M A T H L I N E
JURNAL MATEMATIKA DAN PENDIDIKAN MATEMATIKA
ISSN 2502-5872 (Print)
ISSN 2622-3627 (Elektronik)

Volume 9 Number 4, November 2024, 1139-1151

DEVELOPMENT OF BILINGUAL GETRANS TEACHING AIDS TO UNDERSTAND GEOMETRY TRANSFORMATION MATERIAL

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ABSTRACT
This research aims to develop bilingual getrans teaching aids that can be used to visualise the concept of geometry transformation. The urgency of this research lies in the effort to facilitate students' understanding of abstract concepts in geometric transformations where the development of getrans teaching aids allows students to learn actively, involving physical and visual, which is believed to improve understanding and retention of concepts. Utilizing the 4D model, the Research and Development (R&D) approach is applied. The four phases of the 4D development model are defined, designed, developed, and disseminated. The findings showed that students had trouble grasping the idea of geometric transformation at the define stage. At the design stage, preparation for the development of bilingual getrans teaching aids was carried out. At the development stage, getrans props were made as well as validation of video results by experts and limited trials to students. Then at the dissemination stage, the revised video results were disseminated based on expert advice. The conclusion of this research is that bilingual getrans teaching aids can be used for learning mathematics which students can better understand changes in position, rotation, reflection, or dilation of objects in geometry with better.
Keywords: Bilingual, Getrans, Teaching Aids.

How to Cite: Utami, R., Hidayah, N., Muhammad Fajru Sidqi, M. F., Kuncoro, S. (2024). Development Of Bilingual Getrans Teaching Aids To Understand Geometry Transformation Material. *Mathline: Jurnal Matematika dan Pendidikan Matematika*, *9*(4), 1139-1151. http://doi.org/10.31943/mathline.v9i4.696

PRELIMINARY

Mathematics is one of the important subjects studied by students. This subject has an important role in everyday life, both in education, work, and social life(Daimah & Suparni, 2023). Effective math learning can improve students' understanding and skills in the field of mathematics. One of the factors that can affect the effectiveness of mathematics learning is the use of mathematical teaching aids (Rahman et al., 2018; Salasiyah & Zaki, 2018).

Teaching aids can be used to make it easier for teachers to deliver math material so that students are not bored and saturated with receiving math learning (Asiatul Yulia, 2021). Mathematics teaching aids (manipulative materials) are learning aids using concrete used by teachers to explain subject matter and communicate with students so that it is easy to give

students an understanding of the concept of the material being explained or taught correctly (Jones & Tiller, 2017; Kania, 2018; Laski et al., 2015).

Research suggests that when mathematics teaching aids are used effectively, students can construct mathematical understanding which in turn can be a valuable learning experience. Students who use mathematics teaching aids can connect ideas and integrate mathematical knowledge so that they gain a deep understanding of mathematical concepts in various ways (Cockett et al., 2015; Şandır, 2016). Another study mentioned that mathematics teaching aids can facilitate learning that supports students' abstract reasoning, stimulates students' experiences in the real world, and provides opportunities for students to discover mathematical concepts (Sarumaha & Kurniasih, 2022). In addition, mathematics teaching aids also have a positive effect on concept understanding and mathematical communication skills (Herliana et al., 2021)(Isnaniah & Imamuddin, 2020). Therefore, the use of mathematics teaching aids is still very much needed to make it easier for students to learn mathematics material. For this reason, it is still necessary to employ mathematics teaching aids to facilitate students' understanding of the subject matter.

In addition to mathematics teaching aids, English language competence is also an important factor that can affect the effectiveness of mathematics learning. Many mathematics materials use terms in English. Students' inability to understand mathematical terms in English can hinder students' understanding of mathematical material (Setyowati, 2019). Research states, that students have difficulty working on English story problems because students cannot interpret English sentences into Indonesian (Lutvaidah et al., 2021). Using bilingualism in mathematics is a good way to introduce students to mathematical terms in English (Abror et al., 2023). Therefore, to support the efficacy of mathematics learning, students' English proficiency needs to be improved.

The researcher's interview with a mathematics teacher at SMP Muhammadiyah Pekalongan explained, that students have difficulty in learning transformation geometry material. The abstract nature of the material is where students need the ability to represent translation, dilation, rotation, and reflection material to understand the concept of the material (Fitri & Putri, 2021; Mardiana & Amalia, 2023; Zanthy, 2018). This research developed (geometry of transformation) teaching aids for junior high school students. This teaching aid was developed because students still have difficulty representing the concept of transformation geometry which consists of translation, dilation, rotation, and reflection material. The device developed in the form of getrans props to study the geometry of transformation material is equipped with a guide to using the props, this guide is also

equipped with mathematical terms in English The purpose of this study is to develop bilingual getrans teaching aids for junior high school students.

METHODS

The steps of the development process are explained below; this research employs the 4D model for development (Semmel et al., 1974). The 4D model which consists of defining, designing, developing, and disseminating is the paradigm used in development research (chart 1). This research was conducted at SMP Muhammadiyah Pekalongan. The subjects of this development research were 4 experts, 15 students for small-scale field trials, and in large-scale field trials consisting of all ninth-grade students totalling 25 students.

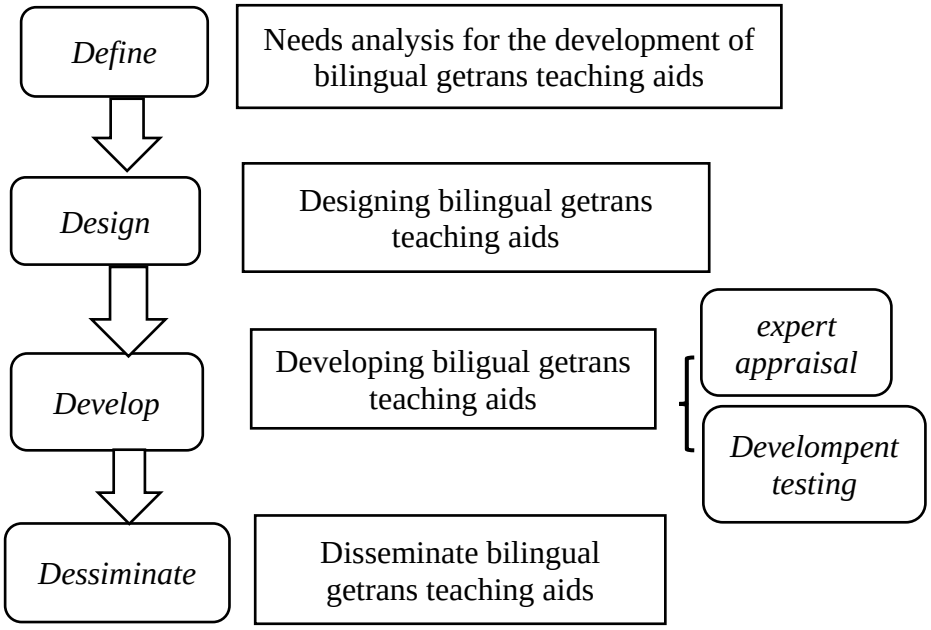

Chart 1. Research Flow of 4D Model Development

The study used tests, questionnaires, interviews, and observation as data collection methods. When the research was planned, observations were made to gather information for future research and development. Teachers of mathematics were interviewed to gather information about research and development needs. Tests are used to get data from large-scale field trials, while questionnaires are used to gather information on the evaluation of the viability and quality of the media created by experts and students in small-scale field trials. Test sheets, questionnaires, interviews and observations have been validated by validators to obtain validation related to these instrument.

The researchers used observations, interviews, and literature reviews to assess the requirements of schools and students interviews were conducted with junior high school mathematics teachers because the geometry transformation material is in grade 9 of junior

high school. Four math teachers in junior high school were questioned by researchers. To do a preliminary diagnosis of the issues encountered in the classroom when learning geometric transformation content, a series of questions were asked during the interview. To evaluate the efficacy, usability, and validity of bilingual getrans teaching aids, a research instrument was created. Two teachers of mathematics studies and three lecturers on mathematics education made up the validator. The validator looks at the researcher's intended aesthetic, technical, and pedagogical elements. The material that is being generated is revised based on ideas from validators. Based on the average score of each bilingual getrans teaching aid that has been validated by the validator and amended by the validator's recommendations, descriptive statistical analysis is used to assess the validity of the bilingual getrans teaching aids (Hobri, 2010). Bilingual getrans teaching aids are very valid if they reach the valid level as the minimum level of validity. The practicality of bilingual getrans teaching aids can be seen from the students' response to using bilingual teaching aids which is 80 % of students gave a positive response. The effectiveness of bilingual getrans teaching aids can seen from the increase in students' understanding of geometry transformation material was calculated using the following Normalised Gain (g) formula (Hake, 1998).

RESULT AND DISCUSSION

RESULT

Define

At that stage, the researchers used observations, interviews, and literature reviews to assess the requirements of schools and students interviews were conducted with junior high school mathematics teachers because the geometry transformation material is in grade 9 of junior high school. Four math teachers in junior high school were questioned by researchers. To do a preliminary diagnosis of the issues encountered in the classroom when learning geometric transformation content, a series of questions were asked during the interview. Teachers of mathematics at SMP Muhammadiyah Pekalongan reported that students are still unable to comprehend the material on geometry transformations and are unable to differentiate between different kinds of transformations. The difficulty was marked by several things, namely: students have difficulty distinguishing the formula in geometric transformations, students can not visualize geometric transformations in the cartesian plane and students are often confused in understanding the types of geometrical transformations.

Researchers also identified the needs of students and teachers (Rukoyah et al., 2021; Silmi et al., 2022) based on the results of interviews and observations in learning geometry

transformation material through the following stage: 1). Front-end analysis is the initial diagnosis of student problems in geometry transformation material. The problem faced by students is that students is difficult to visualize the concept of geometric transformation. 2) Learner analysis is to analyze the characteristics of students. Students typically lack the motivation to learn mathematics and the confidence to convey what they understand. 3) Task analysis is when the researcher analyzes the minimum competence of students on geometric transformation material. The minimum competence of students in geometric transformation material is that students can explain geometric transformations and their types. 4) Concept analysis is the process by which a researcher evaluates the ideas that will be taught and assembles the logical steps that will be followed. The idea that needs to be taught is a geometric transformation, and to understand the content, researchers create getrans props. 5). Specifying instructional objectives, namely researchers write learning goals and anticipated behavioral modifications following operative verb instruction. Expected changes in behaviour that is by using getrans teaching aids students can explain the material geometry transformation.

Design

The design of researchers to create bilingual getrans teaching aids is the second phase of this project. This teaching aid consists of getrans teaching aids and guides to use the teaching aids. In addition, the researcher also designed a validation sheet to assess getrans teaching aids and student response questionnaires. To make it easier to make getrans teaching aids, researchers made a getrans teaching design with the expected objectives. This getrans trainer consists of teaching aids and usage guides. First of all, researchers discussed with the team the form of getrans teaching aids. Researchers also discussed the tools and materials needed to make the props. Researchers determined the criteria or aspects that must be owned by the props to be made. These aspects consist of educational aspects, technical aspects, and aesthetic aspects. Researchers also designed a questionnaire for students' responses to getrans teaching aids. Then the second step researchers and the team discussed the design of the getrans teaching aid user guide.

Develop

At this stage, researchers made getrans teaching aids, compiled guidelines for using getrans teaching aids, validated bilingual getrans teaching aids, tested bilingual getrans teaching aids, and revised bilingual getrans teaching aids. The Getrans teaching aid was

made like a chessboard so that it is easy to carry around. The designed getrans teaching aids were validated by four validators consisting of two lecturers of mathematics education and two math teachers at junior high school. The average total validation from experts is 3.7 so getrans teaching aids are valid. Validators also provided suggestions for improving the getrans teaching aids. The suggestions included: improving the quality of the stickers on the getrans props so that the cartesian coordinate points are not easily erased.

The getrans teaching aids were also tested on the research subjects, namely students of SMP Muhammadiyah Pekalongan. This trial was used to obtain student responses related to the developed bilingual getrans teaching aids. Students demonstrated the returns props individually and in groups. They were very enthusiastic about demonstrating the getrans props. Student response questionnaires were distributed after students demonstrated the getrans teaching aids and 82% of students gave a positive response to the getrans teaching aids. Students also argued that the cartesian coordinate points on the getrans trainer were easily lost when erased so it was necessary to improve and increase the quality of the ink used to print cartesian coordinate stickers.

Revisions to the bilingual getrans teaching aids were made based on the validator's assessment and student responses. The revision is related to adding a summary of the printed getrans teaching aid usage guide so that it can be read directly by students and improving the quality of ink when printing cartesian coordinate point stickers on getrans teaching aids. These two revisions have been made and the getrans props can be used again. Guide to the use of getrans teaching aids can be accessed at the link https://bit.ly/3XzJR7c. Getrans teaching aids can be seen in Figure 1.

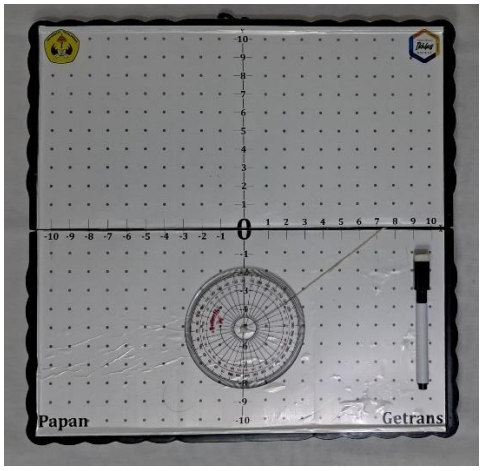

Figure 1. Gentrans Teaching Aids

Disseminate

Three tasks are included in the dissemination stage: validation testing, packaging, diffusion, and adoption. The product that was revised throughout the development stage is subsequently put into use on the real target during the validation testing phase. Goal achievement was measured at the time of implementation. The purpose of this measurement is to assess the created product's efficacy. Researchers must observe how the product accomplishes the goals when it is put into use. The revised getrans teaching aids were then implemented to determine the effectiveness of the getrans teaching aids. Researchers prepared pretest and posttest questions to measure students' understanding of geometric transformation material after students used getrans teaching aids.

The effectiveness of the getrans teaching aids developed is calculated using the N-Gain formula of increasing student understanding of the geometry of transformation material. Students do pretest and posttest questions before and after using trans teaching aids. Students are enthusiastic about using getrans teaching aids with teacher guidance. The table describes the average data of students' pretest and posttest scores in using getrans teaching aids.

Tabel 1. The Average Data of Students' Pretest and Posttest Scores in Using Getrans Teaching Aids

No	Information	Score
1	Average pre test score	35
2	Average post-test score	81,7
3	Score maximal	100

The table 1 is used to analyze the N-Gain value to determine the difference in students' abilities before and after using getrans teaching aids. Based on this analysis, the N-Gain value is obtained which is in the criterion of 0.72. The value describes the high effectiveness of getrans teaching aids in improving student understanding.

DISCUSSION

This study begins with an initial assumption of the difficulty of students in learning geometric transformation material. This conjecture is from the analysis of the results of previous research from several relevant researchers and the results of preliminary interviews with mathematics teacher SMP Muhammadiyah Pekalongan. According to the research, the cause of student difficulties in geometry transformation material is the abstract nature of the material where students need the ability to represent translational, dilation, rotation , and reflection material to understand the concept of the material (Fitri & Putri, 2021; Mardiana

& Amalia, 2023; Zanthy, 2018). Mathematics teachers at SMP Muhammadiyah Pekalongan also stated that students still have difficulty understanding geometry transformation material and students have not been able to distinguish the types of geometry transformations. The results of the analysis of relevant research and interviews were used by researchers to develop bilingual getrans teaching aids. The device was developed in the form of getrans props to learn geometry transformation material equipped with a guide to use teaching aids. Bilingual getrans teaching aids in addition to using Indonesian also use English (bilingual) on some terms so that students can also understand some mathematical terms in English. According to the research using bilingualism in mathematics is a good way to introduce students to math terms in English (Abror et al., 2023; Lutvaidah et al., 2021; Setyowati, 2019). The purpose of this research is to develop bilingual getrans teaching aids for junior high school students.

This development research is divided into four stages: defining, designing, developing, and distributing. Researchers used literature reviews, interviews, and observation to assess the needs of schools and children during the defining stage. The junior high school level was the setting for this study. Four math teachers in junior high school were interviewed by researchers. A brief series of questions was used in the interview to help diagnose the issues students were having with understanding geometry transformation subject in the classroom. It is anticipated that teaching aids for getrans will be developed using the initial diagnosis. The flow of development of bilingual getrans teaching aids can be seen in Chart 2.

At the end of the junior high school math teachers' interview, there are still students who have problems understanding the geometry of material transformation. The difficulty was marked by several things, namely: students have difficulty distinguishing the formula in geometric transformations, students can not visualize geometric transformations in the cartesian plane and students are often confused in understanding the types of geometrical transformations. Teachers have also provided some learning assistance to reduce the difficulties faced by students on geometric transformation material but the teacher explained that the assistance provided by the teacher has not maximized students' understanding of geometric transformation material. Teachers continuously try to reflect on each learning aid provided and design follow-ups from the reflection. For example, providing repetition of material, using Desmos learning media, and providing assistance both in groups and individually.

The second stage in this study is the design of researchers to do the design of bilingual getrans teaching aids. This teaching aid consists of getrans teaching aids and guides to use the teaching aids. In addition, the researcher also designed a validation sheet to assess getrans teaching aids and student response questionnaires. To make it easier to make getrans teaching aids, researchers made a getrans teaching design with the expected objectives. This getrans trainer consists of teaching aids and usage guides. First of all, researchers discussed with the team the form of getrans teaching aids. Researchers also discussed the tools and materials needed to make the props. Researchers determined the criteria or aspects that must be owned by the props to be made. These aspects consist of educational aspects, technical aspects, and aesthetic aspects. Researchers also designed a questionnaire for students' responses to getrans teaching aids. Then the second step researchers and the team discussed the design of the getrans teaching aid user guide.

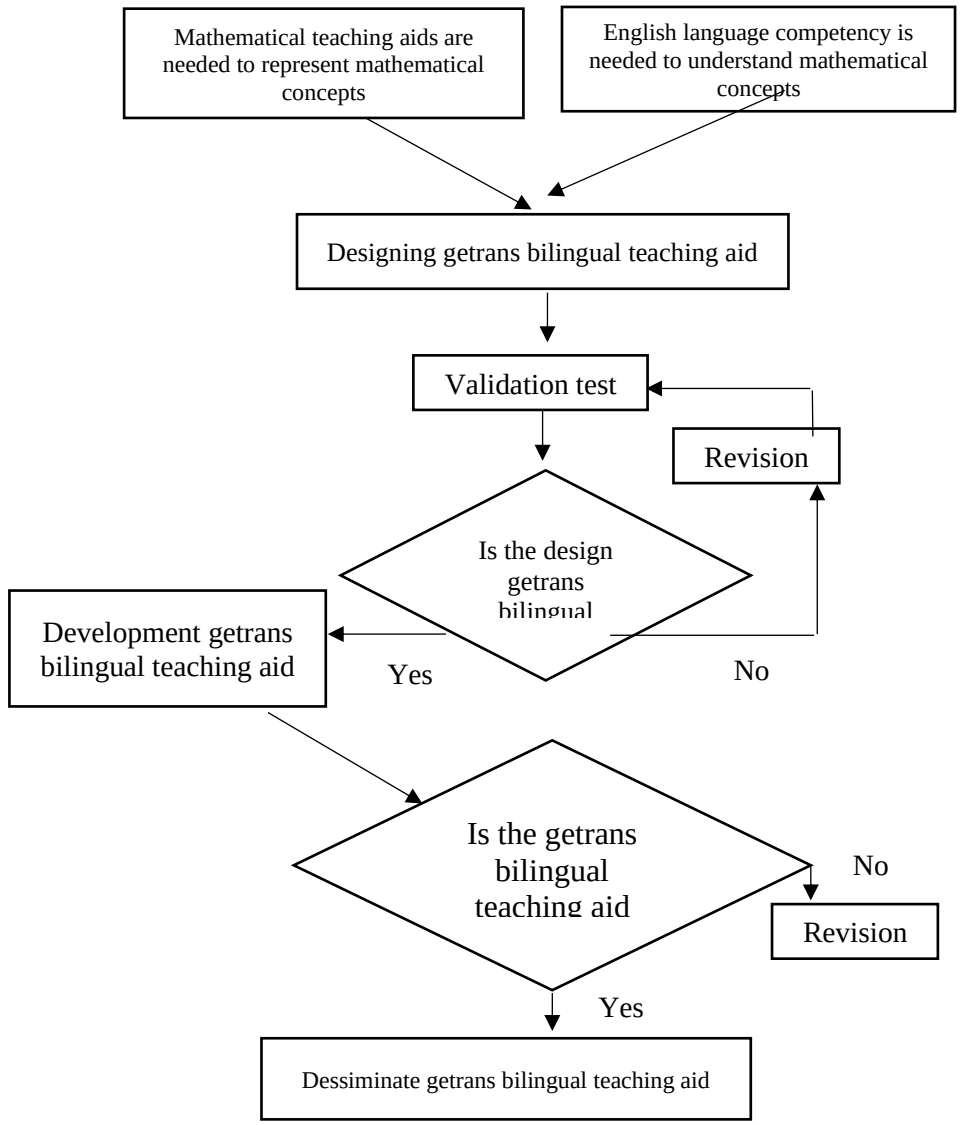

Chart 2. The Flow of Development of Getrans Teaching Aids

The next stage is the development stage. At this stage, researchers made getrans teaching aids, compiled guidelines for using getrans teaching aids, validated bilingual getrans teaching aids, tested bilingual getrans teaching aids, and revised bilingual getrans teaching aids. The Getrans teaching aid was made like a chessboard so that it is easy to carry around. The designed getrans teaching aids were validated by four validators consisting of two mathematics education lecturers and two junior high school mathematics teachers. The average total validation from experts is 3.7 so getrans teaching aids are valid. Validators also provided suggestions for improving the getrans teaching aids. The suggestions included: improving the quality of the stickers on the getrans teaching aid so that the cartesian coordinate points are not easily erased.

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The effectiveness of the getrans teaching aids developed is calculated using the N-Gain formula of increasing student understanding of the geometry of transformation material. Based on this analysis, the N-Gain value is obtained which is in the criterion of 0.72. This is by research that states, that students who use mathematics teaching aids can connect ideas and integrate mathematical knowledge so that they gain a deep understanding of mathematical concepts in various ways cara (Cockett et al., 2015; Şandır, 2016). Another study mentioned that mathematics teaching aids can facilitate learning that supports students' abstract reasoning, stimulates students' experiences in the real world, and provides opportunities for students to discover mathematical concepts (Sarumaha & Kurniasih, 2022). In addition, mathematics teaching aids also have a positive effect on concept understanding and mathematical communication skills (Herliana et al., 2021; Isnaniah & Imamuddin, 2020).

CONCLUSION

The developed getrans teaching aids consist of getrans teaching aids and usage guides that can be used by students and teachers for learning geometry transformation. Getrans teaching aids also provide knowledge of mathematical terms in English because the guidebook is equipped with mathematical terms translated into English.

ACKNOWLEDGMENT

The researcher would like to thank LPPM Universitas Pekalongan for providing a grant for this research. The researcher also would like to thank the FKIP Pekalongan for their support in carrying out this research. We would also like to express our thanks to the teachers and students of SMP Muhammadiyah Pekalongan who have helped the researchers complete the research.

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