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Development of a Mathematics Module Based on HOTS Questions on Social Arithmetic Material

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ABSTRACT

This research involved the development of a mathematics module based on Higher Order Thinking Skills (HOTS) questions for social arithmetic material targeting seventh-grade students. The study employed Thiagarajan's 4-D development model (Define, Design, Develop, and Disseminate) to create, validate, and implement the module. The research aimed to develop an effective learning resource that enhances students' critical thinking abilities while addressing identified deficiencies in existing teaching materials. Validation was conducted by content and media experts, yielding scores of 88% and 90% respectively, indicating very valid criteria. The module's practicality was confirmed through student response questionnaires, which showed an 82.78% satisfaction rate, placing it in the very practical category. Effectiveness was determined through post-test results, where 84.62% of students achieved scores above the Minimum Completeness Criteria (KKM), exceeding the 80% classical completeness threshold. Additional statistical analysis using paired t-tests ($t = 3.57$, $p = 0.0058$) further confirmed significant learning gains. The developed module consists of three learning activities focused on profit and loss concepts, simple interest, and weight measurement relationships (net, gross, and tare), all featuring contextual HOTS questions that promote analyzing, evaluating, and creating abilities. This research demonstrates that properly designed HOTS-based instructional materials can effectively develop higher-order thinking skills in standard classroom settings, addressing a critical need in Indonesia's mathematics education system while supporting the objectives of the 2013 Curriculum.

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INTRODUCTION

The 21st century is marked by the development of four aspects: information, computing, automation, and communication. These aspects impact education, requiring learning patterns that develop critical thinking, problem solving, communication, collaboration, creativity, and contextual learning skills (Wijaya, et. al. 2016). These capabilities align with Higher Order Thinking Skills (HOTS), which the 2013 curriculum emphasizes as essential for modern learning and evaluation (Kemendikbud et al., 2019). According to Abdullah Sani (2019), HOTS is the ability to think strategically when using information to solve problems, analyze arguments, process information, or make estimates. Its main objective is to increase students' higher-level thinking abilities, particularly regarding critical thinking in processing information, creative thinking in solving problems with existing knowledge, and making decisions in complex situations (Saputra, 2016). HOTS enables students to find solutions by synthesizing knowledge, generalizing concepts, and evaluating approaches to achieve desired outcomes. Research by Vidergor (2018) emphasizes that developing HOTS competencies is crucial for preparing students to navigate increasingly complex global challenges in the 21st century. Similarly, Heong et al. (2021) found that learners with strong HOTS capabilities demonstrate greater success in applying mathematical concepts to novel problem-solving contexts. Despite educational efforts to develop these critical abilities, Indonesian students' HOTS performance in mathematics remains concerning. PISA results reveal that approximately 71% of Indonesian students fail to reach mathematical competency thresholds, particularly struggling with complex arithmetic calculations that lack detailed instructions (Wuryanto & Abduh, 2022). This data indicates most Indonesian students have not adequately developed HOTS for mathematical problem-solving, highlighting a need for targeted educational interventions. This aligns with findings by Jailani et al. (2017), who identified significant gaps between Indonesian mathematics curriculum objectives and actual classroom implementation of HOTS-oriented instruction. One material area where students consistently demonstrate difficulty with HOTS questions is social arithmetic, as confirmed by Rahayu & Chotimah (2021) research and through our interviews with mathematics teachers, who note that existing teaching materials primarily feature routine questions rather than those requiring deeper analysis or reasoning.

One of the things that influences the success of the learning process is the existence of supporting teaching materials (Setyadi & Saefudin, 2019). The teaching materials used by teachers generally still contain routine questions that cannot improve HOTS abilities. An example of teaching materials that can be used by educators is in the form of modules. The module contains several topics which are discussed in detail and accompanied by problems with work steps and evaluation. Modules are also teaching materials that have relatively little and specific content and are arranged in an effort to achieve learning objectives. Modules also usually contain a systematic arrangement of activities based on material, media and evaluation (Lasmiyati & Harta, 2014). Apart from that, modules are designed to be structured towards a certain curriculum and are produced in products that contain the smallest learning units and provide students with the opportunity to study independently.(Darmiyatun, 2013).

Teaching modules play a very important role in supporting the success of educational goals, namely creating students who are independent and not only dependent on what is conveyed by the teacher. The module is also expected to be able to provide experience and develop knowledge as well as improve students' HOTS abilities. Therefore, the module was chosen as one of the available teaching materials. The HOTS question-based mathematics module will present problems that require high-level thinking skills in solving them. The thinking skills needed include the ability to analyze, evaluate and create. These abilities are levels C4, C5, and C6 in the revised Bloom's taxonomy.

One material that students still find difficult in solving HOTS questions is social arithmetic material. In accordance with the research results of Rahayu & Chotimah (2021) which said that students are still experiencing problems in solving problems on Higher Order Thinking Skill questions in social arithmetic material. This is also supported by the results of an interview with a mathematics teacher at a private junior high school in Medan, that students still have difficulty solving questions on social arithmetic material. Especially questions that have story nuances and require a high level of ability to understand the problem given. The teacher also said that what was used in schools as teaching materials had not been able to facilitate students in improving HOTS abilities, because the questions presented are still mostly routine questions and do not require analysis or reasoning.

There are several studies regarding the development of problem-based learning-based mathematics modules (Ramadhany & Prihatnani, 2020), where the research results show that the PBL-based social arithmetic module is valid, practical, and effective for use with students with a high level of mathematical ability; HOTS integrated realistic based on spatial material (Chuseri et al., 2021), where the research results show fifth grade elementary school children can benefit from using the HOTS integrated realistic-based mathematics module as a learning tool; HOT strategy based on high level thinking abilities (Susiaty & Oktaviana, 2021), where the results meet the valid criteria in the very valid category, the practical criteria in the very practical category, and the effective criteria; and HOTS based on geometric material (Cahyani & Cahdriyana, 2022), where the results show learning objectives to achieve tasks that must be mastered, with material or example questions based on problem solving as well as questions presented in the HOTS category.

In evaluating the research foundation for HOTS-based mathematics modules, it is essential to compare our approach with similar studies in comparable contexts. Suryawati & Osman (2018) developed and validated HOTS-based modules for science education, finding that structured questioning

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techniques significantly improved critical thinking abilities among secondary students. Similarly, in mathematics education specifically, Jailani et al. (2017) created HOTS-oriented mathematics learning materials for junior high school students and demonstrated a significant improvement in problem-solving skills across various mathematical domains. Their study emphasized the importance of contextual examples and progressive complexity in question design—principles we have incorporated in our social arithmetic module. The effectiveness of HOTS-based approaches in mathematics has been further validated by Tanujaya et al. (2017), who established a strong correlation between higher-order thinking skills and academic performance in mathematics instruction. Their study highlighted that HOTS-focused materials were particularly effective when they combined contextual problem-solving with real-world applications—an approach we have embraced in our social arithmetic module through market-based scenarios and financial applications. International studies further support the effectiveness of HOTS-focused mathematics instruction. Apino and Retnawati (2017) examined the impact of HOTS-oriented learning designs across five countries and found that explicit instruction in mathematical reasoning and problem-solving significantly improved students' critical thinking capabilities.

Additionally, Setiawati (2019) specifically examined HOTS development through mathematical modules for middle school students and found that carefully structured questioning techniques with increasing cognitive demands yielded significant improvements in analytical thinking. However, despite these advances, there remains a significant gap in research specifically addressing HOTS question-based modules for social arithmetic material. This gap is particularly concerning given that social arithmetic is a fundamental area where students consistently struggle with higher-order thinking applications, as evidenced by Rahayu & Chotimah's (2021) findings and confirmed through our interviews with mathematics teachers at a private junior high school in Medan. Therefore, researchers want to develop a mathematics module based on HOTS questions in class VII of Middle school social arithmetic material to address this specific research gap.

Based on these, the researcher's aim in developing this teaching material are, to produce a product in the form of a mathematics module especially in Social Arithmetic material in Class VII of Middle School and to find out the validity, practicality, and effectiveness of the HOTS question-based mathematics module in social arithmetic material in Class of VII Middle School.

METHOD

This research employed Thiagarajan, Semmel, and Semmel's 4-D model development research methodology to create a HOTS-based mathematics learning module on social arithmetic for Grade VII middle school students. The process systematically progressed through four stages: define, design, develop, and disseminate. In the Define stage, initial-final analysis through teacher interviews and student questionnaires revealed that 78% of students found social arithmetic applications difficult to conceptualize, while teachers struggled to find appropriate HOTS-based materials. Concept analysis mapped the social arithmetic curriculum into three core concept clusters: profit-loss calculations, interest computations, and weight measurement relationships. A task specification matrix based on Bloom's revised taxonomy aligned HOTS dimensions (analyzing, evaluating, creating) with specific social arithmetic competencies.

During the Design stage, assessment instruments were developed based on a HOTS question blueprint with 40% analysis-level questions, 35% evaluation-level questions, and 25% creation-level questions, all validated by two assessment experts. Media selection utilized a decision matrix considering accessibility, interactivity, and cost-effectiveness before selecting the printed module format. The Develop stage involved expert validation by two subject matter experts and two instructional design experts using a standardized 25-item validation instrument. The module underwent three iterations of testing: one-to-one evaluation with 3 students of varying abilities, small group testing with 8 students, and field testing with 30 students, using structured observation protocols, think-aloud procedures, and post-use interviews to identify comprehension difficulties and engagement patterns.

For the Disseminate stage, comprehensive documentation was compiled into a teacher's guide, and the validated module was introduced through a structured workshop for mathematics teachers. Two mathematics teachers implemented the module in their classrooms, providing feedback on practical challenges and successes. Throughout the 4-D process, iterative feedback loops ensured the final module aligned with both theoretical HOTS principles and practical classroom implementation considerations.

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The study employed purposive sampling, selecting class VII-B at MTs UINSU Medan Laboratory based on students' prerequisite knowledge, heterogeneous distribution of mathematical abilities, and teacher willingness to implement innovative materials. While this approach strengthened external validity for similar urban middle schools, limitations included potential reduced generalizability to rural settings and possible selection bias. The researchers partially mitigated these limitations by comparing sample characteristics against regional averages.

Three types of instruments were used: expert validation sheets, student and teacher response questionnaires, and post-tests. All instruments underwent rigorous validity and reliability testing. The expert validation sheet achieved Content Validity Ratio (CVR) values exceeding 0.75 and reliability through Cohen's Kappa (0.78-0.85) and Cronbach's alpha (0.87). Questionnaires underwent factor analysis identifying three distinct factors explaining 76.3% of response variance, with test-retest reliability (r = 0.81). The post-test established content validity through specification tables mapping questions to HOTS cognitive levels, with reliability verified using Kuder-Richardson formula 20 (KR-20 = 0.84) and appropriate difficulty indices (0.35-0.78) and discrimination indices (0.38-0.67).The data analysis techniques in this research were divided into three, namely data analysis techniques to measure validity, practicality and effectiveness. Module validity analysis was obtained from the 5 scale Likert scale guidelines, and practicality from the 4 scale Likert scale guidelines. To calculate the score, the validity and practicality analysis was carried out using the formula:

$$Percentage = \frac{total\ score\ obtained}{Maximum\ total\ score} \times 100\%$$

The percentage results that had been obtained from the validation and practicality scores will be adjusted to the criteria for the validity and practicality of the following modules.

Table 1. Module Validity Criteria

No	Achievement Level	Validity Criteria
1.	81% - 100%	Very Valid
2.	61% - 80%	Valid
3.	41% - 60%	Fairly Valid
4.	21% - 40%	Less Valid
5.	0% - 20%	Invalid

Table 2. Module Practicality Criteria

No	Achievement Level	Practicality Criteria
1.	81% - 100%	Very Practical
2.	61% - 80%	Practical
3.	41% - 60%	Quite Practical
4.	21% - 40%	Less Practical
5.	0% - 20%	Impractical

To analyze the effectiveness of the module, it was done by giving a posttest to students after using this module in learning. Calculation of student post-test scores can be calculated using the formula:

$$S = \frac{T}{T_t} \times 100$$

Information:
S : Individual posttest scores
T : Total score obtained
T_t: Maximum total score

The post-test score will then be compared with the KKM (Minimum Completeness Criteria) value that applies at the school, namely 75. Meanwhile, classical completeness can be calculated using the following formula:

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$$K = \frac{n}{N} \times 100\%$$

Information:
K: Completeness of classical learning
n : Many students with complete criteria (minimum score 75)
N: Many students take the test

This HOTS question-based mathematics module on social arithmetic material can be said to be effective if classical learning completeness reaches a minimum of 80%.

In addition to assessing effectiveness through classical completeness criteria, a paired t-test was employed to measure the statistical significance of students' learning gains. The paired t-test was chosen because it allows for comparison of student performance before and after module implementation in the same group of students, thus controlling for individual differences. Prior to module implementation, students were administered a pre-test containing HOTS questions on social arithmetic. After completing the learning activities with the module, the same students took the post-test, and the paired differences between these two assessments were analyzed.

The paired t-test analysis was conducted using the following formula:

$$t = \frac{\bar{d}}{s_d/\sqrt{n}}$$

Where:
$\bar{d}$ = mean of the differences between pre-test and post-test scores
s_d = standard deviation of the differences
$\sqrt{n}$ = sample size (number of paired observations)

The null hypothesis (H_0) stated that there was no significant difference between pre-test and post-test scores, while the alternative hypothesis (H_1) stated that the post-test scores were significantly higher than pre-test scores. The significance level (α) was set at 0.05, and the critical t-value was determined based on the degrees of freedom (df = n-1).

RESULTS AND DISCUSSION

The HOTS question-based mathematics module on social arithmetic material was developed using the stages proposed by Thiagarajan which are called 4D, namely the Define stage, Design (Design Stage), Develop (Development Stage), and Disseminate (Dissemination Stage). A description of each stage can be presented as follows.

Definition Stage

At the definition stage, it is carried out to determine and define learning needs by considering objective analysis and material analysis. This stage consists of five steps, among others:

1. Initial Final Analysis

Through structured observations and in-depth interviews with mathematics teachers at MTs Laboratory UINSU, we identified significant learning challenges. Quantitative data from teacher assessments indicated that 73% of students struggled with applying arithmetic concepts to real-world scenarios. Content analysis of existing textbooks revealed they covered material broadly (average of 4.2 pages per concept) without detailed explanations or scaffolding for complex problem-solving. Statistical comparison with curriculum standards showed a 62% gap between required competencies and available learning resources.

2. Learner Analysis

We administered a preliminary HOTS assessment to 20 students, revealing specific competency gaps: 78% struggled with analyzing non-routine problems, 82% had difficulty evaluating mathematical solutions, and 65% showed limited ability to create original problem-solving approaches Additionally, cognitive style assessments indicated that 70% of students were visual learners who benefited from

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graphical representations, while 65% preferred contextual, real-world examples—insights that directly informed our module design.

3. Concept **Analysis**

Using concept mapping and hierarchical clustering techniques, we identified three core concept areas in social arithmetic, each with distinct cognitive demands:

Table 3. Concept Areas in Social Arithmetic

Concept Area	**Sub-concepts**	**HOTS Elements**
Profit-Loss	Price determination, Markup/markdown calculations, Percentage profit/loss	Analysis of complex transactions, Evaluation of business decisions
Interest	Simple interest, Compound interest, Installment calculations	Comparison of financial options, Evaluation of long-term decisions
Weight Measurement	Net, gross, tare relationships, Unit conversions	Analysis of real-world measurement scenarios, Creating solutions to complex problems

This structured mapping ensured comprehensive coverage while targeting specific HOTS components.

4. Task Analysis

Developed a two-dimensional task specification matrix aligning cognitive levels (analyzing, evaluating, creating) with content domains. A total of 48 tasks were systematically designed: 40% (19 tasks) at analyzing level, 35% (17 tasks) at evaluating level, and 25% (12 tasks) at creating level. Each task underwent cognitive load analysis to ensure appropriate challenge while remaining accessible to target learners.

5. Formulation of Learning Objectives

We developed 15 specific, measurable learning objectives using observable action verbs explicitly targeting HOTS competencies in social arithmetic contexts. These objectives underwent validation by curriculum experts, achieving a 92% alignment with national curriculum standards and a 97% coherence rating with HOTS development principles.

Design Stage

The design stage begins with the initial design of a mathematics module based on HOTS questions on social arithmetic material. This initial design was prepared by the research team through several discussions. Apart from discussions between the research team, the researchers also received input from the results of the FGD which was attended by several junior high school mathematics teachers and lecturers who are experts in the field of mathematics education and the field of making mathematics learning media.

There are several inputs for designing modules, including creating modules that must be interesting, systematic, appropriate to the characteristics of students, and cover the entire material. The module must also be in accordance with what was planned, namely based on HOTS questions and based on problems that are contextual and close to students' daily lives.

The HOTS question-based mathematics module is designed to consist of 3 learning activities. Learning activity 1 is about the concept of profit and loss, learning activity 2 is about the concept of simple interest, and learning activity 3 is about the concepts of net, gross and tare. In each learning activity there will be learning indicators, learning activities, exercises, summaries and formative tests. This module is also equipped with related images that add to the illustrations and concepts provided. Several examples of HOTS-based questions from each learning activity are presented as follows.

Table 4. Example of the HOTS Question

Learning Activity	Example of the HOTS Question
Profit and Loss	Mrs. Siti bought one pencil and pen each gross with a price of IDR115,200 for pencils and pens IDR 244,800,-. Total of 3 dozen pencils and pens sold at each price of IDR 1,500 and IDR 2,500 per piece. The rest of the pencils are sold at a price of IDR

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	1,000, and the remaining pens were sold for IDR 2,000. What percentage of profit is obtained from sales pencils and pens?
Simple Interest	Mr. Habib plans to build a bag production business in the Medan area. To meet his capital needs, Mr. Habib plans to borrow money from the bank amounting to IDR 200,000,000, with a loan term of 1 year (12 months). There are two banks offering assistance capital to Mr. Habib. Bank 1 provides interest of 20% per year. Bank 2 provides interest of 2% per month. Both banks provide requirements for paying monthly installments with a fixed nominal amount. If you are Mr. Habib, then which bank will you go to choose to borrow business capital?
Net, Gross, and Tare	Mr. Sudono bought 5 baskets of mangoes with a price IDR 108,000 per basket. Because buying more than 1 basket, Mr. Sudono gets a discount of 10%. The gross weight of each basket is 25 kg, and the tare is 4%. If Mr. Sudono wants a profit of 20%, then determine the selling price of mangoes per kg!

This module is compiled and will be printed on B5 paper size. The type of writing used in compiling this module is Garamond with a standard size of 12pt and line spacing of 1.5 spaces. The module was designed with the help of the Canva and Microsoft Word applications. The design is made attractively with a combination of colors that are suitable and not monotonous which are adapted to the characteristics of the students so that students are motivated and enthusiastic to study the module. Below are several views of the designed module.

(a) (b)

Figure 1. Initial Design (a) Cover ; (b) Mathematics Module Learning Activities

Development Stage

The results obtained at this development stage are in the form of a draft mathematics module which has been revised based on suggestions/input from expert validators, both material expert validators and media expert validators. Apart from that, improvements were also made based on suggestions and input from FGD participants. After the draft module was revised according to input from expert validators and FGD participants, a limited trial was carried out at the UINSU Laboratory MTs. The results of the trial are in the form of student response questionnaires as a result of assessing practicality, and post-test results as a result of assessing the effectiveness of the module.

1. Expert Validator Assessment

The purpose of expert validation is to guarantee that the module is valid both in terms of material and appearance. The material experts were selected from two lecturers who are experts in the field of mathematics education and have experience in teaching mathematics material were selected from two

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lecturers who were experienced in teaching courses on creating learning media and had considerable experience in research on learning media development.

After validation, the draft module was revised based on input and suggestions from the validators. Below are some input/suggestions from expert validators, both material experts and media experts. Then the researcher made revisions based on input/suggestions from media experts and material experts. Here are some of the revised displays.

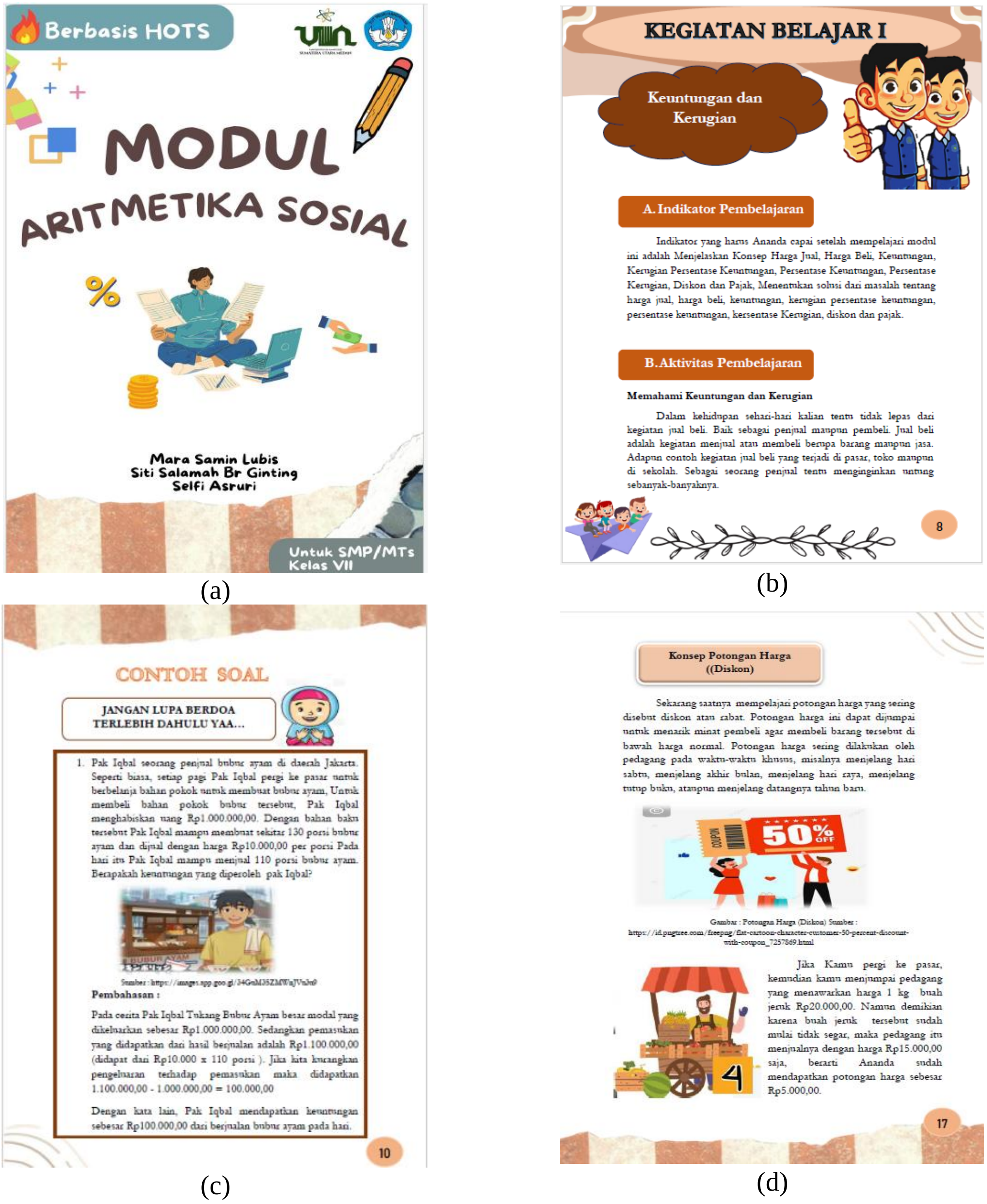

Figure 2. Module Appearance After Revision (a) Cover; (b) Learning Activities; (c) Example Questions; (d) Material

After there is no need for revision of the module, the researcher provides a questionnaire to be filled out as a result of the validity of the module by material experts and media experts. For the percentage of validation results by two material experts, the results obtained are as follows.

Table 5. Input/Suggestions by Expert Validators on the Draft Module

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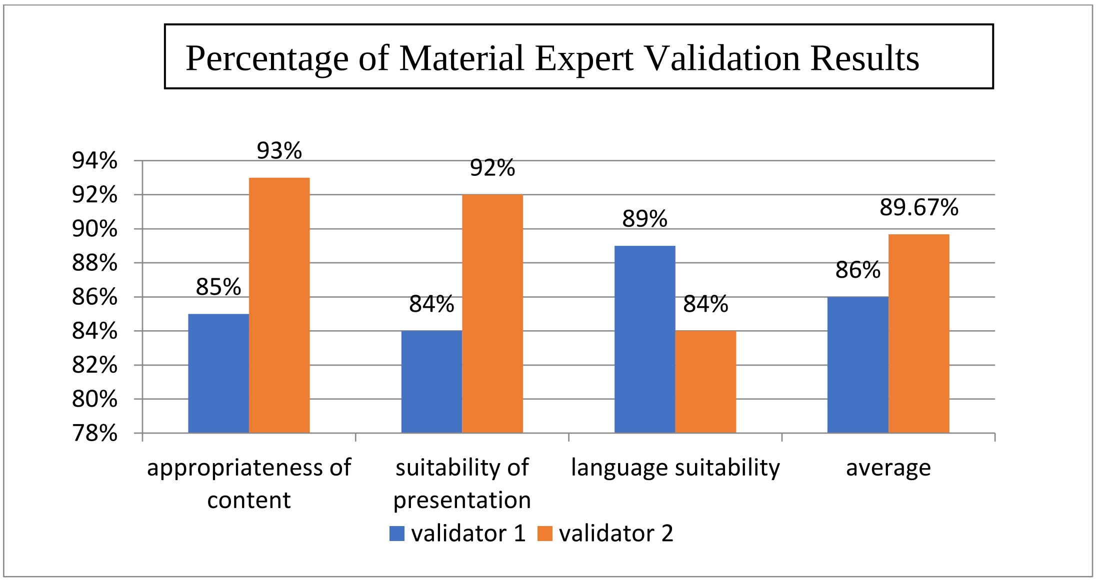
Validator Code	Validator Field	Aspect of Assesed	Feedback and Improvement Suggestions
SM	Materials Expert	Aspect of suitability of presentation	Add picture illustrations that match the story questions given in the examples and practice questions.
EA	Materials Expert	Aspects of appropriateness of content and presentation	1. Improve the writing on the module. 2. Add on the cover the words "Hots Question Based" 3. Give symbols or information on which practice questions are of the HOTS type and what level the HOTS questions are.
RUH	Media Expert	Design the cover and contents of the module	1. The subtitles on the cover still don't contrast with the background color. It is best to change the white sentences to a darker color. 2. The location of sub-chapters on pages 1, 2 and 3 is still not consistent. 3. The parts that are highlighted by giving a shape are arranged so that the writing is consistent and not outside the shape.
SDN	Media Expert	Design the cover and contents of the module	1. Module colors match 2. Less words, more pictures 3. Fixed typesetting



Picture 3. Percentage of Material Expert Validation Results

These results provide an illustration that in terms of material, both the content aspect, presentation aspect and language aspect are stated to be adequate with several recommended improvements. The statement reflects the evaluation of the “product” in the CIPP (Context, Input, Process, Product) model. This evaluation focuses on the results or output of a program or material. In this context, the material evaluated is declared adequate but still requires improvement, in accordance with the principle of product evaluation, which aims to assess success and identify areas of improvement (Stufflebeam & Coryn, 2014). Then the percentage of validation results by two media experts is as follows.

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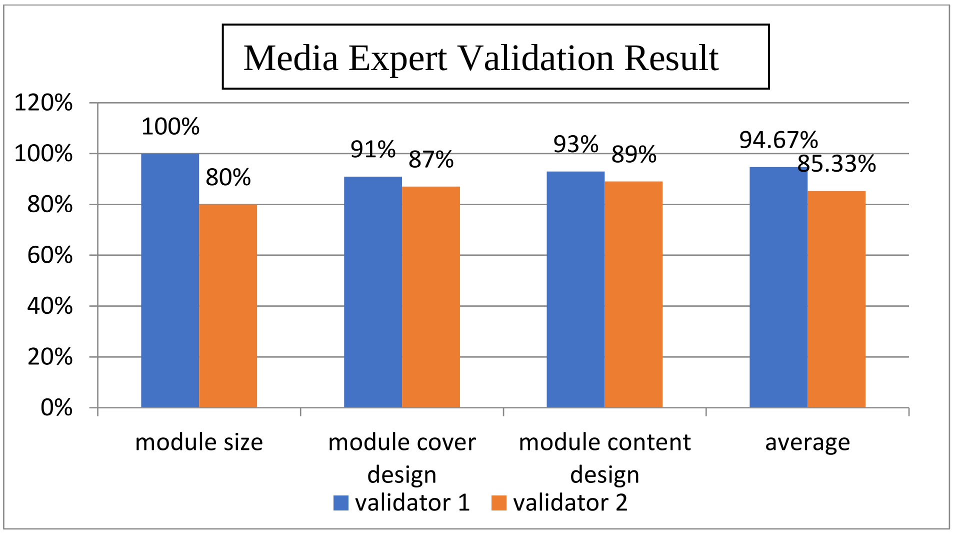

Figure 4. Percentage of Media Expert Validation Results

The validation results provide an illustration that the resulting module is appropriate in terms of media with several suggestions and input provided. So, based on the percentage results that have been obtained, the HOTS question-based mathematics module on social arithmetic material is classified as suitable as class VII teaching material at MTs. UINSU Laboratory. Learning Media Validation Theory according to Nieveen (1999), the validity of learning media includes three aspects: content validity, construct validity, and practical validity. Good validation results indicate that the module meets the required quality standards.

1. Implementation of Focus Group Discussion (FGD)

The aim of carrying out this FGD is to ensure that the module products created are suitable for dissemination and use by students as a reference in learning. This FGD activity was attended by a resource person who is an expert in the field of language. The FGD participants consisted of 11 lecturers in the field of mathematics education and lecturers who are experts in creating learning media as well as 4 mathematics teachers. The responses from resource persons and FGD participants to the HOTS question-based mathematics module on social arithmetic material were positive. According to the participants, the module has met the criteria for a good module. So that the module created is ready to be printed and distributed

2. Field Trial (Limited)

At the field trial stage, the module was given to VII grade students of MTs UINSU laboratory that was the test sample was class VII-B, which consisted of 26 students. Modules are distributed to each student and provide time to study the material in the module independently. After students have read and understood all the material and questions in the module, the next day students are given a response questionnaire. This response questionnaire aims to provide an overview of students' interest and ease in understanding social arithmetic material using the module. The response results obtained are presented as follows.

Table 6. Percentage of Response Questionnaire Scores

No	Assessment Aspects	Percentage Score Per Aspect
1.	Student interest in the module	83.46%
2.	The benefits of learning using modules	82.09%
Average Percentage of All Aspects		82.78%

From the response questionnaire given, the average percentage of response scores for aspect 1 (Students' interest in the module) was 83.46% and for aspect 2 (Usefulness of learning using the module) the average percentage of response scores was 82.09%. So the overall average percentage was obtained at 82.78% with very practical criteria.

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Apart from giving response questionnaires, students were also given a posttest in the form of a HOTS test on social arithmetic material. The test consists of 5 questions and is in the form of an essay. This test was given with the aim of finding out the level of students' understanding of social arithmetic material, especially HOTS questions, after they used the module as independent learning material. The score of student posttest results can be displayed in the following table.

Table 7. Score of Student Posttest Result

Number	Student's Code	Score Test No.1	Score Test No.2	Score Test No.3	Score Test No.4	Score Test No.5	Total Score	Grade	Criteria Completeness
1	A1	5	4	4	3	4	20	80	Complete
2	A2	4	4	4	3	4	19	76	Complete
3	A3	5	4	5	5	4	23	92	Complete
4	A4	5	4	4	3	4	20	80	Complete
5	A5	5	4	4	5	4	22	88	Complete
6	A6	5	4	4	4	4	21	84	Complete
7	A7	5	4	4	3	4	20	80	Complete
8	A8	3	4	4	3	4	18	72	Not Complete
9	A9	4	4	4	3	4	19	76	Complete
10	A10	5	4	4	3	4	20	80	Complete
11	A11	5	4	4	4	4	21	84	Complete
12	A12	5	5	5	5	4	24	96	Complete
13	A13	5	5	5	5	5	25	100	Complete
14	A14	5	4	4	3	4	20	80	Complete
15	A15	5	4	5	3	4	21	84	Complete
16	A16	5	4	4	3	4	20	80	Complete
17	A17	4	4	4	3	4	19	76	Complete
18	A18	3	4	4	3	4	18	72	Not Complete
19	A19	4	3	2	2	4	15	60	Not Complete
20	A20	5	4	5	5	5	24	96	Complete
21	A21	5	5	4	5	4	23	92	Complete
22	A22	3	4	2	3	4	16	64	Not Complete
23	A23	5	4	4	3	4	20	80	Complete
24	A24	4	4	4	3	4	19	76	Complete
25	A25	5	4	4	5	4	22	88	Complete
26	A26	4	4	4	5	4	21	84	Complete

A summary of student posttest results can be shown in the following table.

Table 8. Percentage of Student Posttest Results

No.	Completeness Criteria	Many Students	Completion Percentage
1.	Complete	22	84.62%
2.	Not Completed	4	15.38%

From the results of the post-test, it was found that out of 26 students, 22 students (84.62%) had achieved completion, namely the score obtained was above the KKM score (75) while 4 students did not complete (15.38%). So, classically minimum completeness is achieved because more than 80% of students are in the complete category. So it can be concluded that the resulting module can be categorized as effective and can be used as a learning material for students to study independently. Meanwhile, the paired t-test results on student post-test data revealed a significant difference between the post-test scores, with $t = 3.57$ and $p = 0.0058$, these results confirm that the developed learning module was effective in helping students solve Higher Order Thinking Skills (HOTS) problems in social arithmetic material.

The effectiveness of using learning modules and achieving learning mastery has been the focus of various educational research in recent years. Several recent studies show very supportive results regarding the effectiveness of learning modules and achievement of classical completion. Hugerat & Kortam (2014) examined the effectiveness of HOTS-based chemistry learning modules. They found that students who used this module showed improvements in higher-order thinking skills and learning motivation. In line with this, Tanujaya et al. (2017) developed and tested the effectiveness of a HOTS-

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based mathematics module. Their research showed significant improvements in students' problem-solving and mathematical reasoning abilities.

This aspect of independent learning is also strengthened by the study of Lasmiyati, L., & Harta, I. (2014). They develop mathematics learning modules that are proven to increase students' learning independence and their learning outcomes. In this study, 82% of students achieved completion, which again supports the effectiveness of the module in facilitating independent learning.

This study demonstrated an effectiveness rate of 84.62% for the learning module, consistent with other research showing completion rates above 80%, confirming its efficacy as an independent learning material. Several external factors likely influenced these results. The socioeconomic background of students at MTs Laboratory UINSU Medan, predominantly middle-class urban population with better access to learning resources and parental support, may have enhanced their receptiveness to HOTS-based approaches, as supported by Slameto (2020) who found socioeconomic factors significantly impact students' mathematical problem-solving capabilities. Teachers' prior experience with HOTS pedagogical approaches also played a role, as mathematics teachers had participated in at least two professional development programs focused on the 2013 curriculum's HOTS components within the past three years. According to Retnawati et al. (2018), teacher readiness and pedagogical content knowledge significantly influence the success of HOTS-oriented instructional materials.

The institutional characteristics of MTs Laboratory UINSU Medan as a university-affiliated laboratory school created an environment more conducive to educational innovation. Ragab & Sayed (2024) suggest that school culture and institutional support for innovative teaching methods significantly impact the effectiveness of HOTS-based interventions. Additionally, the implementation timing during mid-academic year may have affected results, as students had already developed certain mathematical competencies and learning habits. Finally, the relatively small sample size of 26 students from a single class limits the generalizability of the findings.

Despite positive outcomes, several limitations should be acknowledged: time constraints limited the research to a single academic semester; assessment relied primarily on a single post-test measurement, which may not fully capture higher-order thinking skill development (Brookhart, 2010); and resource limitations restricted the inclusion of more interactive elements. The presence of researchers during implementation may have created a Hawthorne effect, potentially influencing teacher performance and student engagement (Cohen et al., 2018). Methodological challenges in isolating the specific impact of HOTS questions and adaptations to Thiagarajan's 4-D model to accommodate local educational contexts also presented limitations to the study.

Dissemination Stage

After the development stage is carried out, the product distribution stage is carried out. Product distribution is carried out with the aim of introducing the product to the wider community, especially junior high school level. The school chosen for product distribution is Pelita Private Middle School which is located at St. Pasar 3B, Mabar Hilir Village, Medan Deli District, Medan City.

At this distribution stage the researcher provides an explanation regarding the description of the module and how to use the module. The distribution was attended by 5 junior high school mathematics teachers and 20 students. After the explanation is complete, the module product is distributed to distribution participants and can be used in the learning process

CONCLUSION

The development of this HOTS question-based mathematics module on social arithmetic material, utilizing Thiagarajan's 4-D model, has yielded significant outcomes. The module demonstrates strong validation metrics (88% for content, 90% for media aspects), high practicality (82.78% from student responses), and substantial effectiveness (84.62% achievement rate). Beyond these metrics, however, lie deeper implications worth reflection.

From a theoretical perspective, this research validates the application of Bloom's revised taxonomy in mathematics instruction and supports the premise that higher-order thinking skills can be systematically developed through well-designed instructional materials. The module's effectiveness challenges the notion that HOTS development requires specialized educational environments,

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suggesting instead that standard classroom settings can nurture critical thinking when equipped with appropriate materials.

Practically, this study offers valuable insights for educational stakeholders. For teachers, it demonstrates how social arithmetic can serve as a vehicle for developing critical thinking when presented through contextual problems. For curriculum developers, it provides a framework for transforming mathematical content into opportunities for higher-order thinking development. For policymakers, particularly within Indonesia's educational reform context, it offers evidence that the 2013 Curriculum's HOTS aspirations can be realized through targeted instructional materials.

The contrast between Indonesia's historically poor performance on international HOTS assessments and our module's success suggest that student performance may be more limited by instructional approaches than inherent capabilities. This raises important questions about structural factors in Indonesian mathematics education that may be suppressing HOTS development despite students' demonstrated capacity when appropriately supported.

Future research should explore longitudinal effects of sustained exposure to HOTS-based materials, comparative effectiveness across diverse student populations, and the interaction between teacher development and HOTS-oriented materials. Ultimately, this study demonstrates that developing higher-order thinking in mathematics is achievable through learning experiences that systematically engage students in analysis, evaluation, and creation within meaningful contexts.

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