



Development of A Guided Inquiry Model Mathematics Learning Tool to Improve Students' Analytical Skills in Social Arithmetic

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ABSTRACT: This study aims to develop a guided inquiry model of mathematics learning tools to improve students' analytic abilities in social arithmetic material. The study used the Research and Development (R&D) method with a 4D model that includes the define, design, develop, and disseminate stages. The developed tools consist of a user manual, teaching modules, LKPD, and test packages. The trial subjects were 28 seventh-grade students of SMP Negeri 14 Jember. Data were obtained through validation sheets, observations of learning implementation, observations of analyticity behavior, student response questionnaires, and pretest and posttest tests. The results showed that the learning tools met the valid criteria with an average validity score of 3.72–3.85, practical with an average implementation score of 3.33, and effective based on classical completeness of 82.14%, a high category of N-Gain increase, good category of analyticity behavior, and positive student responses of 89.7%.

KEYWORDS: guided inquiry, analyticity, social arithmetic.

INTRODUCTION

Critical thinking is an essential skill that every individual should possess. Critical thinking is defined as the cognitive process of making decisions and formulating solutions based on analyzing information from multiple perspectives (Wulandari, 2019). Facione et al. (1995) states that critical thinking consists of two aspects, namely ability and disposition. Ability refers to an individual's ability to analyze, evaluate, and draw conclusions logically, while disposition relates to an individual's tendency to use these abilities consistently in various situations (Ginting & Haji, 2024).

Critical thinking disposition can be measured using the California Critical Thinking Disposition Inventory (CCTDI) instrument which includes seven indicators, namely truth-seeking, open-mindedness, analyticity, systematicity, self-confidence, inquisitiveness, and cognitive maturity (Safitri & Syahfitri, 2023). One important indicator is analyticity, namely an individual's tendency to analyze various points of view, anticipate problems, and use logic and evidence in solving problems (Boonsathirakul & Kerdsomboon, 2021).

However, in learning practice, students' critical thinking dispositions are still relatively low. This is indicated by the limited emergence of disposition indicators in the problem-solving process (Sa'adah et al., 2024). Several studies show that students' analytical abilities are still in the low category, which is characterized by a tendency to not be able to carry out in-depth analysis and immediately solve problems without an adequate reasoning process (Uyun & Fuat, 2020); (Syahfitri et al., 2019); (Arafah et al., 2023). Therefore, efforts are needed to develop analytical skills in learning. Analyticity indicators in this research include the ability to apply evidence-based logical reasoning, anticipate possible difficulties, and integrate observation results with theoretical concepts (Facione et al., 1995). One of the materials that has the potential to develop these abilities is social arithmetic, because it contains contextual problems that require logical analysis and the relationship between concepts and real situations (Nuraeni et al., 2020). However, students' mastery of social arithmetic material is still relatively low (Gahung et al., 2024). This condition is influenced by learning practices that are still teacher-oriented, so that students' active involvement in constructing knowledge is not optimal (Surati et al., 2022). Therefore, a learning model is needed that is student-centered and integrates contextual problems (Naja et al., 2022).

One alternative that can be used is the guided inquiry learning model. This model requires active participation of students in every stage of learning, so that they can improve their ability to analyze, synthesize and evaluate information and relate concepts to the context of everyday life (Azizah, 2021). Therefore, the guided inquiry learning model has the potential to improve students' analytical skills. However, empirical studies that integrate the analytical disposition in the development of mathematics learning tools are still limited, because most research focuses on learning outcomes and critical thinking abilities in general (Nesri &



Kristanto, 2020). Apart from that, the development of guided inquiry-based learning tools that explicitly foster analyticity in the context of social arithmetic is still rarely carried out.

Based on the results of previous research studies and interviews with mathematics teachers at SMP Negeri 14 Jember, it is known that learning tools based on the Merdeka Curriculum which are specifically designed to develop students' analyticity are still limited. Therefore, it is necessary to develop learning tools that are oriented towards increasing analyticity. The novelty of this research lies in the development of a guided inquiry-based learning tool that explicitly integrates analyticity disposition indicators in social arithmetic material. Based on this explanation, this research aims to describe the process of developing guided inquiry-based learning tools on social arithmetic material and assess its quality in terms of validity, practicality and effectiveness in increasing students' analyticity.

MATERIALS AND METHODS

This research is research and development using the 4D model proposed by Sivasailam Thiagarajan including the define, design, develop and disseminate stages. The tools developed include a manual for using the device, teaching modules, Student Worksheets (LKPD), as well as test instruments to measure students' analyticity in social arithmetic material. This research aims to produce a guided inquiry model mathematics learning tool that meets the criteria for validity, practicality and effectiveness in improving students' analytical skills.

The definition stage is to identify and determine learning needs through analysis of existing goals and limitations. Activities at this stage include beginning-to-end analysis, student analysis, concept analysis, task analysis, and formulation of learning objectives. The design stage aims to compile learning tools to produce an initial prototype. The development stage aims to produce a draft I of the learning tool which is then validated by experts. Based on the validation results, revisions were carried out to obtain draft II which met the valid criteria. Draft II was then tested to assess the practicality and effectiveness of the learning tools. The dissemination stage is the final stage which aims to disseminate the use of learning tools that have been developed so that they can be used more widely.

The population in this study was all 140 class VII students at SMP Negeri 14 Jember. Sample determination was carried out using a purposive sampling technique, namely selecting samples based on certain considerations that were tailored to the research objectives. The readability test sample consisted of 5 class VIII students who were selected to assess the clarity and understandability of the learning tools, taking into account that they had studied the relevant material. The learning device trial sample was 28 class VIIA students, who were used to test the quality of the learning device before it was implemented more widely.

Data collection in this research used several instruments, namely validation sheets, learning implementation observation sheets, analytical behavior observation sheets, student response questionnaires, and test packages. The tests used consist of diagnostic assessments and summative assessments. The diagnostic assessment is in the form of a pretest in the form of 3 item description questions given before learning. Next, the summative assessment is in the form of a posttest (learning outcomes test) in the form of 3 item description questions given after learning. This test is used to analyze the increase in students' analytical skills before and after taking part in learning using guided inquiry model learning tools.

Next, analysis was carried out on the data that had been obtained. In this development research, aspects of the validity, practicality and effectiveness of learning tools will be analyzed. The validity test was carried out by two Faculty of Education lecturers from the Jember University Mathematics Education Study Program and one mathematics teacher from SMP Negeri 14 Jember to assess the suitability of the learning devices and instruments. The validity criteria are presented in Table 1.

Table 1. Validity Level Interval

No	Range	Category
1	$1 \leq V_a < 2$	invalid
2	$2 \leq V_a < 3$	less valid
3	$3 \leq V_a < 4$	valid
4	$V_a = 4$	very valid



Data obtained from the learning implementation observation sheet was analyzed to determine the practicality of the learning tools. The analysis was carried out by summarizing the results of observations, calculating the average score for each indicator, the average for each aspect, and the total average of learning implementation. The range and category of practicality assessment can be seen in Table 2. The interval for the level of practicality of learning tools.

Table 2. Interval of Practicality Level of Learning Tools

No	Range	Category
1	$1 \leq Pr < 2$	very low
2	$2 \leq Pr < 3$	low
3	$3 \leq Pr < 4$	high
4	$Pr = 4$	very high

The assessment of the effectiveness of learning tools in this research was reviewed from the results of learning tests, increasing students' analytical skills, analytical behavior, and student responses. Learning tools are said to meet the effectiveness criteria if: (1) the learning test results show classical completeness $\geq 75\%$, (2) the increase in students' analytical skills is in the minimum moderate category, (3) students' analytical behavior is in the minimum good category, and (4) student responses show positive results, namely the percentage of "yes" answers to each indicator reaches $\geq 80\%$.

The increase in students' analytic ability is measured based on the results of the analyticity test which is then analyzed using the N-Gain index. The N-Gain formula is presented in Equation (1) below.

$$g = \frac{S_{post} - S_{pre}}{S_{maks} - S_{pre}} \dots(\text{equation 1})$$

Information:

g = N-Gain value

S_{post} = posttest scores

S_{pre} = pretest score

S_{maks} = ideal maximum score

Next, the obtained N-Gain values are classified into the following categories:

N-Gain Range	Category
$g \geq 0,70$	high
$0,30 \leq g < 0,70$	currently
$g < 0,30$	low

RESULTS AND DISCUSSION

The development of guided inquiry-based mathematics learning tools to improve students' analytical skills is carried out using a 4D model which includes the define, design, develop and disseminate stages (Hakiki et al., 2022). The mathematics learning tools developed in this research include a guidebook for using the tools, teaching modules, Student Worksheets (LKPD), as well as test questions used to measure students' analytical behavior that meets the criteria of being valid, practical and effective.

1. Definition stage (define)

The definition stage aims to identify learning needs through initial-finish analysis, students, concepts and tasks (Muqdamien et al., 2021). The results of the analysis show that learning tools are not yet optimal in developing critical thinking dispositions, learning is still teacher-centered, and students' analytical skills are relatively low (Ramadhani et al., 2025). Class VII students are at the formal operational stage so they have the potential to be developed through problem solving activities. Concept analysis focuses on social arithmetic material (gross, net, tare, profit and discount) according to the Merdeka Curriculum. Next, learning objectives are formulated that refer to Phase D learning outcomes to support increasing students' analytical skills.



2. Design Stage

The design stage includes preparing the test instrument, selecting the media, determining the format, and initial design of the device. The test instrument is three essay questions. The media used is HVS paper printing media. The device is designed using a guided inquiry model on social arithmetic material and is equipped with an instruction manual containing guided inquiry syntax, analyticity indicators, and learning procedures. This design is directed at ensuring the systematic implementation of guided inquiry in improving students' analytical skills.

Furthermore, teaching modules are designed for four meetings based on the Independent Curriculum as a guide for learning implementation. Module components include identity, initial competencies, graduate profile, facilities and infrastructure, learning objectives, learning syntax, assessment, as well as enrichment, remedial and reflection, complete with supporting attachments.

LKPD is designed with components including a cover, student identity, learning objectives, problem presentation, scaffolding, solutions and conclusions. The material presented includes gross, net, tare, profit and discount. The test package is designed to include a grid, question items, as well as a rubric and answer key, which are used to measure the effectiveness of the device through pretest and posttest.

3. Development Stage (develop)

The tools developed include manuals, teaching modules, LKPD, and test packages validated by experts to obtain input for improvements before field trials. Validation results are presented in Table 3.

Table 3. Learning Device Validation Results

Device	Va	Category
Guidebook	3,72	Valid
Teaching Module	3,85	Valid
LKPD	3,84	Valid
Test Questions	3,77	Valid

Based on the validation results of the learning tools in table 3, the average validity value for the manual is 3.72, the teaching module is 3.85, the LKPD is 3.84, and the test questions are 3.77. All learning tools are in the valid category so they are suitable for use in the learning process.

Next, there is a development stage, where an analysis of the practicality and effectiveness of valid learning tools is carried out. The test package and LKPD were tested for readability on 5 class VIII students and the results showed that the tools were easy to understand without revision. Next, the device was tested on class VII A students for three meetings by giving an initial test and a final test.

Before learning is carried out, the teacher first studies the user manual for the device to support the optimal implementation of the guided inquiry learning model in improving analytical skills. This is in accordance with opinion Hartono (2022) which states that the manual functions to provide systematic information and guidance to teachers, starting from the preparation, implementation, to learning assessment stages, so that the process of delivering material can take place according to learning objectives effectively and efficiently.

At the first meeting, students were given a pretest for 30 minutes. Next, the teacher begins learning by asking trigger questions related to contextual problems to determine students' initial problem-solving abilities. According to Sundaygara & Khairunnisa (2024), problem solving ability is an individual's ability to use knowledge and skills to find effective solutions to a problem. Therefore, the learning process is directed at training analytical skills through problem solving stages.

Learning activities continued with forming groups consisting of 5-6 students and distributing LKPD. Based on the results of observations, students' analytical abilities are seen when students apply concepts, use evidence, and provide reasons in solving non-routine problems. These non-routine problems are able to encourage students' thinking abilities in solving mathematical problems. This is in line with research by Wibowo et al. (2025) who stated that mathematical problems are problems that require a thinking process in solving them.

When writing down the concepts used, some students still have difficulty understanding the concepts. Therefore, the teacher provides scaffolding to help students understand the steps to solving the problem so that the second indicator can emerge optimally.

This is in line with the opinion of Najwa et al. (2022) which states that the application of scaffolding in the guided inquiry model can help students improve problem solving abilities.

At the stage of processing data and presenting results in the guided inquiry model, students convey observation results, explain conclusions, and actively discuss between groups. This is in line with the opinion of Najwa et al. (2022) which states that problem-solving-based learning can increase student interaction and cooperation. Thus, applying the guided inquiry model can help students understand material, solve problems, and develop analytical skills. The results of this research are in line with the research of Maharani et al. (2019) which shows that problem-based learning can develop critical thinking skills, especially in the analytical aspect. At the last meeting, students took a posttest to determine the effectiveness of the learning tools.

Next, an analysis of the practicality of the learning tools was carried out by observing the implementation of the learning tools during the trial process. Observation results showed that the average implementation of learning tools at each meeting was 3.15; 3.27; and 3.58 with an overall mean of 3.33. This value is in the range $3 \leq Pr < 4$ so it is included in the high category and meets the practicality criteria.

Next, analyze the effectiveness of learning tools in terms of learning outcomes, increase in N-Gain, student analytical behavior, and student responses. The test results showed that 23 out of 28 students achieved completeness with an average score of 79.89 and classical completeness of 82.14%. The increase in ability based on N-Gain consisted of 2 students in the low category, 9 students in the medium category, and 17 students in the high category with the average being in the high category. Apart from that, students' analytical behavior was in the good category and students' positive responses to learning reached 89.7%.

4. Dissemination stage (disseminate)

Learning tools are disseminated online by sharing hard files and soft files with several schools as well as on social media such as WhatsApp, Instagram and Facebook via Google Drive links so that they can be accessed by other teachers. This research was limited to one school due to limited time, energy and adjustments to learning schedules. In addition, the time for carrying out the research was relatively short due to a reduction in the allocation of learning hours so that the implementation of learning tools could not be carried out more widely. However, the application of the guided inquiry learning model is able to support increased indicators of students' analyticity and problem solving abilities. These findings are in line with research (Larosa, 2023; Rani et al., 2023) which shows that inquiry-based LKPD can facilitate mathematical problem solving abilities.

Based on these four indicators, the learning tools are declared effective. Thus, the user manual, teaching module, LKPD, and test package developed have met the criteria of being valid, practical, and effective.

CONCLUSION

Based on the research results, it can be concluded that the guided inquiry model mathematics learning tool developed using the 4D model is able to improve students' analytical skills. Previously, the learning tools used did not facilitate the development of students' analytical behavior optimally during the learning process. The developed guided inquiry model mathematics learning tool is able to facilitate students' habituation of analytical behavior. Increased analytical capabilities are shown through the average N-Gain value which is in the high category. Thus, the learning tools developed have met the criteria of being valid, practical and effective.

As for suggestions for further research, it is hoped that the results of this research can become a reference in implementing more varied and innovative learning. In addition, further research is recommended to develop learning tools on different materials and components of critical thinking dispositions with a wider range of research subjects. It is hoped that this research can become a reference in developing more varied and innovative learning. Further research is recommended to develop learning tools on material and other critical thinking disposition components with a wider range of research subjects.

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