



DEVELOPMENT OF A PROJECT-BASED LEARNING-STEM TEACHING MODULE ON MATHEMATICAL PROBLEM-SOLVING SKILLS RELATED TO PROFIT AND LOSS THROUGH A NATURAL COMPOSTING PROJECT

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Abstract

This study focuses on the development of instructional materials in the form of modules that adopt a Project-Based Learning–STEM framework. The main topic is centred on social mathematics, specifically profit and loss, contextualized through the task of making organic compost. Additionally, this research aims to evaluate the quality of the product based on indicators of validity, practicality, and its effectiveness in fostering mathematical problem-solving skills. The methodology applied is Research and Development, following the ADDIE model, which is executed in stages, from initial needs assessment to final quality verification. This study was conducted at SMP Islam Irsyadul Muftadi'in, involving 17 seventh-grade students. Data collection relied on expert validation instruments, student perception questionnaires, and competency evaluations. Through descriptive statistical techniques, the results of the analysis showed that the designed media achieved a validity score of 88.3%, a practicality score of 78.15%, and a learning achievement rate of 80%. Thus, this tool is deemed to meet the criteria as a reliable and innovative teaching material to support student performance in solving mathematical problems in social arithmetic.

Keywords: Problem-Solving Skills, Project-Based Learning, Social Arithmetic, STEM, Teaching Modules

Abstrak

Penelitian ini berfokus pada perakitan media ajar berupa modul yang mengadopsi skema Project Based Learning–STEM. Topik utamanya diarahkan pada bahasan matematika sosial, yakni laba maupun rugi yang dikontekstualisasikan melalui tugas pembuatan kompos organik. Selain itu, riset ini bermaksud menguji kualifikasi produk berdasarkan indikator kevalidan, sisi praktikalitas, serta efektivitasnya dalam memecah daya pecah masalah matematis. Metodologi yang diaplikasikan adalah Research and Development dengan mengikuti pola model ADDIE yang dieksekusi secara bertahap, mulai dari investigasi kebutuhan awal sampai pada verifikasi kualitas akhir. Agenda ini dijalankan pada SMP Islam Irsyadul Muftadi'in dengan melibatkan 17 peserta didik kelas VII. Proses penjarangan data mengandalkan instrumen validasi para ahli, angket persepsi siswa, serta evaluasi kompetensi. Melalui teknik statistik deskriptif, hasil pengolahan menunjukkan bahwa media yang dirancang memperoleh angka kevalidan 88,3%, skor praktikalitas 78,15%, dan tingkat ketuntasan belajar mencapai 80%. Dengan demikian, perangkat ini dinyatakan memenuhi syarat sebagai bahan ajar yang reliabel dan inovatif untuk menunjang performa siswa dalam menyelesaikan persoalan matematis pada materi aritmatika sosial.

Kata kunci: Aritmatika Sosial, Kemampuan Pemecahan Masalah, Modul Ajar, Project Based Learning, STEM

INTRODUCTION

Mathematical problem-solving skills are one of the fundamental competencies that must be mastered by every student in learning mathematics (Nugraha & Hakim, 2022). However, empirical evidence indicates that this ability remains at a relatively low level. Based on observational data and discussions with subject teachers, it was identified that most students still experience difficulties in analyzing contextual problems, formulating solution strategies, and verifying the accuracy of their

answers (Ling & Mahmud, 2023; Nilimaa, 2023). These challenges are also evident in social arithmetic topics, where students often struggle to apply mathematical principles to contextual problems related to their daily environment (Atta & Bonyah, 2023; Kusumah, 2024). The current educational landscape emphasizes student-centered learning approaches aimed at fostering critical and independent thinking (Indrawati, 2023; Putri, 2023). To achieve this goal, project-based learning integrated with Science, Technology, Engineering, and Mathematics (PjBL-STEM) can serve as an effective alternative (Nurbayani et.al., 2023). Through PjBL-STEM, mathematical concepts are not taught in isolation but are integrated with scientific and engineering principles to address real-world problems, such as organic waste management (Indrasti & Paidi, 2025).

To ensure the effective implementation of the PjBL-STEM model, appropriate instructional materials are required. However, challenges in practice reveal that the development of teaching materials, particularly learning modules specifically designed to support PjBL-STEM within environmental contexts, remains limited (Retno et al., 2025). In fact, well-structured learning modules enable teachers to provide clear guidance in bridging the connection between mathematical concepts and their real-life applications through projects such as natural compost production.

The project of producing natural compost within the topic of profit and loss represents a comprehensive integration of the STEM approach. This includes science through understanding the decomposition process of organic materials, technology through the use of tools, engineering through production design, and mathematics through cost calculations and profit-loss analysis (Ningsih & Susilowati, 2025). Several previous studies have demonstrated that the integration of PjBL-STEM has a positive impact on students' mathematical competencies (Mamahit et al., 2020; Nesri & Kristanto, 2020). However, these studies generally focus on instructional models, while the development of learning modules that integrate environmental contexts as a medium for teaching profit and loss concepts remains underexplored. Furthermore, the integration of real environmental contexts, such as organic waste processing through composting projects, has not been widely utilized as a medium for teaching mathematics, particularly in social arithmetic (Solares-Rojas et al., 2022).

Based on this background, this study aims to develop a PjBL-STEM-based learning module through a natural composting project within the topic of social arithmetic that meets the criteria of validity, practicality, and effectiveness in improving students' mathematical problem-solving skills.

METHOD

This study employed a Research and Development (R&D) method using the ADDIE development model (Analysis, Design, Development, Implementation, and Evaluation) to produce a PjBL-STEM learning module on social arithmetic through a natural composting project (Lestari, Dafik, Susanto, et al., 2025). The selection of the ADDIE model was based on its systematic and structured framework for designing measurable project-based activities aimed at optimizing students' mathematical problem-solving skills (Mengyao & Ismail, 2025). The study was conducted at SMP Islam Irsyadul Muftadi'in during the even semester of the 2025/2026 academic year. The research subjects included expert validators (content, media, and instrument experts) and seventh-grade students for product testing. The trial phase was conducted in two stages: a limited trial involving 8 students selected through purposive sampling based on diverse academic abilities, and a field trial involving 17 students to evaluate the practicality and effectiveness of the module in real classroom settings.

Data collection techniques included needs analysis interviews, expert validation, student response questionnaires, and essay tests measuring problem-solving abilities (Lestari, Dafik, & Isyati, 2025). The validity data were analyzed based on expert validation scores, practicality was measured through student response questionnaires, and effectiveness was assessed based on students' test

mastery, analyzed descriptively (Rustandi & Rismayanti, 2021). These parameters were used to ensure that the developed module met both theoretical and empirical feasibility criteria.

Module Validation Analysis Stage

The feasibility of the PjBL-STEM learning module was assessed through a validity test to ensure product quality before implementation with students. This stage focused on expert evaluation covering content accuracy, language clarity, and media design aesthetics using validated assessment instruments. The level of validity was determined using a four-point Likert scale, where a score of 4 indicates excellent quality and a score of 1 indicates low feasibility. The results of expert evaluation served as a critical basis for determining the appropriateness of the module for instructional use (Sulkipani et al., 2019). The validation scores obtained from the expert assessment sheets were then converted using the following formula:

$$V = \frac{\sum x}{\sum xi} \times 100\%$$

In this calculation, it represents the percentage of the module's validity. Meanwhile, represents the cumulative score assigned by the expert panel, and refers to the maximum possible total score. After the validation assessment of the instructional module is completed, the module's validity level is determined using the evaluation criteria outlined in the following section.

Table 1. Standards for Validating Instructional Modules

No.	Percentage Score (%)	Category
1.	81-100	Very Practical
2.	61-80	Practical
3.	41-60	Moderately Practical
4.	21-40	Less Practical
5.	0-20	Very Less Practical

Based on these assessment criteria, the learning module is considered to have theoretical validity if the percentage score obtained from expert validation is at least $\geq 61\%$.

Practicality Stage of the Learning Module

The practicality aspect aims to evaluate the ease of use of the PjBL-STEM module from the students' perspective as the primary users. The data were collected through a response questionnaire administered after the learning activities were completed. The assessment system was based on a four-point Likert scale, ranging from 1 (strongly disagree) to 4 (strongly agree) (Firmansyah & Rusimamto, 2020). To determine the level of practicality, the collected data were analyzed using the following formula:

$$P = \frac{\sum TSe}{\sum TSh} \times 100\%$$

In this context, it represents the ease of use of the module as a percentage. Meanwhile, it refers to the cumulative score from student responses and represents the maximum possible score in the calculation of the practicality score. (Nurbayani et al., 2020).

Table 2. Standard for Determining Product Practicality

No.	Score Percentage (%)	Category
1.	85-100	Very Practical
2.	75-84	Practical
3.	65-74	Fairly Practical
4.	55-64	Less Practical
5.	0-54	Very Less Practical

Referring to the established parameters, this instructional material is considered to meet the theoretical and practical criteria if the percentage score achieved is $\geq 61\%$.

Effectiveness Stage of the Teaching Module

The analysis of learning outcomes was conducted to evaluate the extent to which the PjBL-STEM module contributes to improving students' problem-solving skills in the topic of social arithmetic. The data was obtained from the results of the final test, which were aligned with the learning achievement indicators. Students are considered to have achieved mastery if they obtain a minimum score of 70, in accordance with the school's Minimum Mastery Criteria (KKM) (Firmansyah & Rusimanto, 2020). Furthermore, the level of classical mastery is calculated using the following formula:

$$x = \frac{\sum PDt}{\sum PD} \times 100\%$$

In this context, it represents the percentage of students who successfully solved the math problems. Meanwhile, it indicates the number of students who met the mastery criteria, relative to the total number of participants who took the exam. The mastery rates obtained were then classified based on the following established effectiveness criteria.

Table 3. Criteria for Determining Product Effectiveness

No.	Interval (%)	Category
1.	$80 < x \leq 100$	Very Good
2.	$60 < x \leq 80$	Good
3.	$40 < x \leq 60$	Fair
4.	$20 < x \leq 40$	Poor
5.	$x \leq 20$	Very Poor

This instructional material is considered to meet the theoretical efficacy criteria if the test scores indicate that students' ability to solve mathematical problems has reached $\geq 60\%$.

RESULTS AND DISCUSSION

All data obtained from the design process of the Project-Based Learning-STEM (PjBL-STEM) module on social arithmetic through a natural compost-making project will be discussed in terms of the product development process, referring to the ADDIE development model (Rustandi & Rismayanti, 2021). The following presents a description of the development stages that have been carried out.

Analysis Stage

The first stage of this study began with the analysis phase to map the learning situation and identify the needs of teachers and students at SMP Islam Irsyadul Muhtadi'in. The main focus of this stage was to identify real challenges in teaching social arithmetic, particularly the topic of profit and loss at the seventh-grade level. The researcher collected data through in-depth discussions with mathematics teachers and conducted direct classroom observations. Through these interactions, information was obtained regarding teaching practices, students' learning difficulties, and the availability of instructional materials. In addition, student participation and active interaction during the instructional process were also observed.

The findings revealed that the teaching of social arithmetic was still conventional and teacher-centered, resulting in students being relatively passive in absorbing the material. This condition led to students' limited ability to relate profit-loss concepts to real-life situations. On the other hand, the available instructional materials had not yet optimally facilitated activity-based learning. The enthusiasm of seventh-grade students at SMP Islam Irsyadul Muhtadi'in showed a positive trend when

learning activities were connected to concrete, real-world experiences close to their environment. This condition highlights the need for instructional materials that go beyond theoretical explanations of social arithmetic by incorporating meaningful project-based activities. Based on these findings, it was decided that developing a Project-Based Learning-STEM (PjBL-STEM) module utilizing natural compost production is highly feasible and appropriate to be implemented in seventh grade as a solution for mathematics learning.

Design Stage

The design phase focused on developing the initial framework of the PjBL-STEM module, aligned with the results of the previous needs analysis. The researcher formulated the material design by considering the characteristics of seventh-grade students at SMP Islam Irsyadul Mubtadi'in and the targeted learning outcomes in social arithmetic. The design process began with determining learning objectives and problem-solving indicators, including students' ability to interpret problems, plan solutions, execute strategies, and verify results (Lestari et al., 2024). The instructional flow was then structured according to the stages of Project-Based Learning, starting from contextual problem orientation, project design for compost production, to test outcomes and reflective evaluation.

In this stage, STEM elements were also integrated into the teaching module. The science component was reflected in understanding the decomposition of organic materials in the composting process. The technology component involved the use of simple tools and media during compost production. The engineering component was implemented through designing and carrying out the natural compost project, while the mathematics component focused on applying social arithmetic concepts such as calculating production costs, revenue, and profit-loss. In addition to designing the module, the researcher also prepared evaluation instruments, including expert validation sheets, student response questionnaires, and test instruments. All these tools were specifically designed to measure students' mathematical problem-solving abilities in social arithmetic at the seventh-grade level.

Development Stage

In this phase, the researcher systematically compiled all module components into a coherent learning resource, including the integration of the Project-Based Learning framework. The development process involved aligning the learning objectives, materials, and activities so that they support the expected learning outcomes. This process included formulating essential questions, designing project plans, scheduling learning activities, monitoring project implementation, and conducting product testing followed by reflective evaluation. Each stage of the project was structured to guide students in actively engaging with the learning tasks while collaborating and reflecting on their progress. All these activities were intended to enhance students' mathematical problem-solving skills, particularly in calculating costs, revenue, and profit-loss analysis through the natural compost-making project. Through this project-based approach, students were expected not only to understand social arithmetic concepts but also to apply them in meaningful real-life contexts.

The module components were systematically organized, including the cover page, learning objectives, user guidelines, social arithmetic materials, student worksheets, and evaluation sections. Each component was arranged sequentially to support a clear and structured learning flow for students. The module visualization was designed using Canva by optimizing color composition, typography, and layout to create an attractive and readable learning resource. In addition, visual elements such as icons, illustrations, and color contrasts were carefully selected to enhance students' attention and comprehension. The visual design was tailored to students' characteristics so that the material becomes more engaging, interactive, and easier to understand during the learning process. An example of the module visualization is presented in detail in Figure 1.

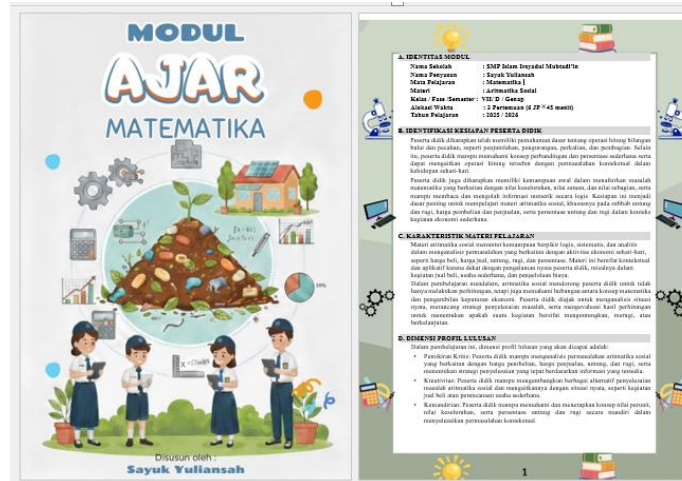


Figure 1. Example of the PjBL-STEM Teaching Module Display

To support the implementation of the natural composting project, the researchers have also supplemented this module with a Student Worksheet (LKPD). A preview of the draft Student Worksheet is shown in Figure 2.



Figure 2. Example of a worksheet

Once the product has been finalized, the next step is the validity testing phase, which involves subject matter experts and media specialists. This evaluation aims to assess the accuracy of the content, linguistic structure, and media aesthetics to ensure they meet quality standards and students' learning needs. A summary of the scores provided by the validators can be found in the table below:

Table 4. Recapitulation of Expert Validation Assessment of the Learning Module

No	Assessed Aspects	Score		Total (x)
		A1	A2	
1.	Content Feasibility	16	20	36
2.	Language Feasibility	15	20	35
3.	Media Feasibility	15	20	35
Total Score from Experts (x)				106

Notes:

A1 = Mathematics Education Instructor

A2 = Mathematics Teacher

All data derived from the validators' scores were then analyzed by calculating the product's validity rate as follows.

$$V = \frac{\sum x}{\sum xi} \times 100\%$$

$$V = \frac{106}{120} \times 100\%$$

$$V = 0,883 \times 100\%$$

$$V = 88,3\%$$

The results of the validity analysis indicate that the percentage of the module's validity level reached 88.3%. This value suggests that the developed Project-Based Learning-STEM (PjBL-STEM) teaching module meets the feasibility standards in terms of content, language use, and media design, and therefore can be categorized as highly valid. After the validation process was completed, the module was revised by incorporating all corrections and suggestions provided by experts during the validation process, thereby improving the overall quality of the product before entering the implementation stage.

Implementation Stage

Entering the implementation phase, the instructional materials that had undergone a series of refinements and revisions by experts were tested in classroom learning activities. In this phase, the PjBL-STEM-based teaching module was implemented in social arithmetic lessons for seventh-grade students at SMP Islam Irsyadul Muftadi'in. During the implementation process, students engaged in learning through a natural compost-making project conducted in groups over several class sessions. Students took full responsibility for planning and evaluating the project. In this process, they were encouraged to solve financial calculations such as capital, revenue, and profit-loss from organic fertilizer production. The teacher acted as a facilitator, guiding students throughout the learning sessions.

Evaluation Stage

The evaluation phase serves as the final stage of developing this project-based STEM instructional material. At this stage, the results of the compost-making project were linked to students' learning outcomes in social arithmetic. This phase was conducted to assess the quality of the teaching module after implementation, particularly in terms of its feasibility and effectiveness in learning activities. Through this evaluation, the researcher aimed to gather information regarding the strengths, limitations, and suggestions for improvement, which would serve as a basis for refining the developed module. The evaluation began by analyzing the results of the practicality questionnaire completed by seventh-grade students. The data were processed to measure the ease of use of the module, and the summary is presented in the table below:

Table 5. Summary of Student Feedback on the Use of the Module

No.	Name	SS	S	TS	STS
1.	AR	7	15	5	-
2.	AIB	8	15	4	-
3.	DA	9	15	3	-
4.	D	7	16	4	-
5.	FZB	9	14	4	-
6.	FUD	8	15	4	-
7.	L	10	13	3	1
8.	MII	7	17	3	-
9.	MSH	8	16	3	-

No.	Name	SS	S	TS	STS
10.	NQ	6	14	6	1
11.	SN	8	15	3	1
12.	WMN	6	17	4	-
13.	ZA	6	16	5	-
14.	Z	8	16	3	-
15.	N	9	14	3	1
Total		116	228	57	4

The information from the student response questionnaire was then analyzed to determine the practicality of the developed media. The calculation used to determine the practicality of the module is based on the following formula.

$$V = \frac{\sum TSe}{\sum TSh} \times 100\%$$

$$V = \frac{(4 \times 116) + (3 \times 228) + (2 \times 57) + (1 \times 4)}{(4 \times 405)} \times 100\%$$

$$v = \frac{(425)(684)(114)(4)}{1620} \times 100\%$$

$$v = \frac{1266}{1620} \times 100\%$$

$$v = 0,7815 \times 100\%$$

$$v = 78,15\%$$

Based on the practicality calculation results, the practicality percentage of the teaching module was found to be 78.15%. This result indicates that the developed PjBL-STEM module meets the criteria for practicality. Therefore, the instructional material is considered highly suitable for use in classroom learning activities. To examine the effectiveness of the module, an evaluation was conducted on the mathematical problem-solving test results of seventh-grade students after the learning sessions were completed. The data show that 14 students successfully exceeded the minimum mastery criterion (KKM), while 3 others still required further guidance as they had not yet met the standard. Examples of students' responses in solving mathematical problems can be seen in Figure 2 and 3.

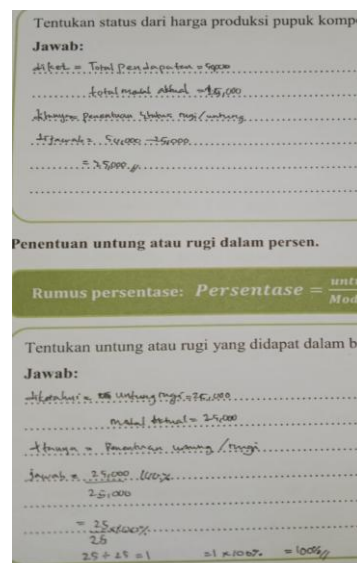


Figure 2. Documentation of the Answer Sheets for the Problem-Solving Competency Test for Seventh-Grade Students Who Scored Above the Minimum Passing Score

Referring to the students' solution presentations in the test instrument shown in Figure 2, it can be observed that the research subjects were able to internalize the problem and accurately apply social arithmetic principles, particularly in profit and loss calculations. The students demonstrated the ability to identify relevant data and key questions, construct systematic solution steps, and perform precise calculations to obtain valid final answers (Ibrahim et al., 2017).

These responses indicate that students not only understood financial concepts theoretically but were also able to apply them appropriately in real-world contexts, such as organic fertilizer production activities (Zhang & Wang, 2024). This achievement is reflected in their ability to identify problems, formulate solution strategies, execute solution plans, and verify their final answers (Rizky et al., 2023). This finding provides evidence that students successfully met the established mastery criteria for mathematical problem-solving skills (Nilimaa, 2023).

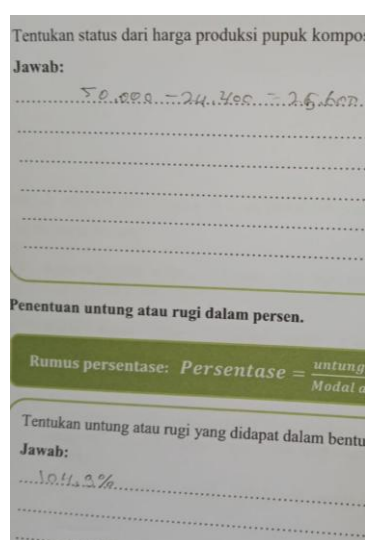


Figure 3. Documentation of the Answer Sheets for the Problem-Solving Competency Test for Seventh-Grade Students Who Scored Below the Minimum Passing Score

Referring to the student's answer sheet presented in Figure 3, it can be observed that the ability to internalize the problem remains suboptimal. The student tended to directly perform numerical calculations without first identifying the known data and the questions being asked. In addition, the solution process appeared unstructured, resulting in cumulative calculations that led to an inaccurate final answer (Koedinger & Nathan, 2004). These findings indicate that the student has not yet fully mastered the principles of profit and loss calculations and still faces difficulties in applying systematic problem-solving steps (Agustina et al., 2026). Consequently, the student's score did not meet the established mastery criteria, as it remained below the minimum standard threshold. To evaluate overall learning achievement, the percentage of classical mastery was calculated using the following formula:

$$v = \frac{\sum PDt}{\sum PD} \times 100\%$$

$$v = \frac{13}{15} \times 100\%$$

$$v = 0,80 \times 100\%$$

$$v = 80 \%$$

Based on the practicality calculation results, the practicality percentage of the teaching module was found to be 78.15%. This result indicates that the developed PjBL-STEM module meets the criteria for practicality. Therefore, the instructional material is considered highly suitable for use in classroom learning activities (Wandani et al., 2023; Retno et al., 2025). To examine the effectiveness of the module, an evaluation was conducted on the mathematical problem-solving test results of seventh-grade students after the learning sessions were completed (Difinubun et al. 2024). The data show that 14 students successfully exceeded the minimum mastery criterion (KKM), while 3 others still required further guidance as they had not yet met the standard. Examples of students' responses in solving mathematical problems can be seen in Figures 2 and 3.

CONCLUSION

This study successfully developed a Project-Based Learning-STEM (PjBL-STEM) teaching module on social arithmetic through a natural compost-making project by following the ADDIE development model procedures. Based on the trial results, the module was classified as highly valid, achieving a validity score of 88.3% from experts, and met the practicality criteria with a practicality level of 78.15% based on students' responses. In terms of effectiveness, the use of this module achieved a classical mastery percentage of 80%, which falls into the very good category in improving students' mathematical problem-solving skills. Therefore, the PjBL-STEM module through the compost project has been proven to be valid, practical, and effective, making it suitable for use as an alternative contextual mathematics instructional material for seventh-grade students at SMP Islam Irsyadul Muhtadi'in.

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