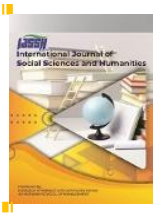

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Development of a Social Arithmetic Teaching Module Based on the Indonesian Realistic Mathematics Education Approach to Support the Numeracy Skills of Junior High School Students

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Teaching Module; Social Arithmetic; Numeracy; Indonesian Realistic Mathematics Education; Plomp Model.

Abstract

This study aims to develop a social arithmetic teaching module based on the Indonesian Realistic Mathematics Education (PMRI) approach that is valid, practical, and effective in supporting the numeracy skills of junior high school students. The low numeracy achievement of Indonesian students, reflected in the 2022 Programme for International Student Assessment (PISA) score of 366, together with the limited availability of contextual teaching materials, motivated this research. The study employed the Research and Development method using the Plomp model, which comprises three phases: preliminary research, the development or prototyping phase, and the assessment phase. The research subjects were seventh-grade students of SMP Katolik Don Bosco Bitung in the 2025/2026 academic year. Data were collected through expert validation sheets, teacher and student practicality questionnaires, and numeracy tests (pretest and posttest), then analysed using percentage scores and the N-Gain formula. The results show that the module met the highly valid criteria with percentages of 90% from the material expert and 91.7% from the media expert, while the test instrument reached 90%. The practicality aspect was categorised as highly practical based on the one-to-one trial (85.2%), small-group trial (88.8%), and field test (85.34%). The module's effectiveness was demonstrated by an increase in students' average scores from 28.63 on the pretest to 65.91 on the posttest, with an N-Gain value of 0.51 in the medium category. Therefore, the developed PMRI-based social arithmetic module is feasible for use as teaching material that supports the numeracy skills of junior high school students.

Contents

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Introduction

Mathematics education plays a strategic role in shaping human resources capable of logical, analytical, and critical thinking as a foundation for both personal and collective progress. In line with the national education goal of forming citizens who are faithful, knowledgeable, capable, creative, and responsible, mathematics learning equips every generation with the skills to solve real-life problems quantitatively. The quality of education, including mathematics education, helps determine the advancement of a nation and produces intelligent and dignified human resources. One indicator of the success of the educational process in schools is students' mathematics learning outcomes, because it is through this subject that students' numeracy skills can be measured directly (Domu & Mangelep, 2025; Wibowo et al., 2022). For this reason, the quality of mathematics learning in schools needs serious attention and continuous improvement in order to meet the competency demands of the twenty-first century.

Nevertheless, the quality of education in Indonesia still faces various challenges and has not yet shown optimal achievement. This condition is reflected in the results of the 2022 Programme for International Student Assessment (PISA), which showed that the numeracy score of Indonesian students reached only 366 and ranked 70th out of 81 countries, far below the average of the member countries of the Organisation for Economic Co-operation and Development (OECD) (Alfaruqi & Nurwahidah, 2025). This achievement indicates that the numeracy skills of Indonesian students still require serious attention and improvement (Domu & Mangelep, 2024; Suryaningsih et al., 2025). At the same time, this situation reveals a gap between the expectations of the national curriculum and the reality of students' numeracy skills in the field, so that systematic and well-tested learning innovations are needed to bridge it.

Numeracy is a core competency that involves the application of mathematical concepts, procedures, facts, and tools in solving problems across various life contexts (OECD, 2019). Numeracy is not merely related to the ability to calculate, but also to the ability to interpret quantitative information and to make decisions based on data. Given the importance of this role, the learning process in schools needs to be designed so as to foster numeracy skills meaningfully, rather than merely memorising procedures. In reality, the numeracy skills of junior high school students remain relatively low. This is evident from students' difficulties in solving contextual problems that demand reasoning, particularly in the topic of social arithmetic. Social arithmetic is often perceived as difficult because it requires a deep understanding of concepts, the precise application of formulas, and the ability to interpret contextual problems such as profit, loss, discount, gross, and net (Dila & Zanthy, 2020; Mangelep, 2025; Wahyuni et al., 2024).

Based on preliminary observations at SMP Katolik Don Bosco Bitung, most students experienced difficulties in learning mathematics, so that their learning outcomes had not reached the established Learning Objective Attainment Criteria (KKTP), particularly in the topic of social arithmetic. These problems were caused by several factors. From the students' side, mathematics is generally perceived as difficult, so that interest and motivation to learn are low, and the mastery of prerequisite concepts is not yet optimal. From the teachers' side, the teaching materials used tend to be

procedural and lack context, so that they are not designed to encourage students to think critically and to develop their numeracy skills (Dila & Zanthy, 2020; Moroki et al., 2025). The results of the needs analysis reinforced this finding: the majority of students relied only on textbooks and wanted teaching materials that were more attractive, illustrated, and colourful.

One learning approach relevant to overcoming these problems is the Indonesian Realistic Mathematics Education (PMRI) approach, which is an adaptation of Realistic Mathematics Education (RME). PMRI emphasises mathematics learning based on real problems that are close to students' experiences and encourages students to discover concepts through the processes of horizontal and vertical mathematisation (Hidayah et al., 2025; Siregar et al., 2020). Through meaningful contexts, students are given the opportunity to reinvent mathematical concepts, so that learning becomes more meaningful and long-lasting. A number of studies have shown that the application of PMRI is able to improve conceptual understanding, problem-solving ability, and students' numeracy skills (Putra & Purnomo, 2023; Putri & Zulkardi, 2019; Yonathan & Seleky, 2023).

To implement this approach in a structured manner, systematically designed teaching materials are required. A teaching module is a learning resource arranged in a structured way that enables students to learn independently or with guidance. A module designed on the basis of a contextual and realistic approach can increase students' active involvement, encourage critical thinking, and help achieve the goals of mathematics learning more effectively (Thoibah et al., 2022). The research of Mardiana et al. (2020) showed that PMRI-based teaching materials are effective in improving mathematical literacy skills, while Ramadhany and Erlina (2020) emphasised the importance of social arithmetic modules based on contextual learning to stimulate higher-order thinking skills. These findings are reinforced by Amalia et al. (2020), who found that PMRI-based media are able to improve students' critical thinking skills.

Based on these various studies, the development of modules based on a contextual approach has great potential to improve students' numeracy skills. However, such development needs to be carried out using a systematic instructional design model so that the quality of the product is guaranteed. The Plomp model was chosen because it is flexible and iterative, thus allowing evaluation and improvement to be carried out continuously without having to complete all stages linearly. Its emphasis on preliminary research makes this model have a strong foundation in formulating problems and finding appropriate solutions for dynamic and contextual educational products.

Although several previous studies have developed PMRI-based teaching materials and social arithmetic modules, there is still little research that specifically integrates the PMRI approach with the Plomp development model to support students' numeracy skills within a particular local school context. The novelty of this study lies in the integration of the PMRI approach, a focus on numeracy skills, and the systematic use of the Plomp model to produce a module that is valid, practical, and effective. The developed module also integrates the local context of the students of SMP Katolik Don Bosco Bitung, so that the learning material is closer to their daily experiences and strengthens the relevance of learning.

Thus, this study is expected not only to produce a teaching module, but also to make a theoretical and practical contribution to mathematics learning innovation that is able to support students' numeracy skills sustainably. Theoretically, this study enriches the body of knowledge on the application of PMRI to numeracy-oriented social arithmetic, while practically it provides ready-to-use teaching material for teachers in the field. Based on this background, this study aims to develop a social arithmetic teaching module using the PMRI approach that is valid, practical, and effective in supporting the numeracy skills of seventh-grade junior high school students. This aim is elaborated into three research questions,

namely how to develop a valid PMRI-based social arithmetic teaching module, how practical the module is to use in learning, and how effective it is in supporting students' numeracy skills.

Method

This study is a Research and Development (R&D) study that aims to produce a product in the form of a social arithmetic teaching module using the PMRI approach that is valid, practical, and effective. The development model used is the Plomp model. This model was chosen because it is flexible and iterative, so that it is easily adapted to the needs of educational products and allows evaluation and improvement to be carried out continuously. Compared with the Borg & Gall model, which is complex and demands many resources; the Dick & Carey model, which is tightly structured yet less flexible; the Four-D model, which is linear; and the ADDIE model, which tends to be rigid, the Plomp model is regarded as the most suitable for developing a dynamic and contextual product.

The research procedure followed the three phases of the Plomp model. First, the preliminary research phase, which comprised needs analysis, curriculum analysis, material analysis, and a literature review to produce the framework of the initial prototype (prototype 1). Second, the development or prototyping phase, which was carried out through tiered formative evaluation, namely self-evaluation, one-to-one evaluation, expert review, small-group evaluation, and field-test evaluation. Third, the assessment phase, which focused on testing the practicality and effectiveness of the final product. At each stage of formative evaluation, revisions were made so as to produce an increasingly refined prototype. Each revision was documented systematically so that the development of the prototype's quality could be traced from one stage to the next.

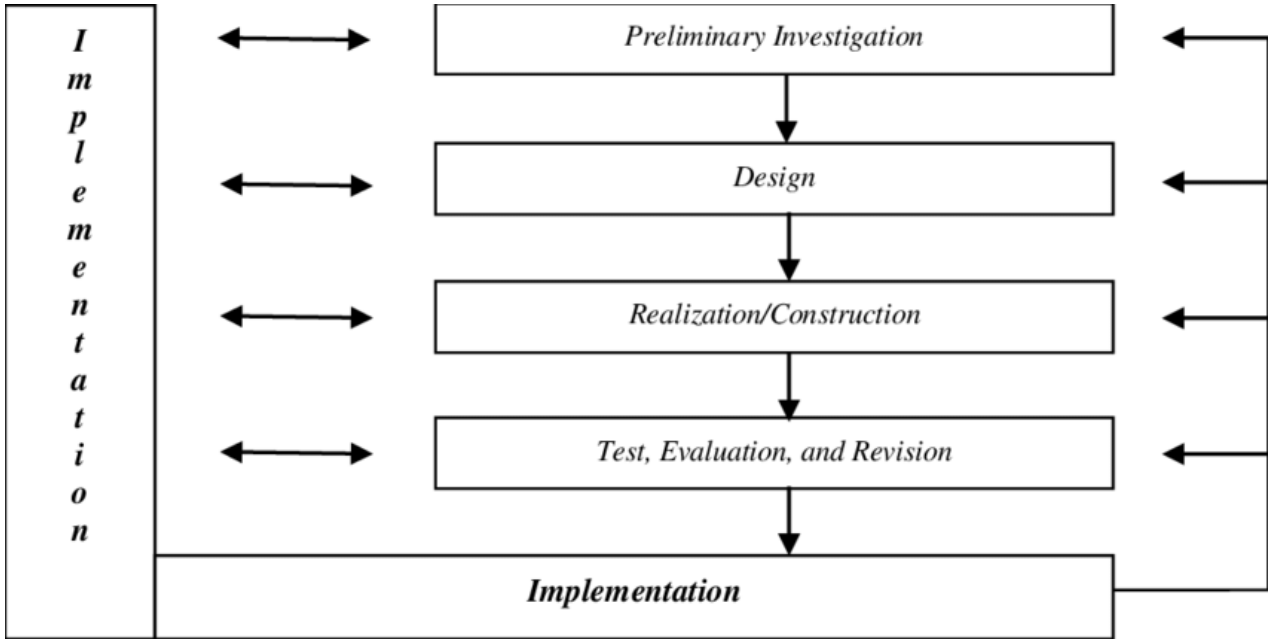

Figure 1. The phases of the Plomp development model

The study was conducted in the seventh grade of SMP Katolik Don Bosco Bitung in the 2025/2026 academic year, specifically from March to May 2026. The research subjects consisted of

validators (lecturers and teachers who were material experts and media experts), three students in the one-to-one trial, nine students in the small-group trial, and 22 students in the field test. The students were selected to represent low, medium, and high academic ability, and did not overlap across the trial stages, so that the results obtained could be considered applicable to various levels of students' cognitive ability.

Data collection was carried out through observation, interviews with the mathematics teacher, expert validation questionnaires, teacher and student practicality questionnaires, and a numeracy test in the form of a pretest and posttest. The validity instrument was a Likert-scale validation sheet that assessed the appropriateness of content, presentation, language, design, and PMRI characteristics. The practicality instrument was a teacher and student response questionnaire, whereas the effectiveness instrument was a set of pretest and posttest items that measured numeracy skills on the social arithmetic material. All instruments were first validated by experts before use so that the data obtained would be valid and accountable.

The analysis of validity and practicality data was carried out by calculating the percentage of scores, namely the total score obtained divided by the ideal maximum score multiplied by 100%. A product was declared valid if it reached at least the valid category (61%-80%) and highly valid if it reached a percentage greater than or equal to 81%, whereas it was declared practical if the percentage of both the teacher and student questionnaires reached at least the practical category. Effectiveness was analysed using the N-Gain Score, namely the difference between the posttest and pretest scores divided by the difference between the ideal maximum score and the pretest score. The module was declared effective if the average N-Gain fell within the medium or high category ($0.30 < g \leq 0.70$ up to $g > 0.70$) and the percentage of students' learning mastery reached the established KKTP. Triangulation of qualitative data from the observation and interview results was used to complement the quantitative data so that the conclusions regarding the quality of the module would be completer and more credible.

Results and Discussions

1. Preliminary Research Phase

The preliminary research phase was conducted to identify the problems underlying the need to develop teaching materials. Data were obtained through interviews with the mathematics teacher and the distribution of a needs-analysis questionnaire to seventh-grade students. The results of the needs-analysis questionnaire showed that 56.5% of students experienced difficulties in the mathematics learning process and 73.9% of students felt bored when studying mathematics. In addition, 100% of students stated that they liked teaching books equipped with pictures, 78.3% of students disliked books that contained only text, 87% of students liked colourful teaching books, and 91.3% of students stated that their reference book was only a textbook. These percentages consistently indicate that students need supplementary teaching materials that are more visually appealing while also being able to support the development of their numeracy skills.

The results of the interview with the mathematics teacher reinforced these findings. The teacher stated that learning had so far relied only on the textbooks available in the library, with the dominant methods being lecture, question and answer, and exercises. The main inhibiting factors were the limited learning resources and students' low interest, so that students tended to be passive and easily bored. The teacher had also never used a module as teaching material and agreed that a PMRI-based social arithmetic module should be developed. The curriculum analysis showed that the school implemented

the Merdeka Curriculum, so the researcher examined the Learning Outcomes in order to formulate the Learning Objectives and the Flow of Learning Objectives for the social arithmetic material.

The material analysis mapped the scope of the concepts to be developed, covering total value and unit value, purchase price and selling price, profit and loss along with their percentages, discount, gross, net, and tare. This material was chosen because it relates directly to everyday buying and selling activities, so that it is in keeping with the principle of didactical phenomenology in PMRI. A literature review was conducted to examine relevant journals and references as the basis for designing the intervention. Based on this overall preliminary analysis, the researcher decided to develop a PMRI-based social arithmetic teaching module that is contextual and supports students' numeracy skills as the initial prototype (prototype 1).

The design of prototype 1 was developed by combining the components of a Merdeka Curriculum teaching module with the characteristics of PMRI. Each learning unit begins with a contextual problem that is close to students' daily lives, followed by exploration activities, discussion, concept summarising, exercises, and evaluation items designed to train numeracy indicators. The module is also equipped with pictures, colourful illustrations, and answer boxes as a space for students to construct their solutions. The arrangement of these components aims to ensure that the module not only functions as reading material, but also as a means that guides students to experience the process of mathematisation gradually, so that this initial design is ready to enter the formative-evaluation stage in the next phase.

2. Development or Prototyping Phase

In this phase, the initial design of the module (prototype 1) was prepared based on the results of the preliminary analysis and was then evaluated formatively. The self-evaluation stage was carried out by the researcher to assess and improve the initial design, particularly errors in writing, typing, and layout. After that, the module was assessed by experts through expert review, which included material-expert validation, media-expert validation, and the validation of the pretest and posttest instruments. The validation aimed to determine the feasibility of the module before it was tried out with students.

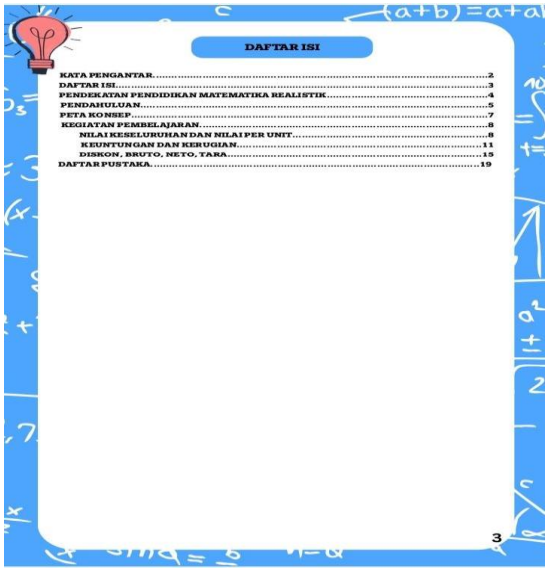

Figure 2. The cover of the developed PMRI-based social arithmetic module

Figure 3. The concept-map page of the developed module

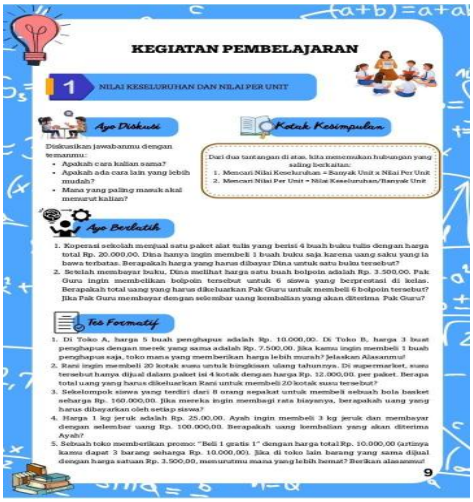

Figure 4. A sample module page presenting a PMRI-based contextual learning activity

Material-expert validation was conducted by a mathematics education lecturer who assessed five aspects, namely content appropriateness, presentation appropriateness, language appropriateness, module evaluation, and the realistic assessment. The validation results obtained a total score of 189 with a percentage of 90%, which falls within the highly valid category, as presented in Table 1. The material expert provided several suggestions for improvement, including refining the narrative of the problems so that they do not directly lead to the answer, correcting typing errors, standardising the way monetary values are written, and adding the formulas for profit and loss. These suggestions became the basis for improvement to produce a subsequent prototype that was more conceptually accurate. The follow-up to each expert suggestion was carried out carefully so that the module would truly meet the feasibility standards before being tried out with students.

Media-expert validation assessed three aspects, namely the module size, the cover design, and the content design, with a total score of 110 and a percentage of 91.7%, which also falls within the highly valid category. The media expert suggested that the answer boxes for students should not use dark colours and should be provided in an adequate size so that students' answers could be read clearly. Meanwhile, the validation of the pretest and posttest instruments assessed four aspects, namely the material and answer key, the construction and form of the items, the language and culture, and the realistic characteristics (PMRI), with a total score of 54 and a percentage of 90% in the highly valid category. Thus, both the module and the test instruments were declared feasible for use after revisions were made in accordance with the experts' input.

After being declared valid, the module was tried out on a limited basis to assess its practicality. The one-to-one trial involved three seventh grade (VII-3) students representing low, medium, and high academic ability. The response questionnaire results at this stage obtained an average percentage of 85.2% in the highly practical category. The aspects assessed included the clarity of language and text, the content and material, and the appearance and attractiveness of the module, with the percentage per

item ranging from 60% to 100%. The input from this stage was used to improve the clarity of the instructions and the appearance of the module.

The next stage was the small-group trial, which involved nine seventh grade (VII-2) students who also represented the three levels of academic ability. The small-group trial obtained an average percentage of 88.8% in the highly practical category. The assessment covered three components, namely the readability and practicality component, the PMRI approach component, and the numeracy-support component, with the percentage per item ranging from 82.2% to 95.6%. The consistently high results on the PMRI approach component and the numeracy-support component indicate that the module had incorporated realistic characteristics well. The input from both stages was used to produce a more practical prototype before it was tested on a field scale.

The entire series of formative evaluations in this phase demonstrated a pattern of gradual improvement in the quality of the prototype. Every piece of input from experts and students was followed up through documented revisions, so that each prototype produced was a refinement of the previous version. This iterative process is the hallmark of the Plomp model and ensures that the module entering the assessment phase had truly been tested in terms of content appropriateness, design, and readability. With the validity criteria being met and practicality being indicated on a limited scale, the module was declared ready to be tried out on a field scale to measure its practicality and effectiveness more broadly.

Table 1. Results of the Expert Validation

Validation Aspect	Percentage	Category
Material-expert validation	90%	Highly valid
Media-expert validation	91.7%	Highly valid
Test-instrument validation (pretest/posttest)	90%	Highly valid

Table 2. Results of the Module Practicality Test

Trial Stage	Students	Percentage	Category
One-to-one trial	3	85.2%	Highly practical
Small-group trial	9	88.8%	Highly practical
Field test	22	85.34%	Highly practical

3. Assessment Phase

The assessment phase consisted of a student-response test on a field scale to assess practicality and an effectiveness test through a pretest and posttest. The field test involved 22 seventh-grade (VII-4) students. The student-response questionnaire results obtained an average percentage of 85.34% in the highly practical category. The aspects assessed included the module size, the material, and the language, with the percentage on each item ranging from 79.9% to 91.8%. Students gave positive responses, including that the module was very attractive, its language was easy to understand, it was equipped with pictures that facilitated comprehension, and it helped them understand the material more quickly. The colourful and illustrated appearance of the module also kept students from feeling bored while reading.

The consistently positive responses on the field scale affirm that the practicality of the module was maintained when used with a larger number of students with a wider range of abilities.

The effectiveness test was carried out by comparing the pretest and posttest results in class VII-4. The pretest was administered before the use of the module to determine students' initial ability, whereas the posttest was administered after learning using the module on the social arithmetic material. The analysis results showed that students' average pretest score of 28.63 increased to 65.91 on the posttest. The total pretest score of 630 increased to 1,450 on the posttest, with a total N-Gain of 11.27. The calculation of the average N-Gain produced a value of 0.51, which falls within the range $0.30 < 0.51 \leq 0.70$ in the medium or effective category. The average difference of 37.28 points between the pretest and posttest demonstrates a substantial improvement in numeracy skills after students learned using the module.

The distribution of N-Gain categories showed that, of the 22 students, the majority were in the medium category, one student reached the high category, and only two students were in the low category. The increase in scores experienced by almost all students indicates that the module was able to help students understand the concept of social arithmetic better than before using the module. Although not all students reached the high category, the relatively even tendency of improvement indicates that the use of the PMRI-based social arithmetic teaching module is effective in supporting students' numeracy skills.

When examined in more detail, the low pretest scores illustrate that, before the intervention, most students were not yet able to solve social arithmetic numeracy problems that demanded the interpretation of context, such as calculating the percentage of profit or determining the price after a discount. After learning using the module, the significant increase in posttest scores indicates that students began to be able to connect the information in the problems with relevant mathematical concepts and to select the appropriate solution procedure. This shows that the module not only improved the scores obtained, but also improved the quality of students' numeracy thinking, namely moving from merely calculating towards the ability to interpret and solve contextual problems. This finding affirms that the connection between context and concept built through PMRI contributes directly to the achievement of learning objectives.

In summary, the research results show that the developed teaching module met all three criteria of product quality. The validity aspect is reflected in the validation percentages of the material expert (90%), the media expert (91.7%), and the test instrument (90%), all of which fall within the highly valid category. The practicality aspect is evident from the results of the one-to-one trial (85.2%), the small-group trial (88.8%), and the field test (85.34%), all of which fall within the highly practical category. The effectiveness aspect is shown by the increase in the average score from 28.63 to 65.91 with an N-Gain of 0.51 in the medium category. Thus, the final product in the form of a PMRI-based social arithmetic teaching module is declared valid, practical, and effective for use in mathematics learning in the seventh grade. The simultaneous fulfilment of these three criteria shows that the module has a complete quality, both in terms of its theoretical foundation, its feasibility in the classroom, and its impact on students' numeracy skills.

4. Discussion

a. The Validity of the Teaching Module

The research results show that the developed teaching module met the highly valid criteria, indicated by the material-expert validation percentage of 90% and the media-expert percentage of

91.7%, as well as the test-instrument validity of 90%. This achievement signifies that the module had met the aspects of content appropriateness, presentation, language, media design, and PMRI characteristics. The high level of validity shows that the content of the material was in accordance with the Learning Outcomes and Learning Objectives for the social arithmetic material, while also incorporating the main characteristics of PMRI, namely the use of contextual problems, the process of mathematisation, interaction, the use of models, and the interconnection between concepts. The validation process, which involved different experts for the material and media aspects, ensured that the quality of the module was reviewed comprehensively, both in terms of substance and presentation. With the fulfilment of these validity criteria, the module had an adequate foundation to be tried out with students in the next stage.

These findings are in line with Freudenthal's idea that mathematics must be connected to reality and regarded as a human activity, so that students are given the opportunity to construct their own mathematical understanding through meaningful contexts (Ardianingsih et al., 2020; van den Heuvel-Panhuizen & Drijvers, 2020). The high validity also affirms that the local contexts raised in the module, such as everyday buying and selling activities, are relevant to the principle of didactical phenomenology in PMRI. In addition, the suggestions for improvement from the experts, such as refining the narrative of the problems and standardising the writing of monetary values, show that the iterative process in the Plomp model plays an important role in improving the quality of the module before it is tried out. This affirms that validity is not a one-off result, but an achievement built through a continuous cycle of revision.

These results support the research of Mardiana et al., (2020); Nurjanah et al., (2023); Sari & Sari, (2019) which showed that PMRI- and RME-based learning tools have a high level of validity and are feasible for use in mathematics learning. Thus, the developed module can be regarded as a product that is theoretically sound and feasible for use as teaching material. This validity becomes an important prerequisite because a valid module will serve as a strong basis for the measurement of the practicality and effectiveness aspects in the subsequent stages.

Furthermore, the different emphases among the five aspects of material validation provide a complete picture of the quality of the module. The realistic-assessment aspect received high appreciation because each subsection of the module begins with a contextual problem that requires students to carry out mathematisation, while the language-appropriateness aspect affirms that the wording of the problems had been adapted to the cognitive developmental level of seventh-grade students. As for the media validation, the high score on the content-design aspect confirms that the choice of colours, illustrations, and layout had taken readability into account. This convergence of assessments from the material expert and the media expert reinforces the claim that the module is not only substantively correct, but also visually communicative, so that these two dimensions complement each other in building a comprehensive product quality.

b. The Practicality of the Teaching Module

The practicality of the module is reflected in the trial results, which were consistently in the highly practical category, namely 85.2% in the one-to-one trial, 88.8% in the small-group trial, and 85.34% in the field test. These results show that the module is easy for students to use, has an attractive appearance, uses language that is easy to understand, and is able to help students understand the social arithmetic material. The presence of pictures, illustrations, discussion activities, challenges, exercises, and contextual problems made students more active and motivated during learning. The consistency of the practicality percentages across three different trial scales indicates that the module can be used stably at

various levels of students' cognitive ability. This stability is an important indicator that the module is feasible for broad application without requiring major modification for each group of users.

This practicality is inseparable from the application of PMRI principles, which place students at the centre of learning. The activities designed give students the opportunity to explore real problems, discuss, and discover concepts independently, so that learning feels easier to follow than learning that focuses solely on the teacher's explanation (Oftiana & Saefudin, 2017). This is relevant to the initial condition found in the needs analysis, namely that students tended to be passive and bored when learning relied only on textbooks and the lecture method. The developed module addressed this need by presenting the material in a contextual, illustrated, and colourful manner.

These findings are consistent with Nieveen's view that a product is said to be practical when it is easy to use and can be applied under real conditions, and they support the research of Nurjanah et al., (2023); Sari & Sari, (2019); Thoibah et al., (2022), which found that modules based on a realistic and contextual approach received positive responses from students. The results of the needs analysis, which found that 100% of students liked illustrated books and 87% liked colourful books, explain why the appearance aspect of the module received a very positive response. Thus, the practicality of the module is determined not only by ease of use, but also by the suitability of the module design with students' preferences and characteristics.

The pattern of increasing practicality percentages from the one-to-one trial to the small-group trial, followed by a slight decrease yet remaining stable in the field test, can be explained through the dynamics of social interaction in learning. In the small-group trial, students obtained the opportunity to discuss, so that individual difficulties were more easily overcome through the contributions of peers, in keeping with the characteristic of interactivity in PMRI. Meanwhile, in the field test with a larger number of students, the wider diversity of abilities and learning paces also influenced the responses; however, the percentage remaining within the highly practical category affirms the robustness of the module in an actual classroom situation. This shows that the practicality of the module is robust and does not depend on the size of the user group, so that the module is feasible for use in everyday classroom learning.

c. The Effectiveness of the Teaching Module

The effectiveness of the module is demonstrated by the improvement in students' numeracy skills, namely the average pretest score of 28.63 increasing to 65.91 on the posttest, with an N-Gain of 0.51 in the medium category. This improvement shows that learning that begins with real problems helps students connect mathematical concepts with everyday experiences, so that students understand the meaning of concepts and do not merely memorise formulas. The horizontal and vertical mathematisation processes facilitated by the module encourage students to move from informal solutions using their own language towards formal understanding gradually (Hidayah et al., 2025; Nguyen & Nguyen, 2024).

The improvement in numeracy skills occurred because the activities in the module were designed on the basis of everyday life contexts that require students to use numbers and mathematical symbols and to interpret the situations given. Thus, students not only learn to calculate, but also learn to use mathematics to solve real problems, in keeping with the nature of numeracy as the ability to apply mathematical concepts and procedures in various contexts (OECD, 2019; Putry et al., 2023). The activities that require students to interpret information and to make decisions also train the higher indicators of numeracy, namely the ability to analyse and to draw conclusions.

The N-Gain achievement in the medium category needs to be interpreted proportionally by taking into account students' initial condition. The very low average pretest indicates that students' starting point was far below mastery, so that the increase towards the posttest average of 65.91 within a limited learning period represents a pedagogically meaningful achievement. This indicates that the module was able to have a real impact even on students who had previously experienced serious difficulties. The consistency of this finding with the results of previous research reinforces the belief that the PMRI approach does not merely improve momentary scores but builds a more solid foundation of numeracy understanding through students' active involvement in the process of mathematisation.

These findings are in line with the research of)Amalia et al., (2020); Mardiana et al., (2020); Putra & Purnomo, (2023), which showed that the application of PMRI is able to improve students' numeracy skills, conceptual understanding, and mathematics learning outcomes. Nevertheless, there were still two students with an N-Gain in the low category, which indicates the need for additional guidance for students with very low initial ability. This condition shows that the effectiveness of the module can be enhanced when it is accompanied by a differentiation learning strategy that attends to the diversity of students' abilities.

d. Implications, Novelty, and Limitations

When viewed from the magnitude of the increase, the rise in the average score from 28.63 to 65.91 reflects a qualitative change in the way students view social arithmetic material. Before using the module, students tended to have difficulty translating word problems into mathematical models, so that many failed to determine the appropriate operation for calculating profit, loss, or the percentage of a discount. After learning with the PMRI-based module, students became accustomed to beginning their solutions from a familiar context and then building models and formal procedures gradually. This shift from a memorising strategy towards a modelling strategy is what explains why the improvement occurred evenly across almost all students, not only among high-ability students. In other words, the module did not merely improve the scores obtained, but also improved students' numeracy-thinking processes.

Overall, the integration of the PMRI approach with the Plomp development model proved to produce a module that is valid, practical, and effective. The novelty of this study lies in the combination of these three elements, namely the PMRI approach, a focus on numeracy skills, and the systematic Plomp model, by raising the local context of the students of SMP Katolik Don Bosco Bitung. The practical implication of this study is the availability of an alternative teaching material that teachers can use to create mathematics learning that is more contextual, active, and meaningful. In addition, this module can serve as a reference for teachers in designing similar teaching materials on other topics by utilising the local context of their respective regions. As for the limitations of this study, its scope is still confined to social arithmetic material and it was conducted at a single school. Therefore, future researchers are advised to develop PMRI-based modules on other mathematics topics, to involve broader and more diverse subjects, and to examine their influence on other mathematical abilities such as problem-solving, communication, and mathematical literacy. Testing through an experimental design with a control group is also recommended in order to strengthen the claim of effectiveness statistically.

Conclusion

Based on the results of the research and development, it can be concluded that the social arithmetic teaching module using the Indonesian Realistic Mathematics Education (PMRI) approach, developed using the Plomp model, has met the criteria of being valid, practical, and effective for

supporting the numeracy skills of junior high school students. The validity is shown by the material-expert validation result of 90%, the media-expert result of 91.7%, and the test-instrument result of 90%, all of which fall within the highly valid category. The practicality is shown by the results of the one-to-one trial (85.2%), the small-group trial (88.8%), and the field test (85.34%), which fall within the highly practical category. The effectiveness is shown by the increase in students' average score from 28.63 to 65.91 with an N-Gain of 0.51 in the medium category. Thus, the developed teaching module is feasible for use as teaching material that supports students' numeracy skills on the social arithmetic topic and can serve as an alternative solution for contextual and meaningful mathematics learning innovation.

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References

Alfaruqi, A. Z., & Nurwahidah, N. (2025). Reflection on Indonesia's PISA scores and the 2024 Madrasah teacher competency assessment results: Challenges in enhancing teacher competence. Jurnal Pendidikan IPS, 15(1), 1–14. https://doi.org/10.37630/jpi.v15i1.2559

Amalia, A. R., Purwati, H., & Nursyahidah, F. (2020). Pengembangan media pembelajaran berbasis PMRI untuk meningkatkan kemampuan berpikir kritis siswa SMP. Imajiner: Jurnal Matematika Dan Pendidikan Matematika, 2(4), 321–328. https://doi.org/10.26877/imajiner.v2i4.5883

Apriliani, E., Andayani, S., & ES, Y. R. (2023). Pengembangan modul matematika berbasis discovery learning materi statistika untuk peningkatan literasi numerasi siswa SMP. EMTEKA: Jurnal Pendidikan Matematika, 4(1), 114–125. https://doi.org/10.24127/emteka.v4i1.2018

Arbain, A., & Sirad, L. O. (2023). Menguatkan resiliensi matematis dan literasi numerasi siswa sekolah dasar melalui inovasi pembelajaran kontekstual dan konstruktif. AKSIOMA: Jurnal Program Studi Pendidikan Matematika, 12(1), 908–919. https://doi.org/10.24127/ajpm.v12i1.6548

Ardianingsih, A., Lusiyana, D., & Rahmatudin, J. (2020). Penerapan pembelajaran Realistic Mathematics Education berbasis etnomatematika untuk meningkatkan HOTS matematik siswa. Mathline: Jurnal Matematika Dan Pendidikan Matematika, 4(2), 148–160. https://doi.org/10.31943/mathline.v4i2.117

Dila, O. R., & Zanthy, L. S. (2020). Identifikasi kesulitan siswa dalam menyelesaikan soal aritmatika sosial. Teorema: Teori Dan Riset Matematika, 5(1), 17–26. https://doi.org/10.25157/teorema.v5i1.3036

Domu, I., & Mangelep, N. O. (2024). Factors that influence students' ability to solve mathematics story problems. International Journal of Mathematics and Science Education, 1(3), 1–9.

Domu, I., & Mangelep, N. O. (2025). Development of Mathematics Learning Model Based on Mapalus Values: Efforts to Improve Mathematical Literacy and Students' Social Skills. Journal of Cultural Analysis and Social Change, 1509–1519.

Han, K., He, Y., Tan, H., Tang, S., Huang, H., & Luo, J. (2017). Online Pricing for Mobile Crowdsourcing with Multi-Minded Users. Proceedings of the 18th ACM International Symposium on Mobile Ad Hoc Networking and Computing, 1–10. https://doi.org/10.1145/3084041.3084058

Hanifah, R., Noornia, A., & Sampoerno, P. D. (2019). Pengembangan pembelajaran dalam membangun pemahaman relasional siswa melalui pendekatan PMRI materi relasi fungsi. Prima: Jurnal Pendidikan Matematika, 3(2), 103–116. https://doi.org/10.31000/prima.v3i2.950

Hernawati, F. (2016). Pengembangan perangkat pembelajaran matematika dengan pendekatan PMRI berorientasi pada kemampuan representasi matematis. Jurnal Riset Pendidikan Matematika, 3(1), 34–46. https://doi.org/10.21831/jrpm.v3i1.9685

Hidayah, N. L., Lailiyah, S., Setyawati, M., & Kiswanto, H. (2025). Proses matematisasi vertikal dan horizontal siswa dalam pemecahan masalah matematika SPLTV ditinjau dari perspektif gender. Pedagogy: Jurnal Pendidikan Matematika, 10(4), 2347–2366. https://doi.org/10.30605/pedagogy.v10i4.7458

Juandi, D., Kusumah, Y. S., Tamur, M., Perbowo, K. S., & Wijaya, T. T. (2021). A meta-analysis of Geogebra software decade of assisted mathematics learning: what to learn and where to go? Heliyon, 7(5), e06953. https://doi.org/10.1016/j.heliyon.2021.e06953

Latipah, E. D. P., & Afriansyah, E. A. (2018). Analisis kemampuan koneksi matematis siswa menggunakan pendekatan pembelajaran CTL dan RME. Matematika: Jurnal Teori Dan Terapan Matematika, 17(1), 1–12. https://doi.org/10.29313/jmtm.v17i1.3691

Lestari, R. S., Nayazik, A., & Kurniati, L. (2021). Development of mathematics teaching materials based on Realistic Mathematics Education using Tri-N on linear equation system material. Journal of Medives: Journal of Mathematics Education IKIP Veteran Semarang, 5(2), 363–374. https://doi.org/10.31331/medivesveteran.v5i2.1722

Mangelep, N. O. (2025). Teori pembelajaran lokal berbasis noticing guru dalam mendukung literasi matematis siswa pada topik pola bilangan.

Mardiana, E., Sa'dijah, C., Qohar, A., & Anwar, L. (2020). Practicality and effectiveness of realistic mathematical learning materials to support mathematical literacy skill of junior high school students. AIP Conference Proceedings, 2216, 060016. https://doi.org/10.1063/5.0000844

Moroki, I., Mangelep, N. O., Mokalu, Y. B., Womboiang, F. G. N., & Moroki, I. (2025). Model Jigsaw Berbantuanan Mind Mapping: Pendekatan Kolaboratif-Visual Untuk Meningkatkan Prestasi Belajar Matematika. Jurnal Lebesgue: Jurnal Ilmiah Pendidikan Matematika, Matematika Dan Statistika, 6(2), 942–951.

Muhtarom, M., & Nizaruddin, N. (2022). Analisis kemampuan mahasiswa dalam pengajuan masalah numerasi. AKSIOMA: Jurnal Program Studi Pendidikan Matematika, 11(4), 3757–3768. https://doi.org/10.24127/ajpm.v11i4.6036

Nguyen, Q. A., & Nguyen, N.-G. (2024). Horizontal and vertical mathematization processes of 10th grade students: The case of Law of Sines. Journal on Mathematics Education, 15(4), 1251–1276. https://doi.org/10.22342/jme.v15i4.pp1251-1276

Nurjanah, N., Rahmawati, D., & Andayani, S. (2023). Pengembangan modul berbasis RME disertai nilai-nilai Islam pada materi aritmatika sosial. EMTEKA: Jurnal Pendidikan Matematika, 4(2), 299–310. https://doi.org/10.24127/emteka.v4i2.822

OECD. (2019). PISA 2018 assessment and analytical framework: Mathematics. OECD Publishing. https://doi.org/10.1787/b25efab8-en

Oftiana, S., & Saefudin, A. A. (2017). Pengaruh pendekatan Pembelajaran Matematika Realistik Indonesia (PMRI) terhadap kemampuan pemecahan masalah matematika siswa kelas VII SMP Negeri 2 Srandakan. MaPan: Jurnal Matematika Dan Pembelajaran, 5(2), 293–301. https://doi.org/10.24252/mapan.v5n2a10

Putra, D. O. P., & Purnomo, Y. W. (2023). Pengaruh pendekatan Pendidikan Matematika Realistik Indonesia (PMRI) terhadap kemampuan numerasi siswa. AKSIOMA: Jurnal Program Studi Pendidikan Matematika, 12(1), 512–523. https://doi.org/10.24127/ajpm.v12i1.6231

Putri, R. I. I., & Zulkardi, Z. (2019). Designing jumping task on percent using PMRI and collaborative learning. International Journal on Emerging Mathematics Education, 3(1), 105–116. https://doi.org/10.12928/ijeme.v3i1.12208

Putry, A. R., Muhtarom, M., & Wulandari, D. (2023). Analisis kemampuan numerasi siswa kelas XI dalam menyelesaikan soal AKM (Asesmen Kompetensi Minimum). Imajiner: Jurnal Matematika Dan Pendidikan Matematika, 5(2), 167–177. https://doi.org/10.26877/imajiner.v5i2.13003

Ramadhany, A., & Erlina, E. (2020). Pengembangan modul aritmetika sosial berbasis problem based learning untuk siswa SMP. Jurnal Cendekia: Jurnal Pendidikan Matematika, 4(1), 212–223. https://doi.org/10.31004/cendekia.v4i1.155

Sari, D. I., & Sari, N. (2019). Pengembangan perangkat pembelajaran berbasis Realistic Mathematics Education pada materi aritmatika sosial. AKSIOMA: Jurnal Program Studi Pendidikan Matematika, 8(2), 310–322. https://doi.org/10.24127/ajpm.v8i2.1954

Setiawan, Y. (2020). Pengembangan model pembelajaran matematika SD berbasis permainan tradisional Indonesia dan pendekatan matematika realistik. Scholaria: Jurnal Pendidikan Dan Kebudayaan, 10(1), 12–21. https://doi.org/10.24246/j.js.2020.v10.i1.p12-21

Siregar, W., Siregar, H., & Syahputra, E. (2020). Pengembangan perangkat pembelajaran berbasis pendekatan realistik untuk meningkatkan kemampuan pemecahan masalah dan self-confidence siswa. Paradikma: Jurnal Pendidikan Matematika, 13(3), 30–40. https://doi.org/10.24114/paradikma.v13i3.22914

Suryaningsih, N. M. A., Poerwati, C. E., Lestari, P. I., & Parwata, I. M. Y. (2025). Early childhood literacy skills: Implementation of the local genius-based STEAM learning model. Indonesian Journal of Educational Development, 6(1), 160–172. https://doi.org/10.59672/ijed.v6i1.4627

Thoibah, A. S., Siregar, S. N., & Heleni, S. (2022). Pengembangan modul matematika berbasis pendekatan kontekstual pada materi segiempat dan segitiga untuk memfasilitasi kemampuan pemecahan masalah matematis siswa kelas VII SMP/MTs. JURING: Journal for Research in Mathematics Learning, 5(3), 213–224. https://doi.org/10.24014/juring.v5i3.18295

van den Heuvel-Panhuizen, M., & Drijvers, P. (2020). Realistic Mathematics Education. In S. Lerman (Ed.), Encyclopedia of Mathematics Education (pp. 713–717). Springer. https://doi.org/10.1007/978-3-030-15789-0_170

Wahyuni, S., Yani, A., Rosana, D., Wilujeng, I., & Nurohman, S. (2024). Improving students' critical thinking skills through the use of PBL-base Google Sites learning media and review students' collaboration skills. Journal of Social Research, 3(10). https://doi.org/10.55324/josr.v3i10.2279

Wibowo, A. I., Muhtarom, M., & Harun, L. (2022). Efektivitas model pembelajaran Problem Based Learning (PBL) dan Discovery Learning terhadap kemampuan numerasi siswa kelas VII SMP Islam Sultan Agung 1 Semarang. Imajiner: Jurnal Matematika Dan Pendidikan Matematika, 4(6), 539–548. https://doi.org/10.26877/imajiner.v4i6.13018

Yonathan, A. B., & Seleky, J. S. (2023). Pendekatan matematika realistik untuk mengoptimalkan pemahaman konsep matematis siswa. JOHME: Journal of Holistic Mathematics Education, 7(2), 143–154. https://doi.org/10.19166/johme.v7i2.6233