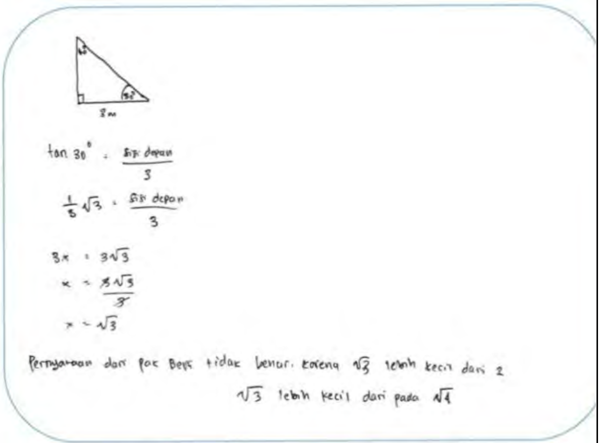
Following the Focus Group Discussion (FGD), the teacher proceeded with implementation activities in the classroom. Utilizing the teaching materials devised during the FGD stage, the teacher engaged students in classroom instruction, as depicted in Figure 5.

Students engaged in learning activities aimed at reinforcing mathematical literacy skills. Figure 6 presents the responses provided by the students. It illustrates a word problem tasking students with assessing the accuracy of Mr. Beni's estimation. The mathematical process involved in this question is interpretation, as students must decipher the information presented in the problem. In Figure 6(a), students approached the problem by calculating the tangent (tan) of 30^o. They then compared this value with $\sqrt{4}$, concluding that Mr. Beni's statement was incorrect since the result was less than 2.

(a) (b)

Figure 5. Teacher and Student Activities in Class

Conversely, in Figure 6(b), students compared the value of sin 30º to the ratio of the perpendicular to the hypotenuse, with the length of the perpendicular being 4 meters as derived from the problem's information.



(a)

Translation:

$$\tan 30^0 = \frac{front\ side}{3}$$

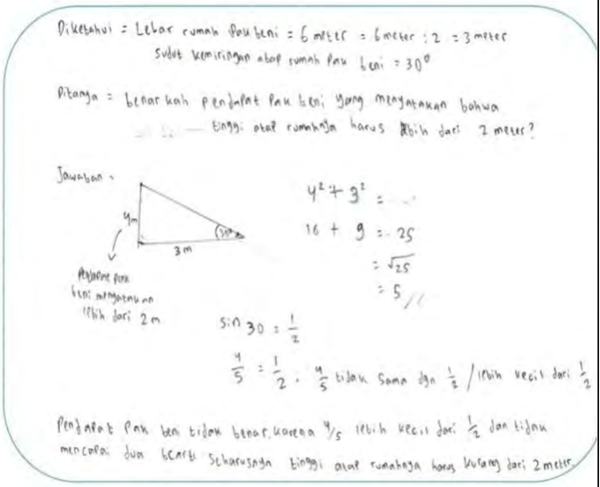
$$\frac{1}{3}\sqrt{3} = \frac{front\ side}{3}$$

$$3x = 3\sqrt{3}$$

$$x = \frac{3\sqrt{3}}{3}$$

$$x = \sqrt{3}$$

Mr Beni's statement was incorrect because $\sqrt{3}$ is less than 2.
$\sqrt{3}$ is less than $\sqrt{4}$



(b)

Translation:
Given:
The span of the framing of Mr Beni's house was 6 meters, so the run was $6 \div 2 = 3\ meters$
The angle of the incline of the roof of Mr. Beni's house is 30^o.

Find:
Is Mr. Beni's opinion that the rest of the roof framing of his house should be more than 2 meters correct or not?

Mr. Beni's opinion was not correct because $\frac{4}{5}$ is less than $\frac{1}{2}$ and does not reach 2, which means that the rise of the roof framing of his house should be less than 2 meters.

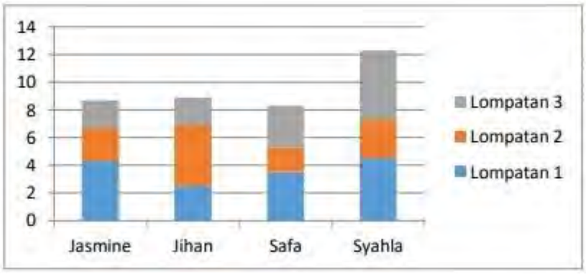
Figure 6. Student's Answer to the Trigonometric Comparison Question

However, an error arose when the students erroneously claimed that $\frac{4}{5}$ is smaller than $\frac{1}{2}$. Despite this, their final conclusion that Mr. Beni's statement needed to be corrected and that the rise of the roof framing should be less than 2 meters remained accurate.

Community: Knowledge Sharing

Following the learning activities, the *Guru Penggerak* proceeded with knowledge-sharing endeavors within the community. They disseminated their insights to fellow educators through online webinars, which drew participants from various provinces across Indonesia. This initiative led to an enhanced understanding of mathematical literacy among participating teachers.

During the webinar sessions, educators gained insights into crafting worksheets and formulating questions designed to reinforce students' mathematical literacy skills. Notably, one of the outcomes of this collaborative effort was the creation of products by participating teachers, such as the one developed by a physical education teacher.



Berdasarkan diagram disamping, Siapakah yang dapat melakukan lompatan terjauh pada lompatan kedua?

Translation:
Based on the chart, who can jump the farthest jump on the second jump?

Figure 7. Question Made by the Physical Education Teacher

Figure 7 depicts a teacher presenting a bar chart illustrating the jump distances of four students. The questions posed by the teacher pertain to uncertainty and data content, with the mathematical process centered on interpretation.

Community: Community Building

The teachers established a mathematical literacy community following the knowledge-sharing activity to foster ongoing collaboration and support. This community was formally registered on the independent teaching platform (PMM), ensuring accessibility to all educators across Indonesia and bolstering the sustainability of the mathematical literacy learning environment for teachers.

Throughout the prototyping stage, it is evident that activities were conducted within a digital environment, classroom settings, and the broader community. Subsequently, the assessment stage ensued, during which the outcomes of the *Guru Penggerak* activities were evaluated to discern the potential effects of the mathematical literacy learning environment, as delineated by the Guskey level. These potential effects, categorized based on the Guskey level, are detailed in Table 5.

Figure 4 shows that students' mathematical literacy abilities were demonstrated, indicating the attainment of Level 5 according to Guskey's model. Beyond the five Guskey levels, the developed mathematical literacy learning environment yielded further potential effects. Notably, the knowledge-sharing stage facilitated the generation of new knowledge among participating teachers. These teachers were subsequently empowered to craft questions to strengthen students' mathematical literacy. This underscores a novel effect of the mathematical literacy learning environment: community learning outcomes.

Table 5. Potential Effects by Guskey Level

Level	Category	Results
1	Participant satisfaction	97.86% of teachers were very satisfied
2	Participant learning	90.71% of teachers were very good at learning
3	Organizational support	Getting support from the school and teacher community.
4	Use of new knowledge or skills	90.48% applied new knowledge well
5	Student learning outcome	Improving students' mathematical literacy skills

The assessment stage has revealed significant potential effects of the developed mathematical literacy learning environment, affirming the alignment of its stages with a digitally supported framework for mathematical literacy learning among teachers. Including knowledge-sharing and community-building stages represents an enrichment of the learning process initially structured around the LEPO framework, giving rise to a novel LEPScO framework (Learning Environment, Learning Process of "knowledge sharing-community building," and Learning Outcome). This evolution has led to the emergence of a learning environment model termed the Digital-Class-Community (D-C-C) model encapsulated within the LEPScO framework, as depicted in Figure 8.

This research has yielded a digitally supported mathematical literacy learning environment for *Guru Penggerak* that meets the validity, practicality, and effectiveness criteria outlined in design research standards (Van den Akker et al., 2007). The D-C-C model, underpinned by the LEPscO framework, comprises a learning environment (D-K-K), a learning process (encompassing training, FGDs, classroom implementation, knowledge sharing, and community building), and learning outcomes characterized by teachers' enhanced understanding of mathematical literacy and their ability to implement activities strengthening it within learning contexts.

The progression within this model starts with a digital learning space hosting training and FGDs, fostering teachers' comprehension of mathematical literacy and its reinforcement in pedagogical practices. This aligns with assertions by Novita and Herman (2021) on the role of digital technology in promoting mathematical literacy and findings from Rushby and Surry (2016) highlighting the positive impacts of digital learning environments.

Subsequently, the learning environment transitions to the classroom setting, where teachers implement teaching materials designed to fortify mathematical literacy. This pedagogical approach aligns with strategies advocated by Höfer and Beckmann (2009) and resonates with recommendations from Kemendikbud (2021) and the professional domain outlined in the AITSL standards (Goos et al., 2020). The assessment stage has validated the effectiveness of the D-C-C model and its potential to foster mathematical literacy among *Guru Penggerak* through a holistic learning approach.

The learning environment extends into the community, facilitating knowledge-sharing activities. Teachers disseminate their expertise through various channels in the mathematical literacy learning environment. This includes conducting webinars with 333 teachers from diverse provinces across Indonesia, sharing instructional videos demonstrating mathematical literacy strengthening practices on YouTube, and distributing informative documents detailing experiences with mathematical literacy implementation within the teacher community, such as the MGMP group on WhatsApp.

These knowledge-sharing endeavors have elicited positive responses from participating teachers, who express enthusiasm and appreciation for the newfound insights and collaborative sharing opportunities. This aligns with the strategy outlined by Kemendikbud (2017b) to promote mathematical literacy through sharing and implementation across various educational ecosystems, including home, school, parents, and the community. The active involvement of all stakeholders is deemed essential for fostering mathematical literacy (Fianto, 2018; Kemendikbud, 2017b).

Efforts to engender engagement and involvement in mathematical literacy are crucial. Juan et al. (2018) underscores the significance of knowledge sharing as a foundational element for creating engagement and fostering collaborative learning environments. By sharing expertise and experiences, teachers enhance their understanding and contribute to the collective advancement of mathematical literacy practices within the broader educational community.

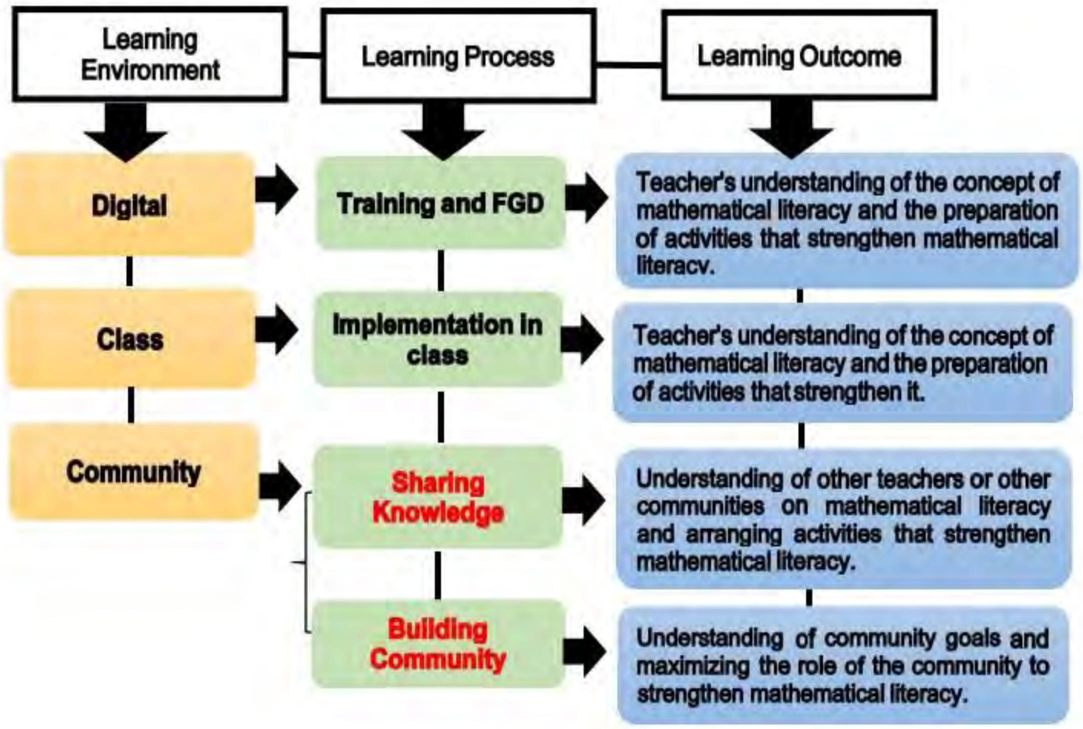


Figure 8. Mathematics Literacy Learning Environment with the LEPscO Framework

In the context of developed mathematical literacy learning environments, knowledge-sharing activities potentially impact not only the designated *Guru Penggerak* but also other participating teachers. Through platforms such as webinars, these teachers can contribute by designing questions pertaining to mathematical literacy within their respective areas of expertise. This emphasis on knowledge sharing is fundamental to fostering an inclusive, responsive, and sustainable learning society, as noted by Rieckman (2018). Such sharing ensures the perpetuation of knowledge, transcending individual or generational limitations. Moreover, it facilitates the dissemination of effective teaching methodologies among educators, as highlighted by recent research (Tonga et al., 2022), thereby offering solutions to common challenges encountered in teaching. This exchange of best practices not only benefits the recipients by providing valuable insights but also contributes to the collective improvement of teaching standards.

In addition to knowledge sharing, activities within a community learning environment serve as crucial avenues for community building. In the realm of mathematical literacy, teamwork is essential for integrating mathematical concepts into practical applications (Smith et al., 2017). Notably, establishing literacy teams within schools represents a significant initiative in advancing mathematical literacy (Kemendikbud, 2017b), thus emphasizing the importance of community building within such learning environments. Learning communities foster collaboration and knowledge exchange among educators, enabling them to engage in discussions, work collaboratively in small groups, and undertake joint projects to promote deeper comprehension and meaningful learning experiences (Kemendikbud, 2022). This approach resonates with various studies that have utilized the Lesson Study Learning Community (LSLC) framework, highlighting the pivotal role of communities in enhancing the quality of learning (Rusiyanti et al., 2022; Fauziah et al., 2020; Rahayu & Putri, 2020). Such research underscores the significance of community engagement in driving educational excellence.

The developed learning environment satisfactorily meets the established criteria for validity. Expert assessments evidence this during the review phase, which confirms the validity of the mathematical literacy learning environment for *Guru Penggerak* across content, construct, and language dimensions. While there were suggestions for improvement, researchers addressed these concerns. According to Van den Akker et al. (2007), validity is attained when a product aligns with established knowledge or scientific principles (content validity) and demonstrates logical consistency in design (construct validity). Analysis of the research findings reveals the validity of the developed mathematical literacy learning environment regarding content, as it adheres to the LEPscO framework and encompasses relevant mathematical literacy content.

Furthermore, the environment exhibits construct validity by aligning with curriculum standards, presenting information appropriately within the Learning Management System (LMS), and effectively enhancing teachers' comprehension of mathematical literacy. Linguistic validity is also upheld, with language adhering to the General Guidelines for Indonesian Spelling (PUEBI), evident, concise, and devoid of ambiguity. These validations affirm the robustness and effectiveness of the developed learning environment for fostering mathematical literacy among educators.

The developed mathematical literacy learning environment successfully fulfills the criterion of practicality, which assesses whether the intervention can be feasibly utilized (Van den Akker et al., 2007; Bakker, 2019). This assessment was conducted across one-to-one, small group, and field test stages. The practicality evaluation indicates that *Guru Penggerak* can effectively engage with the mathematical literacy learning environment without encountering significant difficulties. Furthermore, the developed environment meets the effectiveness criteria, as it demonstrates potential impact and is evaluated based on the Guskey level (Guskey, 2016). According to Van den Akker et al. (2007), effectiveness is determined by how the designed intervention achieves the desired outcomes. These findings affirm that the developed mathematical literacy learning environment is both practical and effective, offering promising prospects for enhancing educators' engagement with mathematical literacy materials and achieving desired learning outcomes.

CONCLUSION

Utilizing the LEPscO framework, this study has successfully developed a valid and practical mathematical literacy learning environment tailored for *Guru Penggerak*. The resultant LEPscO framework comprises a Digital-Class-Community learning environment, a comprehensive learning process encompassing training, focus group discussions, classroom implementation, knowledge sharing, and community building, and defined learning outcomes centered on enhancing teachers' comprehension of mathematical literacy and their ability to fortify it within the learning context. Evaluation of the learning environment's efficacy, measured via the Guskey level, revealed high teacher satisfaction rates, with 97.86% expressing significant satisfaction. Additionally, 90.71% of teachers reported substantial improvements in their learning, while 90.48% demonstrated excellent utilization of newfound knowledge. Notably, the learning environment garnered support from both schools and teacher communities, with observed enhancements in student learning outcomes indicating the cultivation of mathematical literacy skills. Future research recommendations include expanding the application of the LEPscO framework to address other mathematical abilities or further develop teacher competencies. This underscores the framework's potential for broader educational enhancements and professional growth within the teaching community.

Acknowledgment

This article is part of a research project funded by a professional research grant from the Universitas Sriwijaya with the letter number of the Chancellor's letter number 0187/UN9.3.1/SK/2023.

Declarations

Author Contribution	:	TG: Conceptualization, Investigation, Formal Analysis, Writing-Original Draft, Visualization, and Editing. RIIP: Project Administration, Methodology, Editing, Data Curation, Validation and Supervision. Z: Resources, Editing, and Supervision. H: Writing review, Editing, and Supervision.
Funding Statement	:	This research was funded by Universitas Sriwijaya professional research with grant number 0187/UN9.3.1/SK/2023.
Conflict of Interest	:	The authors declare no conflict of interest.
Additional Information	:	Additional information is available for this paper.

REFERENCES

Atase Pendidikan dan Kebudayaan KBRI Singapura. (2021). *Bagaimana Singapura menghasilkan guru berkualitas tinggi* [How Singapore produces high-quality teachers]. Atase Pendidikan dan Kebudayaan KBRI Singapura.

Bakker, A. (2019). *Design research in education: A practical guide for early career researchers*. Routledge.

Bautista, A., Wong, J., & Gopinathan, S. (2015). Teacher professional development in Singapore: Depicting the landscape. *Psychology, Society and Education*, *7*(3), 311–326. https://doi.org/10.25115/psye.v7i3.523

Boman, B. (2020). What makes Estonia and Singapore so good? *Globalisation, Societies and Education*, *8*(3), 115–135. https://doi.org/10.1080/14767724.2019.1701420

Chung, J. (2016). The (mis)use of the Finnish teacher education model: 'Policy-based evidence-making'? *Educational Research*, *58*(2), 207–219. https://doi.org/10.1080/00131881.2016.1167485

Dewantara, A. H., Zulkardi, & Darmawijoyo. (2015). Assessing seventh graders' mathematical literacy in solving PISA-like tasks. *Journal on Mathematics Education*, *6*(2), 117–128. https://doi.org/10.22342/jme.6.2.2163.117-128

Ekawati, R., Susanti, S., & Chen, J.-C. (2020). Primary students' mathematical literacy: A case study. *Infinity Journal*, *9*(1), 49–58. https://doi.org/10.22460/infinity.v9i1.p49-58

Fauziah, A., Putri, R. I. I., Zulkardi, & Somakim. (2020). Developing PMRI learning environment through lesson study for pre-service primary school teacher. *Journal on Mathematics Education*, *11*(2), 193-208. https://doi.org/10.22342/jme.11.2.10914.193-208

Fianto, F. (2018). *Literasi numerasi dalam pengembangan klub STEAM dan wirausaha di sekolah* [Numeracy literacy in STEAM club development and entrepreneurship in schools]. Direktorat Jenderal Pendidikan Dasar dan Menengah, Kementerian Pendidikan dan Kebudayaan.

Goos, M., Geiger, V., Dole, S., Forgasz, H., & Bennison, A. (2020). *Numeracy across the curriculum*. Routledge. https://doi.org/10.4324/9781003116585

Guskey, T. R. (2016). Gauge impact with 5 levels of data. *Journal of Standards and Development*, *37*(1), 32–37. https://learningforward.org/wp-content/uploads/2016/02/february-2016-jsd.pdf#page=34

Gustiningsi, T. (2015). Pengembangan soal matematika model PISA untuk mengetahui kemampuan berpikir kritis matematis siswa kelas VII [Developing PISA model math questions to determine the mathematical critical thinking skills for seventh grade students]. *Jurnal Pendidikan Matematika RAFA*, *1*(1), 139–158. https://openrecruitment.radenfatah.ac.id/index.php/jpmrafa/article/view/1228/1021

Gustiningsi, T., Putri, R. I. I., Zulkardi, & Hapizah. (2022a). Identifikasi lingkungan belajar literasi matematika untuk guru [Identification of math literacy learning environment for teachers]. *Histogram: Jurnal Pendidikan Matematika*, *6*(2), 333–348. http://dx.doi.org/10.31100/histogram.v6i2.2425

Gustiningsi, T., Putri, R. I. I., Zulkardi, & Hapizah. (2022b). Secondary mathematics teachers' ability in solving PISA-like mathematics problems. *AIP Conference Proceedings*, *2577*(1), 0096217. https://doi.org/10.1063/5.0096217

Gustiningsi, T., & Somakim. (2021). Pengembangan soal matematika tipe PISA level 5 konteks pribadi [Developing PISA-type math problems level 5 personal contexts]. *Aksioma: Jurnal Program Studi Pendidikan Matematika*, *10*(2), 915–926. https://dx.doi.org/10.24127/ajpm.v10i2.3535

Höfer, T., & Beckmann, A. (2009). Supporting mathematical literacy: Examples from a cross-curricular project. *ZDM - International Journal on Mathematics Education*, *41*, 223–230. https://doi.org/10.1007/s11858-008-0117-9

Hwang, J., Choi, K. M., Bae, Y., & Shin, D. H. (2018). Do teachers' instructional practices moderate equity in mathematical and scientific literacy?: An investigation of the PISA 2012 and 2015. *International Journal of Science and Mathematics Education*, *16*, 25-45. https://doi.org/10.1007/s10763-018-9909-8

Juan, S. H., Ting, I. W. K., Kweh, Q. L., & Yao, L. (2018). How does knowledge sharing affect employee engagement? *Institutions and Economies*, *10*(4), 49–67. https://juku.um.edu.my/index.php/ijie/article/view/13445/8427

Kemendikbud. (2017a). *Materi pendukung literasi numerasi* [Numeracy literacy support materials]. Kementerian Pendidikan dan Kebudayaan. https://gln.kemdikbud.go.id/glnsite/wp-content/uploads/2017/10/cover-materipendukung-literasi-numerasi-gabung.pdf

Kemendikbud. (2017b). *Modul penyusunan soal Higher Order Thinking Skill (HOTS)* [Higher Order Thinking Skill (HOTS) question preparation module]. Direktorat Pembinaan SMA, Direktorat Jenderal Pendidikan Dasar dan Menengah, Departemen Pendidikan dan Kebudayaan. https://doi.org/10.1017/CBO9781107415324.004

Kemendikbud. (2021). *Panduan penguatan literasi dan numerasi di sekolah* [Guidelines for strengthening literacy and numeracy in schools]. Kementerian Pendidikan dan Kebudayaan

Kemendikbud. (2022). *Strategi pengembangan komunitas belajar guru dan kepala sekolah untuk mendukung implementasi kurikulum merdeka* [Strategies for developing teacher and principal learning communities to support the implementation of an independent curriculum]. Kementerian Pendidikan dan Kebudayaan

Kemendikbudristek. (2022). *Buku panduan capaian hasil asesmen nasional* [Guidebook for national assessment results]. Pusat Asesmen Pendidikan Kemdikbudristek. https://pusmendik.kemdikbud.go.id/

Lestari, Y., As'ari, A. R., & Muksar, M. (2021). Analysis of students' mathematical literacy skill in solving PISA mathematical problems. *MaPan*, *9*(1), 102–118. https://doi.org/10.24252/mapan.2021v9n1a7

Mansyur, A. R. (2021). Wawasan kepemimpinan guru (teacher leadership) dan konsep guru penggerak [Insights into teacher leadership and the concept of teacher mobilizers]. *Education and Learning Journal*, *2*(2), 101–109. https://doi.org/10.33096/eljour.v2i2.113

Meroni, E. C., Vera-Toscano, E., & Costa, P. (2015). Can low skill teachers make good students? Empirical evidence from PIAAC and PISA. *Journal of Policy Modeling*, *37*(2), 308–323. https://doi.org/10.1016/j.jpolmod.2015.02.006

Msimanga, M. R. (2020). Teaching and learning in multi-grade classrooms: The LEPO framework. *Africa Education Review, 17*(3), 123-141. https://doi.org/10.1080/18146627.2019.1671877

Mu, J., Peng, G., & Love, E. (2008). Interfirm networks, social capital, and knowledge flow. *Journal of Knowledge Management*, *12*(4), 86-100. https://doi.org/10.1108/13673270810884273

Nortvedt, G. A., & Wiese, E. (2020). Numeracy and migrant students: A case study of secondary level mathematics education in Norway. *ZDM-Mathematics Education*, *52*, 527–539. https://doi.org/10.1007/s11858-020-01143-z

Novita, R., & Herman, T. (2021). Digital technology in learning mathematical literacy: Can it helpful? *Journal of Physics: Conference Series*, *1776*(1), 012027. https://doi.org/10.1088/1742-6596/1776/1/012027

OECD. (2003). *Learning for tomorrow' s world first results from PISA 2003*. OECD Publishing.

OECD. (2014). *PISA 2012 results: What students know and can do-student performance in mathematics, reading and science*. OECD Publishing.

OECD. (2016). *PISA 2015 results*. OECD Publishing.

OECD. (2019). *PISA 2018 insight and interpretations*. OECD Publishing.

OECD. (2023). *PISA 2022 results (Volume I)*. OECD Publishing.

Pasaloran, O. (2019). Teori Stewardship: Tinjauan konsep dan implikasinya pada akuntabiitas organisasi sektor public [Stewardship Theory: A review of the concept and its implications for public sector organizational accountability]. *Jurnal Bisnis dan Akuntansi*, *3*(2), 419-432. https://doi.org/10.34208/jba.v3i2.518

Perkins, D. N. (2013). Technology meets constructivism: Do they make a marriage?. In *Constructivism and the technology of instruction* (pp. 45-55). Routledge. https://doi.org/10.4324/9780203461976

Phillips, R., McNaught, C., & Kennedy, G. (2010). Towards a generalised conceptual framework for learning: The Learning Environment, Learning Processes, and Learning Outcomes (LEPO) framework. *Proceedings of the 22nd Annual World Conference on Educational Multimedia Hypermedia Telecommunications Toronto Canada 28 June–2 July*, 2495–2504.

Phillips, R., McNaught, C., & Kennedy, G. (2019). The Learning Environment, Learning Processes, and Learning Outcomes (LEPO) framework. In *Evaluating e-Learning* (pp. 23-42). Routledge. https://doi.org/10.4324/9780203813362-3

Piper, B., Simmons Zuilkowski, S., Dubeck, M., Jepkemei, E., & King, S. J. (2018). Identifying the essential ingredients to literacy and numeracy improvement: Teacher professional development and coaching, student textbooks, and structured teachers' guides. *World Development*, *106*, 324-336. https://doi.org/10.1016/j.worlddev.2018.01.018

Putri, R. I. I., & Zulkardi. (2020). Designing PISA-like mathematics task using Asian games context. *Journal on Mathematics Education*, *11*(1), 135–144. https://doi.org/10.22342/jme.11.1.9786.135-144

Rahayu, P. T., & Putri, R. I. I. (2020). Project-based mathematics learning: Fruit salad recipes in junior high school. *Journal on Mathematics Education*, *12*(1), 181-198. https://doi.org/10.22342/JME.12.1.13270.181-198

Rieckman, M. (2018). Key themes in education for sustainable development. In *Issues and trends in education for sustainable development* (pp. 61-84). UNESCO.

Rushby, N., & Surry, D. W. (2016). *The Wiley handbook of learning technology*. John Wiley & Sons. https://doi.org/10.1002/9781118736494

Rusiyanti, R. H., Zulkardi, Putri, R. I. I., & Somakim. (2022). Developing RME-based lesson study for learning community in the learning environment of high school mathematics teachers. *Journal on Mathematics Education*, *13*(3), 499–514. https://doi.org/10.22342/jme.v13i3.pp499-514

Sahlberg, P. (2011). PISA in Finland: An education miracle or an obstacle to change? *Center for Educational Policy Studies Journal*, *1*(3), 119–140. https://doi.org/10.26529/cepsj.418

Satriawan, W., Santika, I. D., Naim, A., Tarbiyah, F., Raya, B., Selatan, L., Timur, L., Bakoman, A., & Panggung, P. (2021). Guru penggerak dan transformasi sekolah [*Guru Penggerak* and schools transformation]. *Al-Idarah: Jurnal Kependidikan Islam*, *11*(1), 1–12. http://dx.doi.org/10.24042/alidarah.v11i1.7633

Smith, W. M., Lawler, B. R., & Bowers, J. (2017). *Introducing mathematical literacy PDSAs into a partnership team*. Association of Public and Land-grant Universities.

Soh, K. (2014). Finland and Singapore in PISA 2009: Similarities and differences in achievements and school management. *Compare*, *44*(3), 455–471. https://doi.org/10.1080/03057925.2013.787286

Stacey, K. (2011). The PISA view of mathematical literacy in Indonesia. *Journal on Mathematics Education*, *2*(2), 95–126. https://doi.org/10.22342/jme.2.2.746.95-126

Stacey, K., & Turner, R. (2015). Assessing mathematical literacy: The PISA experience. In *Assessing mathematical literacy: The PISA experience*. https://doi.org/10.1007/978-3-319-10121-7

Supriyati, Y., & Muqorobin. (2021). Mixed model Cipp dan Kickpatrick sebagai pendekatan evaluasi program pengembangan kompetensi guru berbasis kebutuhan peningkatan kemampuan asesement literasi-numerasi (Cilapp model dalam evaluasi program) [Mixed model of Cipp and Kickpatrick as a program evaluation approach for need-based teacher competency development to improve literacy-numeracy assessment skills (Cilapp model in program evaluation)]. *Jurnal Ilmiah Mandala Education*, *7*(1), 203–223.

Susanti, E., & Syam, S. S. (2017). Peran guru dalam meningkatkan kemampuan literasi matematika siswa Indonesia [The role of teachers in improving the mathematical literacy skills of Indonesian students]. *Seminar Matematika dan Pendidikan Matematika UNY*. http://seminar.uny.ac.id/semnasmatematika/sites/seminar.uny.ac.id.semnasmatematika/files/full/M-41.pdf

Swan, M., & Swain, J. (2010). The impact of a professional development programme on the practices and beliefs of numeracy teachers. *Journal of Further and Higher Education*, *34*(2), 165–177. https://doi.org/10.1080/03098771003695445

Tonga, F. E., Eryiğit, S., Yalçın, F. A., & Erden, F. T. (2022). Professional development of teachers in PISA achiever countries: Finland, Estonia, Japan, Singapore, and China. *Professional Development in Education, 48*(1), 88-104. https://doi.org/10.1080/19415257.2019.1689521

Van den Akker, J., Bannan, B., Kelly, A. E., Nieveen, N., & Plomp, T. (2007). *An introduction to educational design research*. SLO.

Widjaja, W. (2011). Towards mathematical literacy in the 21st century: Perspectives from Indonesia. *Southeast Asian Mathematics Education Journal,* *1*(1), 75-84. https://doi.org/10.46517/seamej.v1i1.12

Wijaya, A. (2016). Students’ information literacy: A perspective from mathematical literacy. *Journal on Mathematics Education*, *7*(2), 73–82. https://doi.org/10.22342/jome.v7i2.3532

Wijaya, A., van den Heuvel-Panhuizen, M., & Doorman, M. (2015a). Opportunity to learn context-based tasks provided by mathematics textbooks. *Educational Studies in Mathematics*, *89*, 41–65. https://doi.org/10.1007/s10649-015-9595-1

Wijaya, A., van den Heuvel-Panhuizen, M., & Doorman, M. (2015b). Teachers’ teaching practices and beliefs regarding context-based tasks and their relation with students’ difficulties in solving these tasks. *Mathematics Education Research Journal*, *27*, 637–662. https://doi.org/10.1007/s13394-015-0157-8

Wium, A.-M., & Louw, B. (2012). Continued professional development of teachers to facilitate language used in numeracy and mathematics. *South African Journal of Communication Disorders, 59*(1), 8-15. https://doi.org/10.4102/sajcd.v59i1.17

Wong, K., Kapoor, V., Tso, A., OConnor, M., Convissar, D., Kothari, N., & Traba, C. (2021). Environments, processes, and outcomes - using the LEPO framework to examine medical student learning preferences with traditional and electronic resources. *Medical Education Online*, *26*(1), 1–9. https://doi.org/10.1080/10872981.2021.1876316

Zulkardi. (2002). Developing a learning environment on Realistic Mathematics Education for Indonesian student teacher. *Thesis.* University of Twente, Enschede.

Zulkarnain, I., Hidayanto, T., & Kamaliyah. (2021). Students mathematical literacy in solving wetlands contextual problems. *Journal of Physics: Conference Series*, *1760*(1), 012044. https://doi.org/10.1088/1742-6596/1760/1/012044