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# Development of Learning Tools Based on Geogebra-Assisted Inquiry Learning Models to Improve Students' Mathematical Reasoning Abilities

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## ABSTRACT

The Geogebra-assisted inquiry learning paradigm was created to increase students' mathematical thinking. This research will identify the learning device. This is development research. This study will be done in SMA Negeri 1 Gebang, Jl. Diponogoro, Pekan Gebang, Kecamatan Gebang, Kab. Langkat, North Sumatra 20856. The research found: 1) The device is valid. 2) The device developed is practical with an average value of 3.07 (category "Medium") and 4.04 (category "High"); 3) it is effective because (a) the final test of students' Mathematical Reasoning abilities was 52% with 21 students (58.33%) declared complete and trial II 30 students (83.34%). (b) Trial I's student response questionnaire score was 89% and trial II's 95%. 4) Students' mathematical thinking improved with a 0.28 score ($0.3 < g \leq 0.7$) in trial 1 and a 0.67 score ($0.3 <$ N-Gain $\leq 0.7$) in trial II, meeting the "moderate" criterion.



## A. INTRODUCTION

Similar results were found in their studies. Thus, media was needed, and GeoGebra was one alternative (Fathoni, 2018). Students must use GeoGebra for other classes. Additionally, this learning medium may increase students' thinking abilities when using GeoGebra, which may boost geometry learning. In interviews with several mathematics teachers at SMA Negeri 1 Gebang, the phenomenon was found to be that during learning activities, teachers rarely or never develop the learning tools students need to achieve their goals. Previous learning tools simply employed learning tools. using a syllabus, manual, and RPP. The lesson plans so far don't incorporate learning syntax/steps from the learning model, and the teacher's handbook is the same as the student handbook, which can be bought at bookshops, and the questions aren't leading. into student life (K. Devina, P., Suanto, E 2021) . In addition, instructors seldom examine if the learning methods employed so far improve students' mathematical ability, particularly mathematical communication.

Learning models, particularly GeoGebra-assisted inquiry models, have not been seen in teacher learning tools. Teacher-prepared learning syntax lacks inquiry. The lesson plan is scientific and lacks a learning model. Teachers do not utilize LKPD gadgets in class. Even if great instruments are essential for learning (E.R Fitri, 2020). Interviews with mathematics instructors show that SMA Negeri 1 Gebang still employs boring learning methods like textbooks and government-provided LKPD. Teachers also say the learning tools are less motivating, imaginative, and creative, making standard and conventional ways tedious. This difficulty stems from the teacher's technical skills. This makes math boring and is the major reason pupils don't like it (Rakhmawati 2018). To increase students' mathematical thinking, GeoGebra-assisted inquiry model-based learning aids may be developed.

Interviews with mathematics teacher Mrs. Suriani show that instructors are not equipped to develop digital-based instruction. Teachers also lack GeoGebra-assisted model learning tool creation skills. Government LKPD and books are utilized for learning (Nurrahman, 2017). Suboptimal learning and unappealing gadget layouts affect student engagement and learning in these shifting situations. Reduce learning outcomes is a challenge for instructors.

The above event shows that this is a major cause of learning aids. The Ministry of National Education designs tools to meet curriculum, audience, and learning difficulty needs. Curriculum needs must be considered while creating learning aids. The learning instruments to be designed must meet curricular standards. According to (Lestari, 2018), the 2013 Curriculum's goals match this. It says that "through the development of the 2013 Curriculum we will produce Indonesian people who are productive, creative, innovative, and affective; through strengthening attitudes, integrated skills, and knowledge." This statement supports 2013 Curriculum development goals.

If there are no curriculum-appropriate learning tools or if getting them is difficult, it is wise to make your own. References from many sources may help create learning tools. These references might come from personal experience or from professionals and peers. We may gather references from books, media, the internet, etc. Even if there are many curriculum-appropriate learning resources, you may still need to design your own. (Islahiyah,2021).

Target attributes are also important. Many instructional tools produced by others are inappropriate for youngsters. The social, geographical, and cultural context, student development phases, initial talents and interests, family history, and so on (Wulamsari, 2016) can be used to modify self-developed learning aids to fit the needs of the students being taught.

Learning tools must also solve problems that develop throughout the learning process. Many instructional materials are difficult for students to understand. These resources cover several themes. Abstract, complex, foreign, etc. material may cause these issues. Building relevant teaching resources for students is necessary to overcome this difficulty. Pictures, images, charts, schemes, etc. are utilized to describe abstract stuff. For students to grasp complex information, it must be simplified to their level of understanding. According to (Yuwono, 2016), learning materials at HKBP Nommenses Pematang Siantar University concentrate on textbooks for mathematics education students that were designed with great quality and usefulness by students with a 90.67% score. The textbook's 87.4% score helped pupils learn and respond. In addition, Ratna Susana Dawa, et al. (2021) created LKPD-focused learning materials at St. Catholic High School. Gabriel said that the LKPD created was valid with an average score of 3.60 and practical with 3.80 by instructors and 3.50 by students. The two studies above show that developing valid, practical, and suitable learning tools can also improve the learning process. The author is interested in developing learning tools in this research, but focusing on textbooks/student books and LKPD.

Math is taught from primary to college. Students are taught to be creative, logical, systematic, analytical, and critical by the end of their study. The Regulation of the Minister of National Education of the Republic of Indonesia (Permendiknas) (2006:22) states that mathematics lessons are very important to be taught to all students, both in elementary schools where they are taught to think logically, analytically, systematically, critically, and creatively and to work together in a team.

According to (Ibrahim, 2018), mathematics is a wide or universal knowledge that underpins modern technology and has the ability to positively influence human understanding. Since science and technology are changing rapidly, education must update all areas, including learning implementation strategies. Because education is also changing rapidly. Because of this, education is fascinating and good to learn and improve. As previously said, mathematics is a universal science that underpins modern technology. Mathematics helps improve human cognitive processes. Mathematical education should help students think logically, analytically, and systematically. To let pupils to learn arithmetic, (Daryanto, 2016) suggests non-repetitive communication. This is necessary to reduce pupil boredom. Class XI students study polynomials. Due of its high understanding need, the topic is difficult to learn. This research employed GeoGebra to help students understand polynomial topics. Polynomial material requires solid learning and application models. This is because polynomial content requires advanced arithmetic.

Geogebra is dynamic, open-source math software. This free software combines geometry, algebra, and calculus. It may aid math studies. Florida Atlantic University's Markus Hohenwarter devised the curriculum. GeoGebra has desktop (Windows, macOS, and Linux), tablet (Android, iPad, and Windows), and web apps. Points, vectors, segments, lines, polygons, conic sections, inequalities, implicit polynomials, and functions may be dynamically changed in GeoGebra. These elements may be entered and modified using the mouse or input bar (Annraena, 2021). GeoGebra calculates derivatives and integrals of functions and stores variables as integers, vectors, and points. GeoGebra helps instructors and students build and prove geometric conjectures. GeoGebra is intended to help students improve their polynomial mathematical reasoning abilities. Only 8, or 28.57%, of pupils cleared the learning curve. The school scores learning completeness 70. 28, or 71.43%, of pupils cannot surpass the completeness score. This data also shows that the polynomial subject in the 2021/2022 academic year was not successfully implemented because 71.43% of students received the low category. score, 28.57% of students scored medium, and 0% scored high since no students scored high. The difficulties arise because pupils' thinking capacity is limited and professors lecture.

The research item in this work was located in SMA Negeri 1 Gebang. The author's early test showed that SMA Negeri 1 Gebang pupils' mathematical reasoning was still inadequate. According to the author's interview with Hilda Agustiawati, a mathematics education educator, students' reasoning abilities have decreased from the previous year because only 3-5 students in each class were science majors. Berlian Silaban, the curriculum field PKS, said students' mathematical reasoning abilities had decreased greatly since they were first placed at SMA Negeri 1 Gebang in 1993 because teachers used the lecture learning method too often and rarely. After being given multiple reasoning-based questions, few pupils could answer them.
A question presented to pupils is:

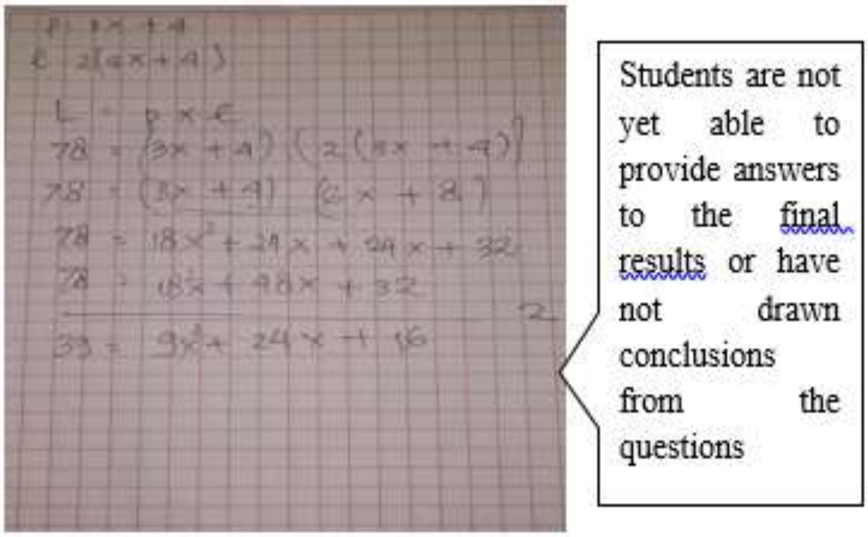


**Figure 1**. Student Answer Results

A student's reaction shows they didn't understand the inquiry. Students prefer to answer questions directly rather than using cognitive abilities to draw mathematical inferences, conduct mathematical operations, or express mathematical assertions in pictures, orally, or in writing. Algebraic equations like p=3x+4, l=2x, and L=78 should allow students to discover the closest proper answer, however they may not be able to obtain the results. final or unanswered. The students couldn't understand or reason on this subject. Student responses indicate inadequate mathematical reasoning at this university. Since teachers must solve every problem, they must respond. Teachers may engage students and turn passive learning into active learning to develop their thinking.

Inquiry Learning improves students' thinking, according to [15] study at SMPS Barito Singkawang. Author explains inquiry learning methodology in study. Mathematical thinking deficits plague many schools. Multiple studies examine students' math ability. Indonesian students' mathematics problem-solving abilities are poor, a survey found. Indonesia took TIMSS, PISA, and other international tests. The 2015 TIMSS evaluation rated Indonesia 45th out of 47 countries in mathematics learning achievement with an average score of 397 (IEA, 2015). This shows Indonesian students' low math ability. Lestari, Noer, and Gunowibowo (2019) watched and interviewed mathematics teachers and class VII students at SMP Negeri 8 Bandar Lampung, a math-challenged school. According to ( Saniyyah, 2021), youngsters' arithmetic deficiencies show in problem solving. Field data shows youngsters' poor mathematics problem-solving. Few class VIII pupils at SMP Negeri 18 Bandar Lampung could create problem-solving techniques when tackling arithmetic issues (Windi, 2019). Because of this, SMP Negeri 18 Bandar Lampung youngsters' math problem-solving abilities remain low. SMP Swadhipa 1 Natar learns online via Whatsapp. Kids' arithmetic problem-solving abilities are still low, according to June 21, 2021 interviews at Swadhipa 1 Natar Middle School. Students must understand, reason, analyze, choose the right method, compute, and evaluate. (Russefendi 2016) said that mathematical problem-solving abilities are vital for future mathematicians, other professionals, and everyday people. Accordingly, the author wants to study "Development of Inquiry-Based Learning Tools Assisted by GeoGebra to Improve the Mathematical Reasoning Ability of Students at SMA Negeri 1 Gebang".

## B. RESEARCH METHODS

This study is part of finished development research. This research uses a 4D development model (Sugiyono, 2015). Development of inquiry-based learning tools using Geogebra is the main emphasis of this project. This research was done in SMA Negeri 1 Gebang at Jl. Diponogoro, Pekan Gebang, District Gebang, Kab. Langkat, North Sumatra 20856 in 2022/2023. The participants were eleventh-graders in their tenth semester. Several eleventh-grade Science Department students participated in this investigation. This research subject was chosen for many reasons, including the students' mathematical thinking. According to Piaget's theory of stages of intellectual development, children over 11 have entered the formal operational stage. This research focuses on establishing a GeoGebra-supported inquiry-based learning strategy. This study will include definition, design, development, and dissemination. His book (Dewi, 2010: 25) lists many advantages of this 4D model: It is better for developing learning tools than learning systems; the impact description is more comprehensive and systematic; and its development involves expert assessment, which means revisions were made based on expert assessments and suggestions before testing the learning tools.

## C. RESULT AND DISCUSSION

This project produced a Goegebra-assisted inquiry learning device for SMA Negeri 1 Gebang class XI Science students' mathematical reasoning. This study design follows the Thiagarajan 4-D model: define, design, develop, and distribute.

Define

Researchers assess the demand for learning tools and their feasibility and needs throughout analysis. This study analyzes student needs, curriculum, and both. General analytical steps in this study are: At this level, XI IPA students at SMA Negeri 1 Gebang are analyzed for cognitive development, academic abilities, and individual or social skills connected to the learning subject, teaching materials, format, and language. In general, SMA Negeri 1 Gebang pupils' cognitive growth is formalizing. Students between 16 and 17 years old think logically, abstractly, and idealistically. Thus, a geogebra-assisted inquiry learning methodology that helps students see abstract theories as concrete issues will help kids grasp mathematics in school.

The initial test analysis of XI IPA students at SMA Negeri 1 Gebang showed low mathematics problem-solving ability. Conclusion from test results. An interview with a mathematics instructor at SMA Negeri 1 Gebang revealed that many students have not yet achieved the KKM score of 75 or more in the previous semester's mathematics exam.

Design

This stage involves choosing the product design, determining the facilities and infrastructure needed, choosing the field design trial stage, and describing the parties' research tasks. These activities involve creating learning materials, methods, and tools. evaluation. This step aims to construct a full learning device for parabolic material to create a prototype. This time includes these activities: The teaching materials comprise teacher and student resources for each of the three meetings. The instructional materials contain challenges, questions, and instructions for pupils to complete.


**Figure 2**. Evaluation activities for developed teaching materials

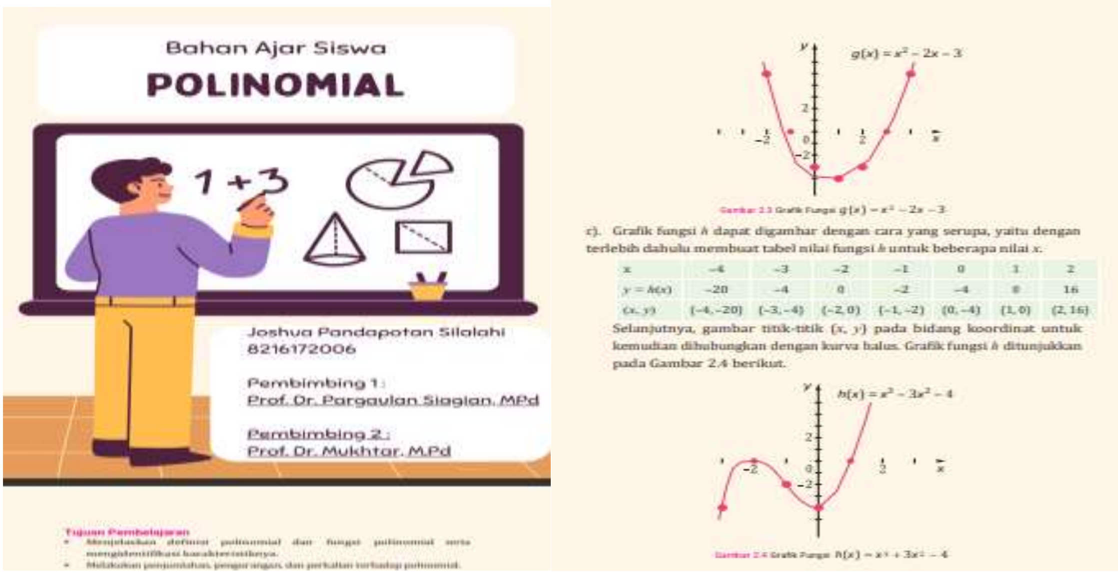


**Figure 4.** Material in the developed teaching materials

*Development*

Draft I, the initial learning tool design, is created during definition and design. The development stage begins with professionals verifying draft I, followed by early field testing. The experts validate the content, which includes all educational tools created during draft I design, to create a usable draft II. Expert approval informs learning tool revisions and improvements. Validated components include content quality, objectives, learning and instructional methods, and device design. The following are the research instrument validation outcomes.

**Table 1**. Summary of Learning Module Validation Results by Experts and Practitioners

| No | Appraised Object | Mark Average Total Validity | Validation Level |
|---|---|---|---|
| 1 | Teaching materials | 4,2 | |
| 2 | Lesson plan | 4,3 | |
| 3 | Student Worksheets | 4,2 | Valid |
| 4 | Reasoning ability | 4,1 | |
| 5 | Student Response | 4,3 | |

Table 1 shows that each learning device's average is 4–5, which is genuine. One might infer that the learning aids created meet the validity standards.

Trial I Learning Completeness of Students' Classical Mathematical Reasoning Skills Analysis Students' mathematical reasoning skills are examined utilizing essay-based assessments in this study to assess learning mastery. The following table reflects students' mathematical thinking ability in trial I.

**Table 2.** Description of the results of the Mathematical Reasoning Ability of Trial I students

| Score Max | Mathematical Reasoning Ability | | | |
|---|---|---|---|---|
| | $X_{min}$ | $X_{maks}$ | $\bar{x}$ | S |
| 100 | 64 | 89 | 76,00 | 7,54 |

According to the table above, the posttest standard deviation of students' mathematical reasoning ability is 7.54. The table below shows students' mathematical reasoning mastery based on trial I's posttest results.

**Table 3.** Level of Mastery of Students' Mathematical Reasoning Abilities Posttest Results of Trial I

| No | Value Interval | Mathematical Reasoning Ability | | Information |
|---|---|---|---|---|
| | | The number of students | Percentage | |
| 1 | $0 \leq$ KKM< 55 | 0 | 0% | Not enough |
| 2 | $56 \leq$ KKM< 75 | 18 | 50% | Enough |
| 3 | $76 \leq$ KKM< 85 | 14 | 38,89 % | Good |
| 4 | $86 \leq$ KKM < 100 | 4 | 11,11 % | Very good |

According to the table above, the posttest standard deviation of students' mathematical reasoning ability is 7.54. The table below shows students' mathematical reasoning mastery based on trial I's posttest results.The table above shows the students' mathematical reasoning posttest scores. In particular, no pupils were extremely poor (0%), 18 (50%) were poor, 14 (38.89%) were adequate, and four (11.11%) were excellent. Trial II Classical Learning Completion of Students' Mathematical Reasoning Ability Analysis This research assessed student competence using an essay-style exam of mathematical reasoning. The table below describes trial II students' mathematical reasoning results.

**Table 4**. Description of Results of Mathematical Reasoning Ability Test II

| Score Max | Mathematical Reasoning Ability | | | |
|---|---|---|---|---|
| | $X_{min}$ | $X_{maks}$ | $\bar{x}$ | S |
| 100 | 60 | 100 | 86,72 | 11,14 |

The table above shows that posttest students' average mathematical reasoning ability was 86.72, with a standard deviation of 11.14. If the trial II posttest results are categorized by student mastery, the following table will illustrate students' mathematical reasoning mastery.

**Table 5**. Comparison of Mastery Levels of Mathematical Reasoning Ability Posttest Results from Trials I and II

| No | Value Interval | Test Mathematical Reasoning Ability I | | Information | Test Mathematical Reasoning Ability II | | Information |
|---|---|---|---|---|---|---|---|
| | | Total | Percentage | | Total | Percentage | |
| 1 | $0 \leq$ KKM< 55 | 0 | 0% | Less | 0 | 0% | Less |
| 2 | $56 \leq$ KKM< 75 | 18 | 50% | Enough | 6 | 16,66% | Enough |
| 3 | $76 \leq$ KKM< 85 | 14 | 38,89 % | Good | 10 | 27,78 % | Good |
| 4 | $86 \leq$ KKM < 100 | 4 | 11,11 % | Very Good | 20 | 55,56% | Very Good |

The table above shows students' mathematical reasoning posttest scores. In particular, 0% of pupils scored extremely poor in the first trial. 18 pupils (50%) were deemed adequate, and 14 (38%), good. Four students—11.11 percent—were named extremely good. In the second trial, zero pupils were put in the very poor group, six (16.66%) in the good group, and ten (27.78%) in the very good group. Twenty students—55.56 percent. According to the table and figure above, Trial I posttest results show that students' mathematical reasoning ability is most dominating in the adequate category. Trial II pupils' mathematical thinking has improved, dominating the very excellent, good, and adequate categories.

## DISCUSSION

Every professional (validator) evaluated the handbook learning medium and found it appropriate for usage, with some minor revisions. Akker agrees with ( Akker, 2013) that learning media practicality criteria are met if the validator can apply what was created. Study ( Annisah, 2012) found that knowing media practicality is crucial. This is because learning material need a basic user interface.

The learning implementation observation score in trial I did not fulfill practicality standards with scores of 2.93 at meeting I, 3.13 at meeting II, and 3.13 at meeting III, and an average of 3.07 (category "Medium"). The created geogebra-assisted inquiry learning model was given to an observer at each trial meeting I and II to determine this. The learning implementation observation score failed trial I's practicality requirements. Meeting I of trial II yielded 3.87, meeting II 4.00, and meeting III 4.27. The average score for monitoring learning execution in trial II was 4.04, which is "High". Akker (2007: 66) states that learning medium is practical if class observations show great or very good outcomes. According to (Marseline, 2019), the Handbook learning media is easy to use and improves student learning. Thus, the interactive manual meets practical requirements.

Trials I and II test analysis showed that students' mathematical thinking met the traditional completeness requirement. This was determined using the above tests. This is because learning tools' content and concerns are based on the learner's learning environment. Students will understand polynomials better using this tool. The first trial's final exam mathematical reasoning performance was 52%, and 21 students (58.33%) finished the examination. Thus, trial I learning aids based on the Inquiry learning paradigm and Geogebra did not meet classical completeness (greater than 80%). The trial II final test of pupils' mathematical reasoning skills met the norms. Thirty students completed the exam, an 83.34% completion percentage. Thus, the Geogebra-assisted inquiry learning model-based learning device has met students' mathematical reasoning skill needs.

## D. CONCLUSION AND SUGGESTIONS

Experts approved the Geogebra-assisted inquiry learning device. The Geogebra-assisted inquiry model-based learning gadget meets practicality criteria based on learning implementation observations. We found that all trial II student activities met the specified time %. The review judged the Geogebra-assisted inquiry model learning device effective. Final Trial I mathematical reasoning test passed. Geography-assisted inquiry model-based learning device did not achieve conventional completeness requirements (>80%) in experiment I. Trial II revealed students' final Mathematical Reasoning test met norms. So, the Geogebra-assisted inquiry learning model-based learning gadget fits students' Mathematical Reasoning demands. Students answered 89% and 95% of the questions in trials I and II. Thus, students liked Geogebra-assisted inquiry learning model-based interactive learning technology. Normalized growth index revealed students' mathematical reasoning abilities rose "moderately" in trial I and 0.28 in trial II, scoring 0.67. Geogebra-assisted inquiry learning may improve pupils' mathematical reasoning. Based on studies and conclusions, suggest: Teachers should utilize the Geogebra-assisted inquiry model learning device to increase grade XI students' mathematical thinking since it fulfills validity, practicality, and effectiveness requirements. Since the researcher only used class categories to form this discussion group, she suggests additional researches focus more on student compatibility. Future research should focus on students' ability to split the group to increase conversation.

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