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Needs Analysis of the Development of Project-Based Mathematics Learning Modules for Grade 2 (Phase A) Elementary School Teachers

Dian Anggraeni Tri Astuti, Mohd Nazir Bin MD Zabit*
Curriculum Studies, Universiti Pendidikan Sultan Idris, Malaysia
E-mail: mohd.nazir@fpm.upsi.edu
* Corresponding Author

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ABSTRACT

Pembelajaran Matematika di sekolah dasar bertujuan membuat siswa memahami konsep matematka, menjelaskan konsep matematika, menjelaskan keterkaitan antar konsep, dan mengaplikasikan konsep secara tepat untuk memecahkan masalah. Kemampuan guru dalam merancang pembelajaran yang efektif dan tepat menjadi bagian penting agar keterampilan tersebut dapat dikuasai siswa sekolah dasar. Oleh karena itu, penelitian ini bertujuan untuk menganalisis kebutuhan guru terkait pengembangan modul ajar pembelajaran matematika berbasis proyek (PjBL) di kelas 2 sekolah dasar dalam Kurikulum Merdeka. Penelitian ini menggunakan metode kuantitatif deskriptif dengan purposive sampling pada 884 guru fase A (kelas 1 dan 2) di Jawa Barat sebagai partisipannya. Data dikumpulkan melalui kuisioner yang mengukur kebutuhan guru dalam pengembangan modul ajar matematika berbasis PjBL dan dianalisis besaran prosentase dan meaan hasil kuesioner menggunakan microsoft excel . Hasil penelitian menunjukkan bahwa 81% guru menyatakan kebutuhan yang tinggi untuk pengembangan modul ajar matematika berbasis PjBL dengan skor rata-rata 4,23 hingga 4,27. Hal ini menunjukkan bahwa guru membutuhkan modul tersebut untuk meningkatkan kemampuan mereka dalam melaksanakan pembelajaran berbasis proyek di kelas matematika. Tema bilangan dan geometri menjadi pilihan utama guru untuk pengembangan modul berbasis PjBL. Berdasarkan hasil analisis kebutuhan, direkomendasikan untuk mengembangkan modul ajar matematika berbasis PjBL untuk guru kelas 2 sekolah dasar dalam meningkatkan praktik mengajar berbasis proyek agar menumbuhkan keterampilan abad 21 siswa, yaitu 4C, yang sesuai dengan tujuan pendidikan Kurikulum Merdeka di Indonesia.

Mathematics learning in elementary schools aims to make students understand mathematical concepts, explain mathematical concepts, explain the relationship between concepts, and apply concepts appropriately to solve problems. The teacher's ability to design effective and appropriate learning is an important part so that these skills can be mastered by elementary school students. Therefore, this research aims to analyze teachers' needs for developing a project-based mathematics learning pedagogy module (PjBL) in grade 2 elementary schools in the Indonesian Merdeka Curriculum. This study used a descriptive quantitative method with purposive sampling on 884 phase A teachers (grades 1 and 2) in West Java as participants. Data were collected through a questionnaire that measured the needs of teachers in developing PjBL-based mathematics teaching modules and analyzed the percentage and meaan results of the questionnaire using Microsoft Excel. The results showed that 81% of teachers expressed a high need for developing PjBL-based mathematics teaching modules, with an average score of 4.23 to 4.27, indicating they are at the agreeable or excellent stage. This result showed that teachers need the module to improve their ability to implement project-based learning in the mathematics classroom. Number and geometry themes were teachers' main choices when developing PjBL-based mathematics modules. The needs analysis results recommend the development of a PjBL-based mathematics

teaching module for grade 2 primary school teachers in improving project-based teaching practices to foster 21st-century skills, namely the 4Cs, in accordance with the educational objectives of the Merdeka Curriculum in Indonesia..

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INTRODUCTION

Mathematics is an important subject that serves as the fundamental basis for the development of modern technology. Furthermore, numerous mathematical concepts that apply to everyday situations can be acquired and mathematics is needed in everyday life to explain the actual situation so that problems can be solved (Wanabuliandari et al., 2023). In Indonesia, the mathematics curriculum begins at the elementary school level to foster students' comprehension of mathematical principles and develop their capacity for logical, analytical, systematic, critical, and creative thinking (Syafri, 2023). Mathematical thinking should examine commercial, social, technical, and scientific advancements, considering the multiple options available to address present-day challenges (Warner & Kaur, 2017).

The Merdeka Curriculum is a new curriculum in Indonesia that uses various learning approaches so students have sufficient time to learn ideas and strengthen their skills (Khoirurrijal, 2022). Project-based learning (PjBL) is a learning model in the Merdeka curriculum that encourages student involvement in determining success. Inspired by John Dewey (1897) and William Kilpatrick (1918), project-based learning aims to provide an engaging, active, and student-centered approach to learning. Project-based learning (PjBL) is a systematic teaching approach that engages students in learning essential 21st-century knowledge and skills (Pellegrino & Hilton, 2012), helps learners learn how to carry out structured inquiry processes (Nofiani & Senen, 2019) and produce products through carefully designed learning tasks (Hallermann et al., 2011). Project-based learning (PjBL) offers a diverse range of choices in the problem-solving process and has the potential to stimulate students intellectually (Craig & Marshall, 2019). While students may enjoy the freedom of learning, it is essential to focus on the predetermined learning objectives established by teachers and students. Thomas et al. (2015) states that project-based learning (PjBL) involves students in problem-solving, decision-making, and investigative tasks. It allows students to work independently for extended periods and results in the creation of realistic products or presentations (Sarpong et al., 2020). Acquiring the 4C competencies of the twenty-first century is of the utmost importance in educating students (Pellegrino & Hilton, 2012).

A deep understanding of math concepts will help students solve everyday problems. Project-based learning (PjBL) helps students understand the daily application of mathematics (Abidin et al., 2020). In addition, students can use reasoning to interpret lessons and connect math to real-world situations (Abidin et al., 2020). As determined by the Ministry of Education and Culture's learning outcomes and school achievement standards, projects may and ought to be constructed emphasizing vital subject matter. Children between the ages of five and seven can gain knowledge of these topics by engaging in various games. Hence, the objective of instructing mathematics in elementary schools nowadays should not primarily revolve around accurately solving math problems, as numeracy entails the capacity to apply number concepts and arithmetic operations in practical situations (Kemendikbudristek, 2021). Consequently, to be adequately prepared for the challenges of the twenty-first century, students must possess a minimum of four essential skills: (1) critical thinking and problem-solving, (2) communication, (3) collaboration, and (4) creativity and innovation (Kay & Greenhill, 2011).

Trend In International Mathematics And Science Study (TIMSS) and Programme for International Student Assessment (PISA) reviews show that Indonesian students' mathematical abilities

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are still below international levels (I. V. S. Mullis et al., 2015; I. V. Mullis et al., 2021). The TIMSS 2015 math and science assessments were conducted using a comprehensive evaluation framework created in cooperation with the countries involved. The framework at each grade level comprises two dimensions: a content dimension that delineates the specific content to be evaluated and a cognitive dimension that delineates the specific thinking processes to be evaluated. Indonesia was ranked 38th out of the 42 countries participating in the TIMSS study in 2011. According to the most recent TIMSS 2015 results, Indonesia ranks 44th out of 49 countries (I. V. S. Mullis et al., 2015).

Furthermore, starting in 2021, Indonesia has implemented a new method of evaluating the numeracy skills of its students by administering the Minimum Competency Assessment (AKM) test. AKM evaluates fundamental skills that are necessary for students to enhance their abilities. The findings of the AKM are presented in the Education Report Card, which displays the assessment of the education system. Student learning outcomes, learning processes, equal distribution of services, school management, and the human resources involved determine assessment results. The first National Education Report Card, released in 2022, revealed that primary school students in Indonesia scored 1.57 in numeracy skills based on the 2021 assessment. The score range for these skills was between 1.40 and 1.79. This data suggests that fewer than 50% of students have attained fundamental numeracy skills, encompassing basic computational abilities in direct equations, basic concepts in geometry and statistics, and problem-solving. The 2022 report on the numeracy skills of Indonesian students reveals that 46.67% of students possess numeracy skills that surpass the minimum requirement. This data represents a notable increase of 16.01% from the previous figure of 30.66% of students falling within the moderate category, which encompasses 40 to 70% of students. Based on the Education Report Card findings, Indonesian students' abilities are still classified as moderate because, as of 2015, there has been no discernible improvement in their TIMMS and PISA scores. According to Prastyo (2020) study, Indonesian students exhibit limited proficiency in mathematics and can only solve basic mathematical problems.

Additional research investigates the perspectives, dispositions, and preparedness of educators, all of which have the potential to impact academic achievement. According to the SMERU Research Institute-RISE Program Study in Indonesia (2020), teacher professional development in Indonesia has been ineffective for over four decades. The research underscores the notion that Continuing Professional Development (CPD) does not yield any significant enhancement in educators' skills or learning practices. Teachers' learning practices fail to materialize following the completion of CPD (Revina et al., 2020). Furthermore, Purnomo's (2017) research revealed that educators often adopt a constructivist stance regarding the essence of mathematics, mathematics instruction, and mathematics learning evaluation. However, this inclination is not accompanied by a suitable curriculum in mathematics. While the teachers who participated in this research tended to adhere to constructivist principles, they also tended to employ more conventional instructional methods. It appears that teachers prefer instrumental instruction over relational instruction. Context-relevant learning is frequently disregarded in instrumental instruction and is synonymous with outcome-based learning instead of process-based learning (Purnomo, 2017).

The empirical evidence indicates that Indonesian education warrants serious consideration. Leung & Mak (2010) argue that the teacher plays a crucial role in integrating the curriculum. The role of teachers is influenced by their understanding and interpretation of curriculum integration, the challenges and obstacles they must overcome, and the necessity for support in the implementation process. According to the World Bank, a mere 5% of primary school teachers in Indonesia possess adequate teaching skills to enhance their students' learning (World Bank, 2016). Approximately 10% of teachers nationwide are absent from classes (ACDP Indonesia, 2014), a more prevalent phenomenon in rural regions. Teacher-centered learning has a lower level of interaction with students compared to learner-centered approaches. (World Bank, 2015). A project-based active learning pedagogy module should be developed to help teachers improve their ability to teach numeracy (math learning) to their students.

A needs analysis study is essential to the module design and development research process. The initial research phase is the needs analysis stage, which is crucial for gathering information about the specific context and environment a researcher intends to investigate (Siraj et al., 2013). This study determined the requirements of teachers in developing a module for project-based mathematics learning. Project-based modules in mathematics are anticipated to be created for the final A phase (grade 2). As

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part of this research, a needs analysis was carried out at the start of the research year to determine the specific requirements of teachers for developing a project-based mathematics teaching module. This module effectively addresses teachers' requirements, enhances motivation, and facilitates learning.

METHOD

This research used a descriptive qualitative approach. The sampling technique used was purposive sampling, which selects respondents based on the researcher's expertise and research objectives (Creswell, 2019). The selected respondents represent the research population (Richey, R., Klein, 2014). The respondents in this study were teachers from primary schools in West Java, Indonesia. The respondents were evenly distributed throughout the West Java region. The sampling technique was purposive sampling on respondents with the qualification of teaching in primary school grade 2 phase A end.

The research instrument used an online questionnaire survey conducted through Google Forms and supplemented with interviews. Primary data were obtained from the questionnaire and supplemented with data obtained from teacher interviews. The questionnaire was intended to analyze the need for developing a teaching module for teachers through a project-based teaching module framework for mathematics (Matematik-PjBL) in grade 2 or final phase A primary schools. Additional interview data was conducted on 5 grade 2 or phase A elementary school teachers to deepen the results of the data obtained from the questionnaire instrument. The questionnaire instrument in this study was divided into three sections. Section I summarizes the demographic information of the respondents. Section II contains three questions regarding the need for teaching modules. Section III contains questions about specific topics that teachers want to be covered in the module. The sections of the research instrument can be seen in Table 1.

Table 1. Sections of the Instrument

Section	Content of the Instrument	Instrument Purposes
Section 1	Demografic Information	Knowing the demographic information of participants in the form of gender, age, teaching experience, academic graduates and place of teaching.
Section II	Module Framefowrk Creation	The level of teacher needs for the development of a Project Based Learning-based mathematics teaching module.
Section III	Module Development Approval	Teachers' level of agreement with the content of the material in the framework of the Project Based Learning-based Mathematics teaching module.

Before utilizing the instrument in this study, it is imperative to ascertain the validity and reliability of the research questions. Multiple experts participated in the questionnaire's validation process to ensure its contents' accuracy. Three of the four experts participating in this validation test verified the construction of the questions. At the same time, the remaining linguist ensured the linguistic structure of the questions was correct and accurate. The experts involved in the evaluation process consist of three highly experienced mathematics teachers with doctoral degrees and one Indonesian language teacher with a master's degree. Before administering the questionnaire to teachers in West Java, the researcher conducted a pilot study in Central Java involving 30 teachers who were asked to complete the questionnaire. This procedure was conducted to ascertain the internal consistency of the items. The Cronbach alpha coefficients were computed using Microsoft Excel based on the data collected during the pilot study. The Cronbach alpha values for the research questionnaires are presented in Table 2.

Table 2. Cronbach Alpha Reliability Test Results Table

Reliability coefficient	Interpretation
0.927	highly reliable

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Table 1 shows the research questionnaire has acceptable internal item consistency, with a Cronbach's alpha value of 0.927 for all fourteen items. Therefore, this review can be used in the study. The study used a 5-point Likert scale, with each point indicating a particular agreement stage, as shown in Table 3.

Table 3. Likert Scale Table

1	**2**	**3**	**4**	**5**
Strongly disagree	disagree	Neither agree	Agree	Strongly agree

The obtained questionnaire data was analyzed using descriptive analysis techniques, specifically by calculating percentages and standard deviations. Similarly, the interview results were processed descriptively.

RESULT AND DISCUSSION

Respondent Demographics

The explanation for the study decisions consists of three primary components: firstly, the demographics of the respondents; secondly, the necessity to develop a project-based mathematics (PjBL) module; and thirdly, the selection of the mathematics subject in phase A.

Table 4. Respondent Demographic Distribution Table

Gender	Percentage (%)
Male	5
Female	95
The age range of respondents	Percentage (%)
20 – 29 years	24.1
30 – 39 years	26.4
40 – 49 years	20.1
≥ 50 years	29.4
Teaching experience	Percentage (%)
≤ 5 years	25.3
6 – 10 years	17.3
11 – 15 years	17.6
≥ 16 years	39.8
Education	Percentage (%)
Bachelor's degree (S1)	98.2
Master's degree (S2)	1.8
Doctoral degree (S3)	-

Needs Analysis Regarding the Necessity of Module Development

The questionnaire employed descriptive analysis to ascertain the needs of teachers for module development. The mean and standard deviation for each item were computed using the data analysis feature in Microsoft Excel. The mean values obtained from Torrefranca (2017) and Arikunto (2013) were utilized to interpret the mean values presented in Table 5 and 6.

Table 5. Interpretation of Mean Value (Torrefranca, 2007)

Mean Rating	Interpretations	
4.5 – 5.0	*Strongly Agree*	*Excellent*
3.5 – 4.49	*Agree*	*Very Good*
2.5 – 3.49	*Undecided*	*Good*
1.5 – 2.49	*Disagree*	*Fair*
1.0 – 1.49	*Strongly Disagree*	*Poor*

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Table 6. Interpretation of Average Value (Arikunto, 2013)

Mean Rating (%)	Interpretations
0 - 20	Very Unnecessary
21 - 40	No Need
41 - 60	Medium
61 - 80	Need
81 - 100	Very need

The results of the questionnaire related to the needs of module development were analyzed and calculated the percentage and standard deviation, the results of the needs analysis can be seen in Table 7.

Table 7. Table of Mean Scores and Interpretations Related to the Need for Project-Based Mathematics Module Development (PjBL)

No.	Statement	Respondents' Total Score (n=884)	Total Score Percentage (n = 4420)	Mean±STD
1	The application of mathematics learning using a project-based learning approach is very necessary.	3739	84.59	4.23±0.649
2	The development of a math learning module using a project-based learning approach is needed.	3745	84.73	4.24±0.600
3	The development of a mathematics learning module using a project-based learning approach can help teachers' ability to implement project-based learning in mathematics classes in the future.	3779	85.50	4.27±0.577

For items 1 to 3, statements related to teachers' needs for applying and developing project-based mathematics modules (PjBL) to improve their skills in implementing project-based learning in their mathematics classes. Based on Arikunto's (2013) criteria, teachers gave an approval rate of 81% which is a very necessary level. In addition, based on Torrefranca's (2017) criteria, the level of teacher need for the three statements above reached a score of 4.23 to 4.27, indicating an agreement or very good level. The studies of Leong et al. (2020) and Galadima et al. (2019), show that module development is essential to improve pedagogy and teaching and learning processes. The attributes of the resulting learning modules should be capable of assisting teachers in preserving students' comprehension of mathematics concepts (Leong et al., 2020). In the context of this research, a needs analysis was conducted at the beginning of the research year to ensure that teachers require the development of a project-based mathematics teaching module. This ensured that this module could meet teachers' needs, increase their motivation, and support their learning. Some studies show that teachers face difficulties in exploring relevant mathematical concepts (Diego-Mantecon et al., 2021). In addition, this project-based learning (PjBL) model involves complex projects that require considerable time to complete. Teachers also face challenges in preparing students to understand the use of mathematics in everyday life in context, as well as understanding the necessary mathematical rules and procedures (Diego-Mantecon et al., 2021). The success of project-based learning models in the classroom depends on the role and knowledge of the teacher (Avishai & Palatnik, 2022). Design and preparation issues were also studied by Gillies & Boyle (2010) who studied teachers' experiences in collaborative learning. Their analysis showed that teachers gained valuable experience in using the project-based learning (PjBL) model, but they also faced some challenges in that collaborative learning and projects require careful preparation and planning, require higher levels of concentration and good time management. The key to successful implementation and management of the project process in project-based learning (PjBL) relies on the teacher's mastery of the subject content and flexibility in his/her instructional planning (Nicole & Ambra, 2014).

In another country, such as Taiwan, a project was created and executed to tackle the issue of students' low mathematics performance in TIMSS and PISA. This project involved developing a fundamental activity module and supporting the professional growth of mathematics teachers to use the

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module effectively, thereby engaging students in learning mathematics. The results demonstrated that the project greatly enhanced students' cognitive and emotional involvement in learning mathematics. These outcomes can guide government education reforms and propose practical instructional strategies for teachers and educators to boost student engagement in East Asian countries (Lin et al., 2018). Project-based learning also allows students to apply mathematical methods to identify additional problems, offering new learning experiences highlighting the interconnectedness of various scientific fields (Ramadhani & Fitri, 2020). In addition, the research from (Susanto et al., 2021) is that the Project Based Learning (PjBL) model based on local culture effectively improves the students' critical thinking skills. Additionally, it has been demonstrated that using this project-based learning approach makes students more motivated and interested in learning (M. D. Nasution et al., 2021; S. W. Nasution, 2022). Ester Paruntu et al., (2018) showed the results of her research that the scaffolding-based project learning model was adequate for mathematical communication skills.

Based on the needs analysis results of elementary school teachers who need a project-based learning model applied in mathematics learning in the form of a learning module. The module is expected to be used in the future and can improve the competence of elementary school students.

Table 8. Analysis of the approval stage of the content requirements

No	Phase A Learning Outcome Items	Respondents' Total Score (n=884)	Persentase (total shoes = 5 x 884 = 4420)	Mean±STD
	Numbers			
1	Understand and have number sense in numerical numbers up to 100	3821	86.45	4.32±0.612
2	Read, write, determine place value, compare, order, and perform composition and decomposition of numbers.	3861	87.35	4.37±0.567
3	Perform addition and subtraction operations on whole numbers using concrete objects up to 20.	3876	87.69	4.38±0.612
4	Understand fractions as part of the number concept by dividing an object or group of objects equally. The fractions introduced are half and quarter.	3755	84.95	4.25±0.636
	Total		86.61	
	Algebra			
5	Understand the meaning of the mathematical symbol "=" in a mathematical sentence related to the addition and subtraction of integers 0 to using pictures	3825	86.54	4.33±0.579
	Measurements			
6	Comparing the length and weight of objects directly and comparing time duration	3777	85.45	4.27±0.620
7	Measure and estimate the length of objects using non-standard units.	3730	84.39	4.22±0.676
	Total		84.92	
	Geometry			
8	Recognize various flat shapes (triangle, quadrilateral, triangle, circle) and spatial shapes (block, cube, cone, and ball).	3856	87.24	4.36±0.591
9	Compose (composition) and decompose (decomposition) a flat shape (triangle, square, and triangle).	3727	84.32	4.22±0.658
10	Determine the position of an object relative to another object, specifically in terms of right, left, front, and back.	3792	85.79	4.29±0.607
	Total		85.78	
	Data Analysis and Probability			
11	Sort, categorize, compare, and present data from many objects utilizing tally marks and pictorial representations.	3665	82.92	4.15±0.709

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Teachers assigned an approval rate of 81% to items 1 to 11, specifically statements on topics or materials recommended for module teaching development according to Arikunto's (2013) criteria. This demonstrates the indispensability of the topic and strong endorsement of the topic for developing teaching modules. Furthermore, according to Torrefranca's (2017) criteria, the level of teacher need for the three statements mentioned above was rated between 4.15 and 4.38, indicating an agreement. The researcher will choose the number and geometry theme based on the theme with the highest percentage value.

The findings from the teacher interviews were utilized to enhance the survey results. The individuals interviewed consisted of nine primary school teachers from phase A. The interviews with teachers employed open-ended questions to gather information. Specifically, two questions were asked: (1) What challenges do phase A teachers face when implementing project-based math learning in the classroom? and (2) Do phase A teachers require a project-based math teaching module? If the answer is affirmative, please provide a detailed explanation. Respondents indicated their comprehension of project-based learning in response to interview question item 1. Nevertheless, they encounter challenges when implementing it since numerous children struggle to comprehend or master the mathematical concepts taught in various classes. Consequently, educators encounter difficulties while instructing. Regarding question item 2, teachers emphasized the significance of creating project-based math modules to offer more explicit guidance to teachers.

According to the findings of the survey and interviews, the subject of numbers and geometry is considered appropriate for implementation in project-based learning. The ability to understand and manipulate numbers, known as numerical cognition, is crucial for everyday life (Ribeiro & Santos, 2017). The topic of numbers necessitates logical thinking, which can be facilitated through project-based learning that students can directly apply to their everyday experiences (Julian, 2017). The number-processing comprises two primary elements: number comprehension, which entails grasping the meaning of numerical symbols, and number production, which encompasses reading, writing, and counting numbers. Conversely, calculus is a necessary framework for performing mathematical computations using symbols or language, including addition, subtraction, multiplication, and division. Geometry encompasses theoretical concepts that necessitate students to effectively regulate their cognitive processes to comprehend the subject matter (Cetintav & Yilmaz, 2023). Geometry, a mathematical discipline that deals with spatial relationships, is mandatory for aspiring mathematics teachers in Indonesia (Kholid et al., 2022). Project-based learning enables students to have a successful learning experience by instructing them on identifying and utilizing the essential methods required to accomplish their learning objectives. These skills also enhance their success in future learning endeavors. The introduction of project-based learning in schools, as assessed through standardized tests, improved student geometry performance (Han et al., 2016).

CONCLUSION

Considering the statement that teachers should implement and develop project-based mathematics modules to improve their skills in implementing project-based learning in their mathematics classes and taking into account the highly required or highly approved pass rate, it is clear that module development should be done. Project-based math teaching modules should be developed to accelerate the math learning process. This will help teachers improve students' skills. This aligns with the goals of implementing the project-based learning paradigm, which includes fostering a more dynamic environment for teacher-student interaction and facilitating smooth problem-solving when handling assignments and subject matter. In this learning paradigm, teachers might be facilitators by monitoring students' progress in the learning activities they complete through interaction. It is said that teachers use the learning approach to build rapport and engage with their students. Therefore, future research will concentrate on creating modules that allow students to perform project-based math tasks related to numbers and geometry.

In conclusion, developing project-based math teaching modules offers a promising approach to enhance student learning and improve teacher expertise in this pedagogy. While initial development may require time, collaborative efforts and professional development support can address this challenge. Furthermore, incorporating formative assessments within the projects can ensure students maintain a

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strong foundation in mathematical concepts alongside developing valuable skills such as problem-solving and collaboration.

This research has several limitations. First, this research is a needs analysis research, so it is necessary to follow up the development of teaching modules in accordance with the research results obtained. Secondly, this study only involved final phase A primary school teachers in the West Java region of Indonesia, so the results may not be generalizable to primary school teachers in other regions of Indonesia. Despite some limitations, this study makes a valuable contribution to our understanding of teachers' needs for project-based mathematics modules. Further research is expected to accommodate the needs analysis obtained from this study as a frame of reference for developing project-based mathematics teaching module designs.

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BRIEF PROFILE

Dian Anggraeni Tri Astuti was born on October 20, 1979 in Jepara, Indonesia. She took her undergraduate education, majoring in Fisheries Management at Bogor Agricultural University (IPB), from 1998 to 2003. After graduation, the author plunged into the world of education. In 2010, she continued her Master's education with a Family Science and Child Development major at IPB and graduated in 2012. The author had a career in education, teaching elementary school from 2005 to 2010. and an elementary school principal from 2010 to 2014. Since 2015, the author has been the character school director under the Indonesia Heritage Foundation.

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