

# DEVELOPMENT OF DISCOVERY LEARNING ASSISTED BY CABRI EXPRESS TEACHING MATERIALS TO IMPROVE STUDENTS' COMMUNICATION ABILITY AND MATHEMATICAL DISPOSITION

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## ABSTRACT

The purpose of this study was to improve students' mathematical concepts through improving communication skills and students' mathematical dispositions using Discovery Learning assisted by Cabri Express. This research is development research using the 4-D development model, which consists of the Define, Design, Develop, and Disseminate phases. The subjects in this study were 18 students. Data collection techniques in this study used the instrument questions given in the form of written tests, while the data analysis techniques in this study were data collection, data processing, data presentation, and concluding. So that the conclusions that can be drawn from this study are Cabri Express assisted teaching materials on flat plane material developed using three stages, namely define, design, and develop. Teaching materials have been validated with an average value of 87.3% with very valid and very practical criteria. Thus, the Cabri Express-assisted Discovery Learning teaching material on flat-sided spatial construction material is feasible to use. Furthermore, the teaching materials developed received a positive response from students with a percentage of 76% in the "interesting" category. Students' mathematical communication ability is 74% and students' mathematical disposition is 76% in the Good category. This proves that using teaching materials based on discovery learning assisted by Cabri Express improves students' communication skills and mathematical dispositions.

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## INTRODUCTION

Mathematics is one of the subjects that is disliked by students because students have difficulty understanding the concepts in Mathematics. Hidayat (Rismayantini et al., 2020) states that the

reason students don't like Mathematics is that it has an abstract nature which causes students to experience difficulties in understanding or solving a problem. This is because Mathematics is a vertically structured subject where to study Mathematics material there is a sequence that is fulfilled.

The nature of Mathematics is sometimes not noticed by the teacher, so students have errors in finding concepts. Building a flat side room is one of the materials that often have misconceptions, so material derived from building a flat side room will have problems in its delivery. In research that has been carried out (Afdila et al., 2018; Cesaria et al., 2021; Damayanti & Rufiana, 2021; T. Hidayat, 2019; Maharani & Prihatnani, 2019; Ningrum & Budiarto, 2016; Nurfajriyanti & Pradipta, 2021; Nurlaila et al., 2018; Putra et al., 2022; Rumasoreng & Sugiman, 2014; Safitri et al., 2019; Sutrisna et al., 2021). The elements, most students are wrong in determining the volume and surface area and almost all students are wrong in working on questions with the theme of flat-sided space shapes. One factor that determines the success of student learning is the disposition of mathematics. Students with a high disposition will be more persistent, diligent, and interested in exploring and trying new things. These students will have more knowledge than other students. This is what causes students to have certain abilities, then the disposition will support students' mathematical abilities mathematically.

The assessment of the mathematical disposition above is contained in the affective domain which is the aim of mathematics education in junior high schools based on the 2013 Curriculum, namely students have an attitude of appreciating the usefulness of mathematics in life, namely having curiosity, attention, and interest in learning mathematics, as well as an attitude of perseverance and trust themselves to solve problems (Hendriana et al., 2013; Yulianty, 2019). Meanwhile, according to Katz (Aprilianti et al., 2022), a disposition is a tendency to consciously, regularly, and voluntarily act in certain ways that lead to the achievement of certain goals. In the context of mathematics, mathematical dispositions are closely related in terms of how students perceive and solve problems; are confident, diligent, interested, and think flexibly to explore problem-solving with various alternative strategies. Mathematical disposition is also related to students' tendencies to reflect on their thoughts (Gumilar, 2022).

Research conducted at SMPN 3 West Karawang obtained the results of students who met the indicators of confidence in using mathematics 32%, flexible thinking in mathematics 35%, persistent and tenacious 35%, curiosity in mathematics 39%, reflecting on ways of thinking 32%, appreciating the application of mathematics 36% and appreciating the role of mathematics 38%. This shows that the percentage of students' average mathematical disposition scores is less than 40% which is classified as low (Sari & Sutirna, 2021).

This affects the low ability of students' mathematical thinking as described above. From the assessment of the affective domain, as stated in the 2013 curriculum, it can be seen how important it is to increase the disposition of mathematics in the process of teaching and learning mathematics. In the learning process, students' mathematical dispositions can be seen from the students' desire to change strategies, reflection activities, and analysis activities to obtain a solution. Students' disposition towards mathematics is seen in class discussions. For example, the level of students' desire to learn mathematics, explain the solutions they get, and defend their explanations. However, the teacher's attention in the learning process to students' mathematical dispositions is still lacking (Sari & Sutirna, 2021).

Mathematical communication skills and mathematical dispositions are essential components of mathematical hard-soft skills that need to be possessed and developed by students studying mathematics. The importance of having mathematical hard skills and soft skills is in line with the objectives of learning mathematics (Bernard & Rohaeti, 2016; Ruhayat & Sugandi, 2016). The objectives of learning mathematics are: a) communicating using symbols and mathematical ideas; b) fostering self-confidence, showing appreciation for the beauty of the regularity of mathematical properties, an objective, and open attitude, curiosity, attention, and interest in learning mathematics. Mathematical hard skills are seen in the objectives of item a) while for Item b) the soft skills section is needed by students in facing future challenges.

Based on an analysis of the opinions of several experts, Sumarmo (Aprilianti et al., 2022; Hasina et al., 2020; I. Lestari & Andinny, 2020; Rahmawati et al., 2019; Sugandi & Bernard, 2018; Sumarmo et al., 2012; Supriyati et al., 2021) summarizes indicators of mathematical communication skills including expressing a situation, picture, diagram or real-world situation into mathematical language, symbols, ideas, and mathematical models; explain and read meaningfully, state, understand, interpret, and evaluate a mathematical idea and mathematical presentation orally, in writing, or visually; listening, discussing, and writing mathematics; and state arguments using their language. The description above illustrates that through mathematical communication students learn to explain ideas and/or express their understanding in the form of language and mathematical symbols orally and/or in writing. The process of mathematical communication can assist students in constructing concepts by interpreting a series of mathematical processes and applying them in solving mathematical problems.

In exploring and developing students' mathematical communication skills, teachers must expose students to various contextual problems and stimulate them to communicate their ideas. The 2013 mathematics curriculum requires the simultaneous, balanced and sustainable development of knowledge competence and mathematical skills as part of the hard-soft skills of mathematics. It is expected that the process of developing mathematical soft skills can form habits, desires, awareness, dedication, and strong tendencies in students to think and act mathematically positively. Polking (Jamiah, 2018) calls such a tendency to do and think mathematically a mathematical disposition. Then Polking details the mathematical disposition in the indicators: a) self-confidence, solving problems, giving reasons, and communicating ideas, b) being flexible in examining mathematical ideas and trying to find strategies to solve problems in various ways; c) diligent in showing interest and curiosity, d) tend to monitor, think metacognitive, e) apply mathematics in other fields of study and everyday problems; and f) appreciate the role of mathematics in culture and values, mathematics as a tool, and as a language.

Recognizing the importance of communication skills and mathematical dispositions, it is necessary to find the relationship that occurs with soft-skill abilities so that teachers can seek learning by applying learning models that can provide opportunities and encourage students to practice communication skills and mathematical dispositions. Mathematical disposition is an individual attitude toward a perspective on Mathematics, which will display behavior of curiosity, diligence, confidence, and interest in Mathematics (Hendriana & Soemarmo in Mayratih et al., 2019 ). Disposition indicators according to Hendriana & Soemarmo (Kurniawan & Kadarisma, 2020) are as follows: (1) self-confidence; (2) flexibility; (3) diligently doing the task; (4) interest and curiosity; (5) reflecting on their reasoning.

The urgency of increasing students' mathematical communication and disposition in learning mathematics is in stark contrast to the reality on the ground, based on research results

(Abdullah et al., 2020; Cahyani et al., 2021; W. Hidayat & Sariningsih, 2018; Ilmi et al., 2018; Lamonta et al., 2016; Ma'rifah et al., 2020; Munawaroh et al., 2018; Noviana et al., 2018; Nugrawati et al., 2018; Nurainah et al., 2018; Rosita, 2014; Rosmawati et al., 2018; Supriadi & Damayanti, 2016; Viki & Handayani, 2020). Lack of students' understanding skills when determining the initial formula and determining solutions systematically in solving problems. Students' mathematical dispositions greatly influence students' logical intelligence, this is illustrated by research at XI IPA MAN 2 Cirebon conducted by Maemanah & Winarso (2019) that according to the analysis of the resulting data, there is an influence between students' mathematical dispositions and mathematical logical intelligence.

The problem of increasing students' communication skills and mathematical dispositions is important to improve, an effective solution is the use of the discovery learning method because in several studies this method has been proven to be able to improve students' Hard Skills and Soft Skills in Mathematics. Based on the results of research (Dina et al., 2019; Imayati, 2018; Purnama et al., 2019; Qodariyah & Hendriana, 2015; Rahman, 2017) at the junior high school level illustrates that students' communication abilities and mathematical dispositions can be improved through discovery learning. However, in the discovery learning method there are weaknesses as stated by Eggen and Kauchak (Lestari, 2017) the weaknesses of this learning model tend to take up more time and if students don't listen as carefully as they should, they often have wrong conceptions about the topics they are studying. Weaknesses of the Discovery Learning Method were put forward by Suherman (W. Lestari, 2017; Suhanis, 2020) However, the Discovery learning method also has weaknesses, namely students who have less ability to express relationships between concepts will find it difficult and inefficient to teach on large-scale classes.

The problem of learning effectiveness needs to be found for solutions to overcome these weaknesses, there are important points in the application of discovery learning according to Sugandi (2016), namely guided discovery learning emphasizes the process of searching and finding. The subject matter is not given directly. The role of students in this strategy is to find and find subject matter for themselves, while educators act as facilitators and guides for students to learn. For this reason, it is necessary to find a way out to bridge the interaction between students and teachers as facilitators in learning, so the use of Cabri Geometriv1.4.5 Software is the right solution. In line with the results of research conducted by Batubara (2018) that learning that is assisted by the Cabri 3D V2 Plus software media students will feel happier in the learning process and are motivated to study harder for satisfying results. This is following the law of learning known as the Law of effect put forward by Edward L. Thorndike (Batubara, 2018), learning will be more successful if the student's response is pleasure or satisfaction to a stimulus. A sense of pleasure or satisfaction will arise as a result of praise obtained by students. So it can be concluded that the problem-solving abilities of students whose learning uses Cabri 3D are better than the problem-solving abilities of students whose learning uses conventional learning methods.

Thus to carry out Mathematics learning as above, teachers need to know and be able to implement various learning approaches that can arouse students' interest and intellectuality, improve communication skills and mathematical dispositions, and apply technology and other aids. Given the importance of the learning approach to encourage students to be active and productive in class, the discovery learning method was chosen with the help of the Cabri Express application.

## METHOD

The purpose of this study was to develop teaching materials for flat-sided geometric shapes based on Discovery Learning assisted by Cabri Express to train students' communication skills and mathematical dispositions and to describe the quality of the resulting teaching materials. The method used in this study is the 4D development research method. The 4D model was chosen because it has stages in development that is very systematic, brief, and suitable for the product being produced, 4D stands for Define, Design, Develop, and Disseminate. The subjects in this study were 18 class VIII students for the 2022-2023 academic year. The instruments used were questionnaires and tests in the form of description questions regarding mathematical communication skills.

The steps for developing teaching materials for building flat sides based on Discovery Learning assisted by Cabri Geometry are based on the 4D model as follows: 1) Define, this stage has the goal of determining the requirements needed in the development of learning, carried out by paying attention to and adapting to learning needs. In this stage several analyzes are carried out including analysis of the initial state to the final state, learning, concepts, tasks, and learning objectives; 2) Design, In this stage, it is used for the development of prototypes of teaching materials assisted by Cabri Express, including the selection of media to be used and the format of the content teaching materials; 3) Develop, In this stage the development of teaching materials is carried out, validating teaching materials, making improvements and improvements to teaching materials based on the validator's suggestions; and 4) Dissemination, in this stage the manufacture of teaching material products or the distribution of products that meet valid, practical, and effective criteria is carried out.

The validation of Cabri Express-assisted teaching materials was carried out by experts consisting of material experts and media experts. Based on suggestions from material and media experts, improvements were made to the teaching materials made. Practicality is measured by giving questionnaires to students, while effectiveness is obtained based on the results of giving mathematical communication tests which are carried out after learning using teaching materials assisted by Cabri Express is made. Data collection and analysis techniques were carried out by providing valid questionnaires, and practicality, and measuring the effectiveness of using descriptive questions. Assessment of validation and practicality uses a Likert scale with scores of 1, 2, 3, and 4. The average score for the percentage of validity and practicality criteria is calculated using the formula (Sugandi et al., 2021):

$$Persentase = \frac{\text{Skor yang diperoleh}}{\text{Skor maksimum}} \times 100 \%$$

The results of the validity and practicality percentages are then interpreted according to the criteria as in Table 1 (Sugandi et al., 2021)

**Table 1 .** Interpretation of validity and practicality categories

Percentage (%)	Criteria
85% - 100%	very decent/very good
70% - 85%	decent/good
50% - 70%	good enough/good enough
1% - 50%	not worth it/not good



The effectiveness of Cabri Express-assisted teaching materials, seen from 1) scores of mathematical communication skills in solving communication problems on flat side shapes consisting of 6 questions; 2) the scores on the results of the student's mathematical disposition scale were 32 item scales, and 3) the results of the questionnaire about learning to students and teachers. The score was obtained from the research results using the following formula.

$$Persentase = \frac{Skor\ yang\ diperoleh}{Skor\ maksimum} \times 100\ %$$

The results of the percentage values obtained are then interpreted according to the criteria in Table 2.

**Table 2.** Interpretation of the level of mathematical communication

Percentage (%)	Criteria
0 – 60	Very Less Good
21–40	Not good
41–60	Pretty good
61–80	Well
81–100	Very good

The test results were analyzed based on each communication and mathematical disposition indicator and continued by calculating the percentage.

## RESULTS AND DISCUSSION

### *Results*

The first stage of the 4-D development model was carried out in the Define stage, by conducting a front-end analysis before developing teaching materials and analyzing the needs needed in the learning process in class VII MTs Nurul Huda Pangalengan. At this stage, the researcher conducted interviews with the mathematics teacher and distributed a questionnaire to one of class IX. The interview was held on March 24, 2021. Based on the results of the interviews and observations made, information was obtained that in the teaching and learning process, the teacher only used the blackboard using the lecture method. No one has yet used teaching materials assisted by Cabri Express, especially the Flat Side Room Building material. These existing problems became the background for the development of teaching materials using the Cabri Express-assisted Discovery Learning method on the Flat Side Building material in class VIII MTs Nurul Huda. After that, they conducted a concept analysis by conducting interviews with the class VII math teacher at MTs Nurul Huda to get more information about the teaching materials used in learning. The results of the interviews are used to design teaching materials assisted by Cabri Express, especially the method of preparing LKS assisted by Cabri-Express, writing techniques in teaching materials assisted by Cabri-Express, and how the steps for Discovery Learning are appropriate to student characteristics. The teaching materials used have been adjusted to the subject matter of flat shapes which have been adapted to the KI, KD, and Competency Achievement Indicators expected concerning the 2013 curriculum used in MTs. Nurul Huda.

Interviews with educators who teach Mathematics at MTs. Pangalengan sub-district area and the results of the literature resulted in the finding that the discovery learning method with the help of Cabri Express was applied to the Material of Building a Flat Side Room for class VIII SMP. While there are many misconceptions about flat-sided geometric materials, PowerPoint's use of these materials isn't very effective. So it is necessary to develop teaching

materials assisted by Cabri Express with the Discovery Learning method on Flat Room Materials Assisted Cabri Express.

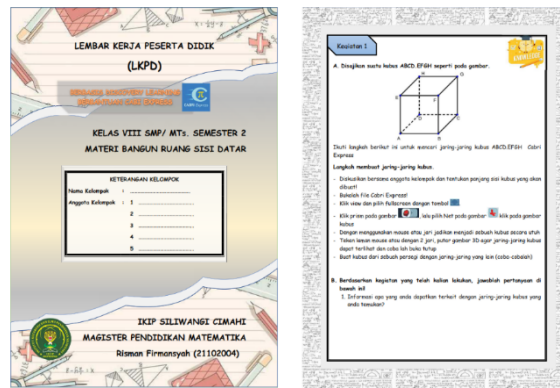
Based on the results of the analysis that had been carried out previously from the results of interviews and literature studies, the misconceptions about flat-sided geometrical material in class VIII were very concerning. This misconception affects students' hard-soft mathematics abilities because students tend to dislike mathematics. In addition, from the results of interviews with MTs students' mathematical communication abilities. Nurul Huda was less developed and the student's disposition towards mathematics tended to be weak, so the purpose of making teaching materials for the Cabri Express-assisted discovery learning method was to improve students' communication skills and mathematical dispositions on flat and correct geometrical material. students' misconceptions about Flat Sided Space Construct.

After performing the Define stage, then the Design stage is carried out. Preparation of Benchmark Reference Tests is the stage where the design of teaching materials with the Discovery Learning method. The development of this teaching material begins with compiling program contents such as starting typing material, making sample questions, making practice questions, and evaluating, as well as designing teaching materials. Next, determine the order of presentation according to the syntax of the Discovery Learning method.

The selected teaching materials are teaching materials in the form of LKPD assisted by Cabri Express which are developed into teaching materials using the Discovery Learning method. LKPD assisted by Cabri Express was chosen to be presented as an interactive teaching material to provide learning experiences for students and media to find concepts in the learning process. In addition to discovering concepts through the Discovery of Learning syntax, teaching materials are adapted to assignments and concept analysis, then validated and tested at the development stage.

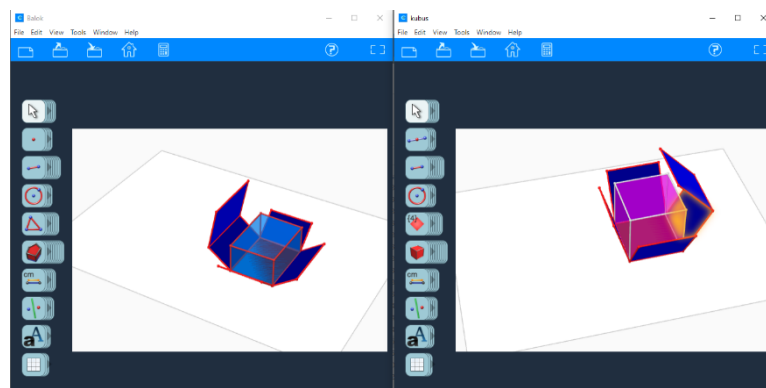
This teaching material uses LKPD assisted by Cabri Express. LKPD is made on A4 paper size, while writing uses Times New Roman, Comic Sans MS, Hobo Std, and Microsoft Uyghur Fonts with the font size adjusting the appearance. The Cabri Express spatial learning material was made beforehand with the \*.cab format, while the spatial structure that was made consisted of 2 parts, namely the design consisting of ribs and the skin structure in the form of flat planes or nets. The Cabri Express material made consists of cubes, triangular prism blocks, rectangular prisms, pentagonal prisms, triangular pyramids, rectangular pyramids, and 5-sided pyramids.

Adjustment of teaching materials with core competencies, basic competencies, and syllabi based on the 2013 curriculum are the steps in making the initial design of this product design. Teaching materials are in the form of LKPD and media materials assisted by Cabri Express. The LKPD display provided is arranged based on the Discovery Learning learning model, the LKPD display used is as follows:



**Figure 1.** LKPD display

To stimulate students' knowledge to find the expected concepts, Cabri Express interactive media is used, while the display of the media used is as follows:



**Figure 2.** Cabri Express Interactive Media Display

The third stage carried out in researching the development of the 4-D model is Develop. Teaching materials that have been designed are then validated against material expert validators and media validators. The material expert evaluates the suitability of the material with KD, the accuracy of the material, the updating of the material, encouraging curiosity, presentation techniques, presentation support, presentation of learning, and flow coherence and coherence. Media experts assessed several aspects: Size of teaching materials, Cover Design of Teaching Materials (cover), and Content Design of teaching materials assisted by Cabri Express. The two experts assessed several aspects of language from straightforward aspects; Communicative; Dialogic and Interactive; Compatibility with the Level of Student Development; Consistency and Integration of Thought Flow; and Use of Terms, Symbols, or Icons. The expert validator has the criteria of being experienced in his field. The description of the validation results by stage I media experts is presented in Table 3

**Table 3 .** validation results and each expert in stage I

No	Validators	Percentage	Criteria
1	Material Expert	61 %	good enough/good enough
2	Media Expert	54 %	good enough/good enough
<b>Average Expert Validation</b>		<b>67.3 %</b>	<b>good enough/good enough</b>

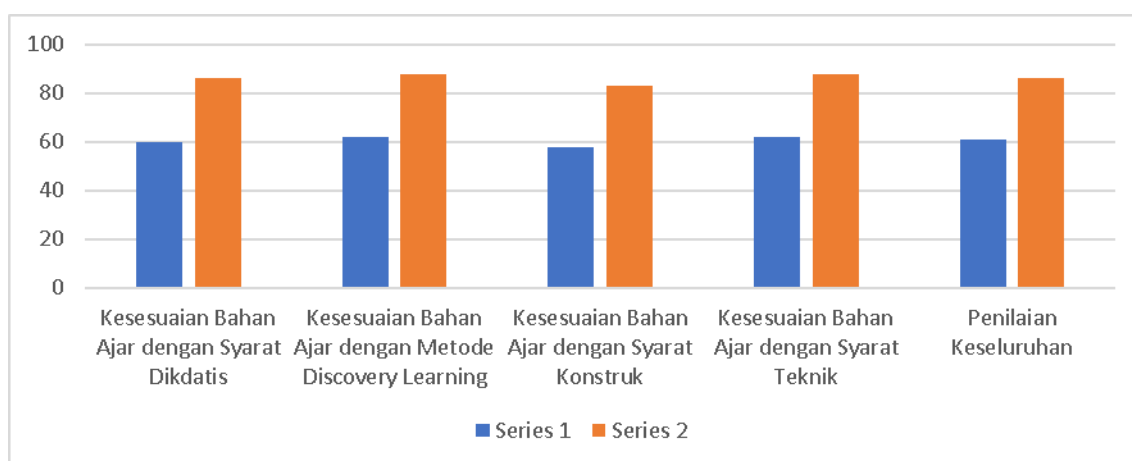


After the product design has been validated by material experts, design experts, and linguists, the researcher revises the product design which was developed based on the expert's input. A description of the validation results by material experts and stage II media experts is presented in Table 4.

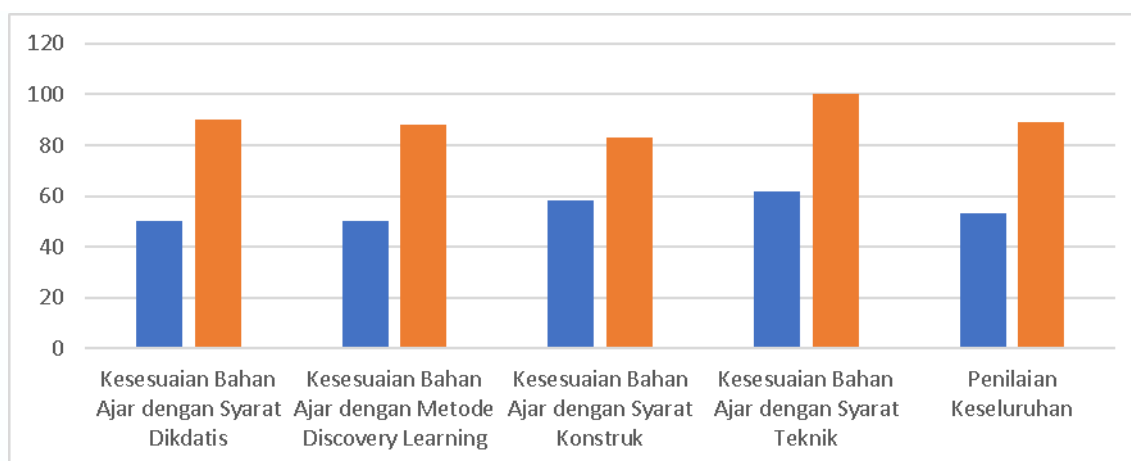
**Table 4 .** validation results from each expert in stage II

No	Validators	Percentage	Criteria
1	Material Expert	86 %	very decent/very good
2	Media Expert	89 %	very decent/very good
<b>Average Expert Validation</b>		<b>87 %</b>	<b>very decent/very good</b>

An overview of the percentage of expert validation results before and after revision is shown in Figure 3 and Figure 4.



**Figure 3 .** Comparison of the percentage scores of stage I and stage II of the material validator



**Figure 4 .** Comparison of the percentage scores of stage I and stage II media validators

Figure 3 and Figure 4 shows that overall indicators from the aspects of material, design, and grammar have undergone significant improvements so that the resulting products can be used in the learning process.

Field trials are carried out to ensure data and determine the effectiveness of the product widely. Field trial respondents consisted of students and teachers. There were 18 students in class VIII MTs Nurul Huda by giving a questionnaire to find out the students' responses to the attractiveness of the teaching materials assisted by Cabri Express. The results of field trials at MTs Nurul Huda obtained the following data:

**Table 5 .** the results of testing on students of as many as 18 people

No	Data Results	Percentage	Criteria
1	Response to learning	76.1 %	Well
2	Mathematical communication test results	74.5%	Well
3	Mathematical disposition scale results	75.6 %	Well

Communication skills and dispositions of mathematics towards learning have good criteria with a score percentage of 74.5% and 75.6%, respectively. So this correlates with the response to retaliation with a score of 76.1%, with good criteria.

The last stage of 4-D development research is Dissemination. From the product trials, the responses of students and educators said that this product was very feasible and interesting, but the lack of sample questions and the cover design and contents page design were less attractive. Validation is also being carried out by two experts.

Based on the validation and revisions that have been carried out as well as the trials that have been carried out, the development objective is to produce a product in the form of teaching materials based on Discovery Learning with the help of Cabri Express on flat-sided space building material following the development objectives. The teaching materials that will be developed are expected to be able to help students understand the concept of material, be effective as a better source of learning for students, and make students more interested in learning mathematics.

Because this research is a limited test stage of the thesis development of the Cabri Express-assisted discovery learning method to improve the communication skills and mathematical dispositions of students who use the R & D borg and gall method as a whole, the dissemination is only to the teachers of MTs Nurul Huda Pangalengan in the form of feedback.

### ***Discussions***

The development referred to in this study is the creation of teaching materials with the learning syntax of the discovery learning method, because discovery learning according to Eggen and Kauchak (Lestari, 2017) and Suherman (W. Lestari, 2017; Suhanis, 2020) has weaknesses, especially when applied in class large and students with junior high school age. In developing the teaching materials that were developed more towards the use of LKPD to guide students towards the desired learning steps, while developing the concept of the power of thinking using teaching media used Cabri Express. The development of teaching materials assisted by Cabri Express is researched through several stages as explained in the Results section to produce complete and good teaching materials. The developed teaching materials train students' communication skills through student learning activities using Cabri express with LKPD as a guide for learning steps. The LKPD that was made in advance pays attention to the right information content according to directions from the validator of media experts and

material experts, so that the learning outcomes help students find the concept of building a flat-sided space.

Testing of teaching materials is carried out after the development of teaching materials has obtained very feasible and very good criteria from material experts and media experts. From the results of the trials conducted, it was found that the teaching materials used could produce good communication skills and students' mathematical dispositions. The resulting students' mathematical disposition is good because students feel challenged to try and be fully involved in learning. This proves that using interactive learning will produce good student interest in learning so that students' dispositions in learning mathematics become better. This happens because mathematics is a human activity as expressed by Hans Freudenthal (Gazali, 2016) "mathematics as human activity". According to Hans Freudenthal's (Gazali, 2016) opinion, in the use of teaching materials with the Cabri geometry-assisted discovery method, students carry out their concept discoveries and are given interactive media that can be observed to find information materials to complement concept discovery. In addition, students learn on their own because they feel happy and challenged by their learning (Thotndike in Batubara, 2018).

Along with good students' mathematical dispositions, the results of teaching materials development trials can produce good students' mathematical communication skills, because students' mathematical communication can be trained using students' abilities to compile information obtained from student learning outcomes in finding concepts as stated by Sumarmo (Aprilianti et al., 2022; Hasina et al., 2020; I. Lestari & Andinny, 2020; Rahmawati et al., 2019; Sugandi & Bernard, 2018; Sumarmo et al., 2012; Supriyati et al., 2021). Through using the LKPD that was made, students were trained to explore and analyze the information obtained to find the concept of building flat-sided spaces with the help of Cabri Express. So that from the results of the trials conducted, it can be said that the communication skills and mathematical disposition of students toward the flat-sided geometrical concept can be improved by using the development of teaching materials using the Cabri Express-assisted discovery learning method.

## CONCLUSION

From the product trials, the responses of students and educators said that this product was very feasible and interesting, but the lack of sample questions and the cover design and contents page design were less attractive. Validation is also being carried out by two experts.

Based on the validation and revisions that have been carried out as well as the trials that have been carried out, the development objective is to produce a product in the form of teaching materials based on Discovery Learning with the help of Cabri Express on flat-sided space building material following the development objectives. The teaching materials that will be developed are expected to be able to help students understand the concept of material, be effective as a better source of learning for students, and make students more interested in learning mathematics.

Because this research is a limited test stage of the thesis development of the Cabri Express-assisted discovery learning method to improve the communication skills and mathematical dispositions of students who use the R & D by Borg and Gall method as a whole, the dissemination is only to the teachers of MTs Nurul Huda Pangalengan in the form of feedback.

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