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The Development of A Braille Geometry Module Based on Visual Impairment Students Synthetic Touch Ability With RMT Approach

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Abstract. This research aims to develop a Braille geometry module based on visual impairment students synthetic touch ability with RMT approach that was valid and practically using ADDIE development design. This module optimizes students' synthetic touching ability and develop RMTs three cognitive functions i.e., the cognitive function of qualitative thinking, quantitative thinking with precision, and abstract relational logic thinking. A media experts and material experts validated the module. The student' response questionnaire measurement the practicality of the module. Data were analyzed using descriptive quantitative. The results showed the validity of the geometry Braille module from material and media experts that showed module validity average in 86, 1%. Some revisions are needed, especially on the representation of the quadrilateral model which needs appropriating to students' physiological and structural abnormalities. Based on data collected from small-scale and large-scale students who have completely filled 10 statements in the questionnaire, shows that students response assessment validation score is included in category "very good". Thus those results indicated a high level of practicality. This result research showed that the module has good validity and practicality, especially for visual impairment students' geometries object understanding that has limited visualization.

INTRODUCTION

Education is an effort made to prepare students in facing problems, mastering knowledge, and forming thought patterns and procedures for attituded. It is in line with the Minister of National Education Regulation Number 22 of 2006 concerning the standard content of mathematics learning content and the standard competencies of graduates contained in the learning objectives of mathematics in the Minister of National Education Regulation Number 23 of 2006. To achieve the objectives of learning mathematics, the participation of various educational units is needed in carrying out the planning, implementation, assessment, and supervision of the learning process, so that the process runs effectively and efficiently as the educational process standards contained in the Minister of National Education Regulation Number 19 of 2015.

A learning plan needs to be designed well, starting from the placement of time, selection of materials and appropriate learning methods, creating a learning atmosphere that is productive and attractive to students [1]. From this, we can see the significant role of the teacher in determining the achievement of learning outcomes and the success of learning in schools [2, 3, 4]. The effectiveness of the teacher to teach will show the quality of learning that is done, both the effectiveness in terms of positive expectations of student success, reliable classroom management and appropriate learning design.

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The learning design is interpreted as a learning tool, such as modules, student worksheet, learning plan and other learning media created by the teacher so that learning takes place interactively, fun, efficiently and provides space for the initiative, creativity, independence of interests and development of student' psychological. To design a learning device that is suitable to the needs and characteristics of students, course it's not easy for a teacher. One of a student who has special characteristics and needs in learning mathematics is visual impairment. Visual impairment student has limitations in obtaining experiences of kinesthetic or visual sensory.

According to [5], all this time, the teacher uses general textbooks to teach mathematic to blind students, while other learning media such as the Braille module, not yet exist in schools. The module is learning tools that are arranged systematically and include material content, methods, and evaluations for self-instructional learning. Braille is a tactile writing system for the visually impaired that has a basic unit of Braille cells, where each cell consists of six arising points, three rows with two dots [6]. The Braille Module in this paper is a module written using Braille letters and contains embossed figure so that it can be touched by the visually impaired using their touching or tactile ability. Active tactile is generally used to explore and manipulate a physical object to recognize the different shapes of physical objects. In this sense, fingertip skin is the most sensitive access to tactual information. Tactual abilities possessed by the visually impaired are influenced by the perception of synthetic touch which refers to tactual exploration of an object form that can still be reached by one or two hands and then described its parts, and analytical touch perception that refers to tactual exploration of parts of an object successively, then mentally the parts are constructed into a unified whole (Lowenfield in [7]).

Although there are various regulations, it doesn't mean that equal educational services are provided to visual impairment. Many teachers still use the limitations of the visually impaired as a reason for not learning certain concepts of mathematics with the learning experience. In fact, the teacher often experiences difficulties and obstacles during the learning process which is generally still dominated by the old paradigm, which the teacher actively transfers knowledge to the mind of students and they receive the knowledge passively so that students do more activities memorizing concepts (Marpaung in [8]). Learning that tends to be monotonous and unidirectional, doesn't habituate students' mathematical reasoning and communication so a result of student learning outcomes become low [9]. The use of old paradigms in mathematics learning is often caused by the difficulty of teachers in teaching and relate the abstract concept of mathematical with specific learning innovations.

Rigorous Mathematical Thinking (RMT) is a learning approach developed based on Vygotsky's sociocultural theory and Feuerstein Mediated Learning Experience (MLE) theory. This approach contains learning activities that mediate students to construct and represent understanding by integrating the mental operations they have [10]. Through RMT, the teacher is conditioned as a mediator in the formation of students' self-concepts by developing cognitive functions of mathematical thinking, in such a way as form general thought patterns and good mathematical thinking skills. Because it's based on the MLE theory, the general criteria that are embedded in the interaction of teachers and students must contain intentionality, transcendence, and meaningfulness. Through these interactions, it's also expected to form cognitive functions that are needed by students for each learning activity and the use of mathematical, psychological tools. According to [11], there are three aspects of RMT cognitive function that are interconnected to provide cognitive functions with integrity as mental activities or psychological processes. Aspects of cognitive functions that are interrelated will provide graded cognitive functions, namely: general cognitive functions for qualitative thinking at level 1, cognitive functions for quantitative thinking with accuracy at level 2, and cognitive functions that aim at leveling for relational logical thinking abstract at level 3. Cognitive functions in each level of thinking is a mental process that has a special meaning with a level abstractness of properties and the rigorous in different mental organizing.

The positive influence of the implementation of the RMT approach in mathematics learning can certainly be an alternative solution to the difficulty of learning abstract mathematical concepts. Especially concepts that contain symbols that are not easily understood by students if without guidance or mentoring by teachers, for example, geometry concept. With the RMT approach, the teacher is expected to be able to mediate students in the process of constructing geometry concepts by optimally stimulating and using psychological tools.

From previous research, researchers found that there are still many teachers who teach quadrilateral material using the old paradigm and only verbally (imitation). As a result, students learn quadrilateral concepts by memorizing what is conveyed by the teacher and aren't fully able to achieve abstract relational thinking at level 3 cognitive functions of RMT [12]. In addition, teachers also still find it difficult to find suitable teaching materials to help understand the quadrilateral concept suitable for the limitations and needs of the visually impaired.

Based on the facts above, an effort is needed to improve the quality of learning geometry, especially the visual impairment students' understanding of the basic geometrical concepts relating to the recognition of geometrical objects like the quadrilateral concept. One way is to develop a learning tool in the form of a Braille module using the

RMT approach. Some rules on module development related to the feasibility of a teaching material are applied in the development of this Braille module, namely the material and media feasibility [13]. Thus, the module must satisfy the contents feasibility or scientific truth in accordance with the basic competencies that students must achieve when learning quadrilateral, the clarity of information presented, the structure and systematics of module, linguistic and graphical in accordance with blind students as users with visual limitations. The rules for developing of module with RMT approach are not much different from the rules of writing geometry textbooks with the RMT approach developed by [14]. It's just that the geometry textbook was developed for undergraduate mathematics students by considering activities involving problem-solving, open problems, connection problems, creativity, etc. The development of the textbook used the Plomp model, while the Braille module discussed in this paper is developed using the ADDIE model which consists of the analyze, design, development, implementation, and evaluation stages. The Braille module developed is expected to help visual impairment students visualize quadrilateral objects by optimizing their tactual ability, so students can construct and understand quadrilateral concepts well.

METHOD

This type of research is Research and Development by using the ADDIE model (Analyze, design, development, implementation, and evaluation) which was adapted from the model raised by [15]. This research focuses on the development stage only and is limited to ADDI with the steps presented as in Fig.1 about the following research procedure.

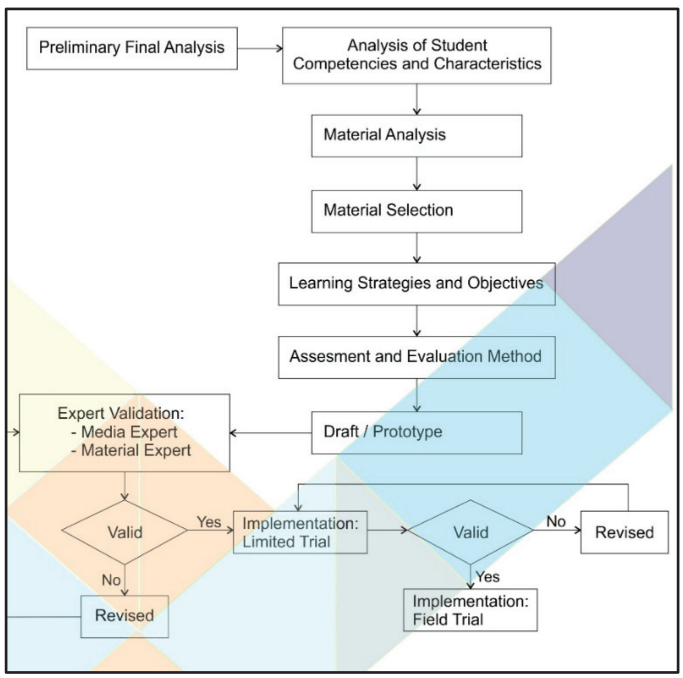

FIGURE 1. Research procedure

In the analysis stage, researchers analyze the competency students must achieve, an analysis of the characteristics related to the learning capacity, knowledge, skills and attitudes that students have. While in the design stage, the researcher conducted the design using a learning reference frame that was focused on three activities, namely the selection of material according to student characteristics and competency demands, the learning strategies applied and the assessment and evaluation methods used.

At the development stage, the researcher embodies design specification until a prototype of the development product is obtained. A mathematical lecturer reviewed the initial prototype. The results of the initial product revision are reviewed again by the material expert to get product validation, then validated by the media expert to assess its quality. A product that meets the validity criteria will be tested limited to one low vision student and a totally blind student at the implementation stage. The product that meets the practicality criteria will be applied in the learning of all seventh-grade students of MTs Yaketunis to find a picture of the extent to which the development product can interest attention and motivation student learning. Product assessment is done through a review and input by a peer reviewer (lecturer); review and input by a material expert (lecturer); and assessment by media experts (Braille expert educator from MTs Yaketunis). The data used in this study are qualitative data in the form of category values, which are very good (VG), good (G), sufficient (S), less (L) and very less (VL). Quantitative data in the form of assessment scores VG = 5, G = 4, S = 3, L = 2, VL = 1.

Analysis of the data in this study used descriptive data analysis with two variables, namely the development variables and product characteristics, and the variable quality of the Braille geometry module. The product development process was carried out by collecting references about quadrilateral as a source of material, both books and journals. In addition to quadrilateral material, researcher also collected references on the cognitive functions of the RMT approach contained in the module to stimulate the achievement of quadrilateral learning objectives namely: general cognitive functions for qualitative thinking at level 1, cognitive functions for quantitative thinking with accuracy at level 2, and functions cognitive aims to generalize to abstract relational logical thinking at level 3.

Qualitative data analysis was performed using [14] data analysis techniques to analyze the validity and practicality of the module. Activities in Miles and Huberman's data analysis are data reduction, data display, and conclusion drawing/verification. In this study, the module developed is said to have feasibility, if the average assessment results by experts have validity that reaches a minimum value of "G" or the "Good" category. While the data analysis description of student responses to the use of modules is done using a Likert Scale.

RESULT AND DISCUSSION

This development research produced a Braille geometry module based on visual impairment students synthetic touch ability with the RMT approach on quadrilateral material. This geometry module contains the map of concept that illustrates the scope of the material to be discussed, while quadrilateral material covered consists of the parallelogram, rectangle, rhombus, and square as presented in the following Fig.2.

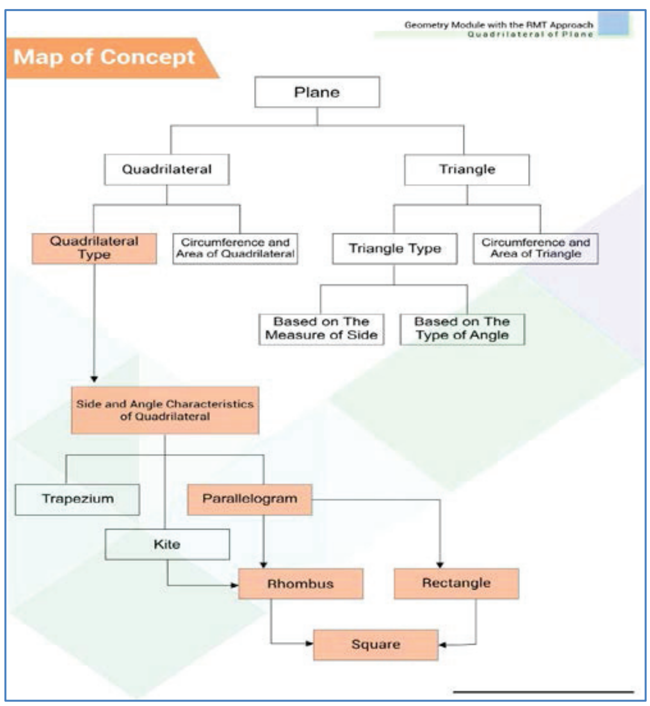

FIGURE 2. The map of concept quadrilateral

The quadrilateral material in the module is presented to stimulate the understanding of the quadrilateral described in the map of concept above. The presentation of material contains the cognitive functions of the RMT approach are general cognitive functions for qualitative thinking (level 1), cognitive functions for quantitative thinking with accuracy (level 2), and cognitive functions that aim to generalize to abstract relational logical thinking (level 3). To stimulate the quadrilateral understanding of quadrilateral students, this Braille geometry module contains mathematical problems relating to cognitive function achievement of labeling, visualizing, comparing, searching systematically to gather clear and complete information, using more than one source of information, encoding, and decoding at level 1. Examples of mathematical problems related to level 1 achievement of RMT are the problem of labeling and visualizing quadrilateral to activate the ability of synthetic touch as presented in the following Fig. 3.

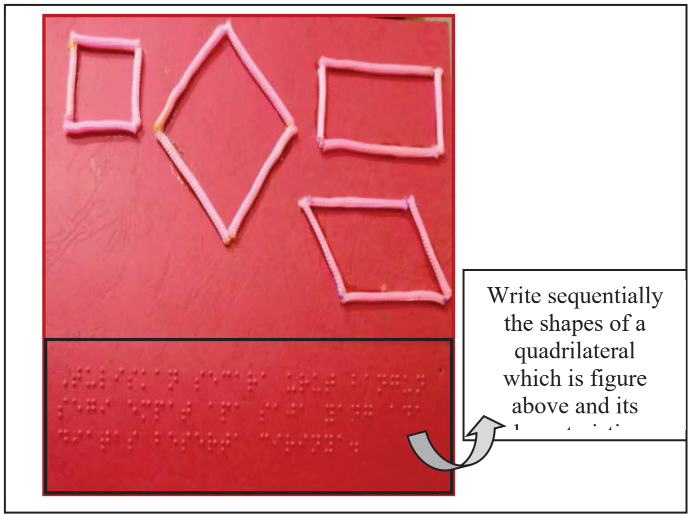

FIGURE 3. The problem of labeling and visualizing quadrilateral

It also includes mathematical problems related to the achievement of the cognitive functions on level 2, namely conserving constancy, quantifying space and spatial relationships, analyzing, integrating, generalizing, and being precise. This module emphasizes the achievement of cognitive functions of abstract relational, logical thinking or level 3 RMT approach because based on [12] students are not fully able to achieve abstract relational thinking. Therefore, problem in the module is focused on cognitive functions activating prior mathematically related knowledge, providing mathematical logical evidence, articulating mathematical logical evidence, defining the problem, hypothetical thinking, inferential thinking, projecting and restructuring relationships, forming proportional quantitative relationships, mathematical inductive thinking, and etc according to the cognitive function level of RMT [10]. Examples of mathematical problems relating to level 3 achievement of RMT are the problems of quadrilateral relations to activate the ability of synthetic touch as presented in the following Fig. 4.

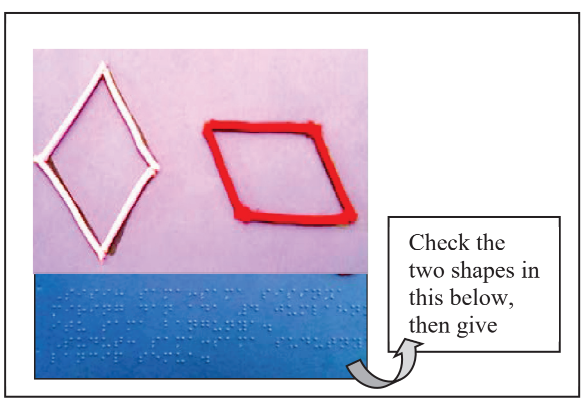

FIGURE 4. The problems of quadrilateral relations

The development of this Braille geometry module is also validated by material and media experts. To measure feasibility of the module contents, the material expert is given a question that contains 13 questions with a maximum score for each statement is 5, so that the highest total score is 65. The results of validation based on content feasibility can be seen in Table 1 below.

TABLE 1. Validation Results Based on the Content Feasibility of the Material Expert

Number	Component	Maximum score
1	Module present material that is in line with Core Competencies and Basic Competencies in the 2013 curriculum	5
2	Suitability of the formulation of Competency Achievement Indicators with Basic Competencies	5
3	Module become an alternative choice of teaching materials to teach quadrilateral material	4
4	Module presents quadrilateral material systematically	4
5	Module contain quadrilateral material that can increase students' insights to the quadrilateral concept and its relation	4
6	Suitability of module presentation with moral values and social values (polite, kind, beautiful, and communicative)	4
7	Module presents quadrilateral material in a clarity, concise, coherent, easily understood manner	4
8	Module presents quadrilateral material in a clarity, concise, coherent, easily understood manner	4
9	Suitability of module examples with learning material	4
10	Module presents sufficient problems (in terms of amount and time allocation)	4
11	Module presents varied problems	5
12	The module presents an accurate problem (according to the concept and definition of the material) and in line with the Competency Achievement Indicator	4
13	Suitability of questions and answer keys	4
Total Score		55
Percentage of Score		84, 6%

Based on Table 1 above it is known that the module validation score is 55 or 84,6%. These results are included in the category X > 41,6 which means "very good". So, for the feasibility of the contents of the module with the Rigorous Mathematical Thinking approach is classified as very good.

To measure feasibility of the module presentation, the material expert is given a question that contains 5 questions with a maximum score for each statement is 5, so that the highest total score is 25. The results of validation based on content feasibility can be seen in Table 2 below.

TABLE 2. Validation Results Based on the Material Presentation Feasibility of the Material Expert

Number	Component	Maximum score
1	The clarity of module includes the Competency Achievement Indicators to be achieved	5
2	Module presents the module structure (introduction, content, activities and closure) systematically.	4
3	Module provides motivation and attractiveness of students to learn the module completely.	5
4	Module provides interaction to students	4
5	Module presents complete information and in accordance with the material	4
Total Score		22
Percentage of Score		88%

Based on Table 2 above it is known that the module validation score is 24 or 88%. These results are included in the category X > 16 which means "very good". So, for the feasibility of the material presentation of the module with the Rigorous Mathematical Thinking approach is classified as very good.

The average evaluation result of material and presentation feasibility by a material expert was 86,3%, then the module was revised according to a suggestion from the material expert. The revised module is consulted again with the material expert to obtain the revised results that have been fixed. After that, the revised module is converted into Braille.

The revised product which has been written in Braille is assessed to a media expert who is a Braille expert teacher from MTs Yaketunis to see the quality resulting from the development of a module conducted by the researcher. In addition to getting a module quality assessment, researchers also get advice from a media expert who is used by the researcher as a reference for the revision of the final module.

To measure feasibility of linguistics aspect, the media expert is given a question that contains 5 questions with a maximum score for each statement is 5, so that the highest total score is 25. The results of validation based on content feasibility can be seen in Table 3 below.

TABLE 3. Validation Results Based on the Linguistics Feasibility of the Media Expert

Number	Component	Maximum score
1	Clarity and readability of the module or activity instructions	5
2	The module has clear information	4
3	The module uses sentences that are in accordance with Indonesian Language Rules	4
4	Module uses effectively and efficiently language	4
5	Clarity of the module includes indicators of achievement to be achieved	4
	Total Score	21
	Percentage of Score	84%

Based on Table 3 above it is known that the module validation score is 21 or 84%. These results are included in the category X > 16 which means "very good". So, for the feasibility of the linguistics presentation of the module with the Rigorous Mathematical Thinking approach is classified as very good.

To measure feasibility of presentation aspect, the media expert is given a question that contains 4 questions with a maximum score for each statement is 5, so that the highest total score is 20. The results of validation based on content feasibility can be seen in Table 4 below.

TABLE 4. Validation Results Based on the Presentation Feasibility of the Media Expert

Number	Component	Maximum score
1	Module presents the structure (introduction, contents, activities, and closures) systematically	4
2	Module provides motivation for students to learn	4
3	Modules provides interaction to students	5
4	The module presents the complete information clearly, including instructions for using the module, table of contents, bibliography, glossary and module page	4
	Total Score	17
	Percentage of Score	85,5%

Based on Table 4 above it is known that the module validation score is 17 or 85,5%. These results are included in the category X >12,8 which means "very good". So, for the feasibility of the presentation of the module with the Rigorous Mathematical Thinking approach is classified as very good.

To measure feasibility of graphical aspect, the media expert is given a question that contains 12 questions with a maximum score for each statement is 5, so that the highest total score is 60. The results of validation based on content feasibility can be seen in Table 5 below.

TABLE 5. Validation Results Based on the Graphical Feasibility of the Media Expert

Number	Component	Maximum score
1	The module uses the following text sizes: (1) Easy-to-read font size (2) Compare the proportional letters between titles, subtitles and contents of the manuscript (3) Avoid using capital letters for all texts	4
2	Module doen't use many letter combinations	5
3	Module have consistency in layout (titles, subtitles, instructions, use of modules, illustration of material in accordance with problems encountered by students and terms that students use, etc.)	4
4	Module have harmonious / harmonious layout elements	5
5	Module presents models that fit the range of students' touches	4
6	The module presents illustrations that match with problems encountered by students	5
7	Module display models that match the illustrations presented	4
8	Module display illustrations and models that clarify the material	5
9	Module display models and clear illustrations	5
10	Module uses images, illustrations and model that attract students' attention	5
11	The module display design consists of interesting cover, the identity of the writer, cover illustrations represent teaching material and proportional size and type of paper	4
12	Module makes it easy to understand the contents of the material	4
	Total Score	53
	Percentage of Score	88,3%

Based on Table 5 above it is known that the module validation score is 53 or 88,3%. These results are included in the category X >38,4 which means "very good". So, for the feasibility of the graphical presentation of the module with the Rigorous Mathematical Thinking approach is classified as very good.

The average evaluation result of feasibility' linguistics, presentation and graphical by a media expert was 85,9%, then the module was revised according to a suggestion from the media expert. The revised module is consulted again with the media expert to obtain the revised results that have been fixed. So the average validity of the Braille geometry module from both media expert and material expert is 86,1%, which shows that the quality of the learning products developed is very good. In other words, this Braille geometry module is appropriate for use in learning. Regarding the advice of the media expert, the researcher followed up on the revised picture in the module. Initially, the researcher presented a picture of the parallelogram in a position that was not straight or tilted, but it turned out that it was difficult to understand by visual impairment students because the picture was attached to the paper and couldn't be lifted up by the student. The advice of the media expert, the picture of the parallelogram is presented in a straight position so that it is easy for students to understand through their touch and easy in the making process.

The assessment is in the form of responses to the Braille geometry module conducted by students of seventh-grade of MTs Yaketunis, Yogyakarta. Students' responds are carried out by filling in the response checklist sheet which consists of five aspects of assessment which are spelled out in ten questions. The five aspects of the assessment are the relevance of the material, easy of understanding, learning independence, interest in the module and module presentation. Student answers are divided into five criteria: strongly agree = 5, agree = 4, sufficient agree = 3, disagree = 2, strongly disagree = 1.

The next stage is the researcher converts the processed scores into qualitative values according to the assessment criteria. Based on data analysis above it is known that small-scale student response assessment validation score is 62. These results are included in the category X >51,2 which means "very good". So, for the small-scale student response assessment of module with the Rigorous Mathematical Thinking approach is classified as very good.

Whereas, the large-scale student responses validation score is 70. The assessment results are included in category X> 51,2 which means "very good". So, for large-scale student responses to module with the Rigorous Mathematical Thinking approach is classified as very good. According to the guideline table the module evaluation criteria from the aspect of student responses are included in the excellent category. It can be concluded that the module developed has satisfy the practicality criteria.

Based on the assessment of material experts, media experts, and visual impairment student responses described in the data analysis above, this Braille geometry module has been sufficient the criteria of assessment for a good learning media, so that the Braille geometry module is feasible to use.

CONCLUSION

Based on the results of the field analysis of a Braille geometry module, it is concluded that the module is valid and practical to be used as literature on quadrilateral learning, especially for students of Yaketunis. The validity of the module is assessed regarding result of material and media experts indicating that the average evaluation result of material and presentation feasibility by a material expert was 86,3%, whereas the average evaluation result of feasibility' linguistics, presentation and graphical by a media expert was 85,9%. So the average validity of the Braille geometry module from both media expert and material expert is 86,1%, which shows that the quality of the learning products developed is very good or satisfy validity criteria. Besides that, this module also satisfied the practicality criteria because result of the aspect of student responses are included in the excellent category, either small-scale student responses nor large-scale student responses. Although it has satisfied the criteria of validity and practicality of a teaching material, but this module hasn't been tested for effectiveness so that in the future it is hoped that it can be continued by testing the effectiveness of the module in improving the particular skills of blind students. that have limited visualization.

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