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The development of geometry learning using traditional dance context assisted by GeoGebra

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Abstract

Research related to crazy bamboo dance, a traditional dance from Maluku and North Maluku, is still oriented towards cultural studies and has not been integrated into mathematics learning. On the other hand, the use of GeoGebra classrooms in previous research mainly refers to the influence on mathematics learning, so there is still a lack of development research based on GeoGebra classrooms that are integrated with cultures such as crazy bamboo dances. The purpose of this study is to produce learning tools in the form of a learning implementation plan (LIP), teaching materials (TM), and student worksheets (SW). In this case, the context of crazy bamboo dance is more focused on the dance medium, namely bamboo, to study tube material. The development model used is a 4D modified model from Thiagarajan. The results of this study produced an RME-based learning tool in the context of crazy bamboo dance assisted by GeoGebra classrooms that are valid, practical, and effective. In addition, the products produced can be used in geometry learning by teachers and students. Still, through this research, teachers can design and develop ethnomathematics-based learning tools by integrating them with the available mathematics software, one of which is Geogebra Classroom.

Keywords: GeoGebra; geometry learning; realistic mathematics education, traditional dance

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Introduction

In mathematics learning at school, geometry is an important thing to be learned and mastered by students (Deviani et al., 2017; Marasabessy et al., 2021; Novita et al., 2018). Walle (Yupinus et al., 2020) et al., 2020) explained the importance of learning geometry because everyday life involves many geometry concepts and leads students to explore, which impacts problem-solving skills and helps students believe entirely in the real world. One of the geometry materials taught at the junior high school level in grade IX is to build a curved side room in the form of a tube. However, in reality, many students still need help learning to make a curved side room or have trouble answering questions about the material to build a curved side room (Agustini & Nelly, 2021). Several previous studies, including the results of research by Agustini and Fitriani in 2021, support it. Agustini and Nelly (2021) found that students have not been able to do questions related to building curved side rooms because they have not mastered the concept of building curved side rooms and cannot remember formulas related to the material. In addition, the research results of Rita et al. (Novita et al., 2018) show that some errors that occur in geometry learning are errors in drawing space buildings, and the influence of facilities in the form of mathematical software in geometry learning has not been utilized optimally.

Problems related to the study of geometry, specifically the construction of curved side spaces, were also discovered by researchers. Based on the results of interviews and observations of researchers with teachers and ninth-grade students at SMP Negeri 9 Ambon, information was obtained that learning related to building curved side rooms needed to be supported by good learning tools. It can be seen from the learning process that still uses package books conventionally. On the other hand, students tend to listen to explanations from the teacher, even though the teacher should be able to take advantage of objects in everyday life to be explored by students in studying the material for building curved side rooms. Furthermore, students' knowledge of the prerequisite material for learning curved side space building still needs to improve. It can be seen from some mistakes made by students in drawing and determining the elements related to the material in the results of their work.

Teachers should prepare a sound learning system to support mathematics learning by building curved student spaces, meaning that every teacher must be able to facilitate their students by developing practical learning tools for students (Yupinus et al., 2020). Teachers in geometry learning must use real-world contexts because geometry material is closely related to the daily life of students. One of the learning designs that teachers can use is to use realistic mathematics education (RME). According to Meirida et al. (2021), RME requires students to construct knowledge with their abilities through the activities they carry out in learning activities. Laurens et al. (2018) also explained that the characteristics of RME in geometry learning are understanding contextual problems, starting discussion groups, and problem-solving. It also supports Van Hiele's level of geometry thinking (Suherman, 2016), consisting of (1) visualization level, (2) analysis level, (3) informal deduction rate (sequencing), (4) deduction rate, and (5) rigor level. The use of technology in the form of mathematical software is also needed in learning to build curved side rooms, according to the results of previous research. Thus, this research leads to the development of RME-based mathematics learning teaching context of crazy bamboo dance assisted by GeoGebra classroom.

GeoGebra classroom is a virtual platform with the same purpose as the parent application. GeoGebra, with its advantages that can be accessed for free and provide more exciting and interactive tasks to students, thus supporting the pedagogical aspects of teachers in guiding students to understand mathematical concepts, making simulations of theorem proof, and solving mathematical problems (Aminudin et al., 2021). One of the other aspects that can be integrated with the GeoGebra classroom is RME. Learning mathematics with the RME approach is very helpful for students to understand mathematical concepts that are abstract from the natural world around them. Some of the results of previous studies showed a positive influence on using the GeoGebra classroom in geometry learning. The research results by Aspriyani and Suzana (2020) showed that e-modules developed based on RME with the help of GeoGebra software could improve student learning achievement. In addition, the results of the research of Miatun and Khusna (2020) show that by using the GeoGebra classroom, the explanation of the material can be conveyed clearly, and students can also actively participate in solving the given geometry problems.

On the other hand, the context used in the RME approach to learning is the context of the crazy bamboo dance, a traditional dance of the Maluku people. Crazy bamboo dance does not require a variety of trinkets and accessories, just like dance in general. Crazy bamboo dance only requires a bamboo bar with a length of 2.5 to 3 meters and a diameter of 8 cm; the number of players or bamboo holders must be odd, with a minimum of seven people depending on the bamboo segment used (Soamole & Rokhmansyah, 2018). In various official activities, the crazy bamboo dance is usually performed as the opening dance of activities, one of which is at the Ambon Bay Festival, where this festival aims to promote Maluku tourism nationally and internationally (Rahma, 2019; Wikipedia, 2021). The bamboo context in this dance is students' basic knowledge to build an arch side room in the form of a tube.

Previous studies on RME and GeoGebra classrooms have been carried out in geometry learning. Nursyahidah and Albab (2021) examined the use of GeoGebra classrooms using the context of putu cakes in learning the relationship between surface area, height, and radius with tube volume. In addition, research by Nur'aini et al. (2017) related to learning geometry mathematics realistically with GeoGebra. Still, research on culture in the form of traditional dances, in this case, crazy bamboo dance integrated with GeoGebra classroom, has never been done. Culture can be used to explore several mathematical concepts as a transformational effort to bring mathematics closer to the reality and perception of its people and use culture as a context for learning mathematics in schools (Prahmana & D'Ambrosio, 2020). The purpose of this study is to produce learning tools in the form of learning implementation plans (LIP), teaching materials (TM), and student worksheets (SW). All of these are based on RME using the context of crazy bamboo dance assisted by GeoGebra classroom for tube material.

Methods

This study aims to produce an RME-based geometry learning tool in the context of crazy bamboo dance assisted by a valid, practical, and effective GeoGebra classroom. The type of research used is development research. In this study, learning development refers to the development of learning tools in the form of learning implementation plans (LIP), teaching materials (TM), and student worksheets (SW). The learning device development model used in this study is a 4-D model from Thiagarajan, which consists of four stages: define, design, develop, and disseminate (Ratumanan & Rosmiati, 2019). However, this research is limited to the development stage because the process of dissemination in development research takes a long time. The 4-D development model is used because the description at each step of development is clearly and systematically outlined and becomes the basis for the general development of learning (Litay et al., 2016).

In this learning tools case, the development procedure in this study consists of three stages: the defining stage, the design stage, and the development stage. At the defining stage, the final initial analysis, student analysis, concept analysis, task analysis, and specification of learning objectives were carried out. Media selection, format selection, and initial design were carried out at the design stage. Expert validation, readability testing, and learning device trials were carried out at the development stage.

The population in this study was all ninth-grade students of SMP Negeri 9 Ambon, while the sample in this study was all class IX-7 students totaling 29 people. The validators in this study were three people consisting of one mathematics education lecturer and two junior high school mathematics teachers. This study's readability test involved three students with different mathematical abilities: high, medium, and low. The observer consists of three people who are students of mathematics education. Learning indicators developed in elements, nets, surface area, and tube volume.

The data collection technique in this study provided a validation sheet of learning tools to validators, provided observation sheets of teacher and student activities to observers, provided teacher and student response sheets, provided readability test sheets to three students, and final student test questions to all students in the experimental class and control class. This study uses control classes to determine the effectiveness of learning devices using t-test analysis.

The data were analyzed by calculating the average score of the assessment of the three validators from the learning device validation sheet that has been given. In determining the validity of learning devices, this study used the assessment classification of the validity of learning tools proposed by Pattimukay (2009) in Table 1 below.

Table 1. Classification of assessment of the validity of learning tools

Average Score	Classification
$1 \leq R_s < 1.5$	Bad
$1.5 \leq R_s < 2.5$	Not good enough
$2.5 \leq R_s < 3.5$	Good
$3.5 \leq R_s < 4$	Very good

Learning tools are likely valid if the classification of each validated device meets the minimum classification. The data on the results of teacher and student activities during learning were analyzed by calculating the average value of the implementation of teacher and student activities from the observation sheets that the three observers had filled in. To find out the classification of the percentage of teacher and student activity proposed by Pattimukay (2009) can be seen in Table 2 below.

Table 2. Percentage classification of teacher/student activity

Percentage	Classification
$80\% \leq A_{t/s} \leq 100\%$	Very high
$70\% \leq A_{t/s} < 80\%$	High
$60\% \leq A_{t/s} < 70\%$	Medium
$50\% \leq A_{t/s} < 60\%$	Low
$0 \leq A_{t/s} < 50\%$	Very low

The activities of teachers and students in the learning process are said to be effective if the percentage of learning implementation based on teacher and student activities is ≥70%; if the teacher and student activities are <70%, then revisions are considered. Data on the response of teachers and students to the learning process in the classroom were analyzed by calculating the average score of the teacher and student response questionnaire filled out by them after participating in learning for four meetings. Learning tools are said to be practical if the percentage of positive responses from teachers and students is at least 70% in the agree and strongly agree categories (Pattimukay, 2009). This study analyzed unpaired samples using a t-test to determine the effectiveness of learning devices. This t-test analysis was carried out on the learning outcomes of students who used learning tools that had been developed with student learning outcomes compared to classes that did not use learning tools developed by researchers. Before the t-test analysis is carried out, a prerequisite normality test is first carried out using the Lilifors test and a homogeneity test using the Levene Test.

Thus, the learning tools developed are valid if each validated device's classification meets the minimum classification of good (Pattimukay, 2009). Moreover, the practical results of teacher and student responses are positive, with a percentage of teacher and student responses > 70% (Pattimukay, 2009; Trilaksono et al., 2018), and is effective if the value of sig. <0.05 (Jusmawati et al., 2015), or H0 is rejected and H1 is accepted.

Results

The results of the research and development carried out are presented in two parts. First, how to develop geometry learning in the form of realistic mathematics education (RME) based learning tools in the context of crazy bamboo dance assisted by GeoGebra classroom in the form of learning implementation plans, teaching materials, and student worksheets. Second, the learning tools' quality includes validity, practicality, and effectiveness.

Development of learning tools

Defining stage

The defining stage consists of five stages: front-end analysis, student analysis, task analysis, concept analysis, and specific learning objectives. The explanation of the five steps is as follows. First, Front-end Analysis: At this stage, the identification of the problems faced by mathematics teachers at SMP Negeri 9 Ambon, especially class IX mathematics teachers, was carried out. The results of this initial analysis obtained that the learning process in the GeoGebra classroom is still centered on the teacher. On the other hand, the use of textbooks provided by the school is the only teaching material used in the learning process, so most students tend to do irrelevant things during the learning process. It shows that the teacher uses one of the ready-to-use learning tools and does not use learning media.

Second, Student Analysis: The students analyzed were class IX-14 students of SMP Negeri 9 Ambon for the 2022/2023 School Year. The results of the student analysis showed different or heterogeneous cognitive abilities of these students. On the other hand, the prerequisite material for studying the tube material they have already learned before. Based on interviews with students, the information was obtained that there has never been learning based on the RME approach assisted by GeoGebra classroom. So it can be said that RME-based learning in the context of crazy bamboo dance assisted by GeoGebra classroom is new for students and teachers.

Third, Concept Analysis: In the concept analysis activity, researchers and teachers identify and formulate the primary material for students so that the material to be taught in this study is material for building curved side rooms in the form of tubes according to the 2013 curriculum in grade IX junior high school. Fourth, Task Analysis: In the task analysis activity, the researcher and the teacher describe the tasks that students can learn or complete. These tasks include tube elements, tube nets, tube surface area, and tube volume, and Fifth, Specification of Learning Objectives: From the results of the analysis of concepts and tasks, it can be formulated the specification of learning objectives on the material to build the curved side room in the form of a tube, namely Basic Competencies, and Competency Achievement Indicators.

The core competencies and indicators of competency achievement at each meeting are presented in Table 3 below.

Table 3. Specification of learning objectives

Meeting	Learning Objectives
I	Through the process of observing, questioning, collecting information, processing information, and communicating the results of processing information in individual and group assignments, students can: 1. Determining the elements of the tube 2. Determining the tube nets
II	Through the process of observing, questioning, collecting information, processing information, and communicating the results of processing information in individual and group assignments, students can: 1. Determine the tube surface area formula 2. Calculating the surface area of the tube

Meeting	Learning Objectives
III	Through the process of observing, questioning, collecting information, processing information, and communicating the results of processing information in individual and group assignments, students can: 1. Determine the tube volume formula 2. Determine the tube volume formula
IV	Through the process of observing, questioning, collecting information, processing information, and communicating the results of processing information in individual and group assignments, students can: 1. Solving contextual problems related to the surface area of the tube 2. Solving contextual problems related to tube volume

Design stage

The design stage consists of three stages that are carried out, namely, media selection, format selection, and initial design. First, Media Selection Results: The selection of media used in the learning process of RME-based geometry assisted by GeoGebra software on the material to build the curved side room in the form of tubes, namely images and videos of crazy bamboo dances, GeoGebra classrooms, computers/laptops/handphones, LCD projectors, sincere boards, erasers, and markers. Second, Format Selection Results: The selection of formats to be developed in this study is a learning structure in the form of a learning implementation plan (LIP), teaching materials (TM), and student worksheets (SW). They are adjusted to the steps and characteristics of the RME approach in the context of crazy bamboo dance assisted by the GeoGebra classroom.

Third, Initial Design: At this stage, the initial design of learning tools in LIP, TM, and SW was welcomed for four meetings. All results at this stage are called draft I, which can be described as follows: (a) Learning Implementation Plan (LIP). The LIP developed is based on the characteristics and steps of the RME approach to the context of the crazy bamboo dance assisted by GeoGebra classroom on the activities of teachers and students, (b) Teaching Materials (TM). The TM developed for students was created in the GeoGebra classroom for four meetings. As for bamboo made on the RME-based GeoGebra classroom context of crazy bamboo dance on tube material, and (c) Student Worksheet (SW). Like TM, SW was developed for students to use and created in the Geogebra classroom for four meetings. The SW is also blinded to the RME-based GeoGebra classroom context of crazy bamboo dance on tube material that is adapted to the learning objectives to be achieved by students.

The distribution of the initial design of the learning tools developed for each meeting is presented in Table 4.

Table 4. Initial design results

Learning Tools	Meeting	Time Allocation	Learning Materials	Achievement Indicators Competence
LIP, TM, and SW	First	2 x 40 minute	Elements and tube nets	1. Determining the elements of the tube 2. Determining the tube nets

Learning Tools	Meeting	Time Allocation	Learning Materials	Achievement Indicators Competence
	Second	3 x 40 minute	Tube surface area	1. Determine the tube surface area formula 2. Calculating the surface area of the tube
	Third	3 x 40 minute	Tube volume	1. Determine the tube volume formula 2. Determine the tube volume formula
	Fourth	2 x 40 minute		1. Solving contextual problems related to the surface area of the tube 2. Solving contextual problems related to tube volume

Development stage

At this stage of development, expert validation, readability testing, and learning device trials are carried out. Expert validation is carried out by one Mathematics Education lecturer and two junior high school mathematics teachers to validate learning tools in general and in each LIP, TM, and SW. Teachers and students carried out the readability test. At the same time, the trial of learning tools was carried out through the number of meetings designed. At the end of the learning, four final tests were carried out on students. The final test results in students of this experimental class will be matched with the test results in the control class to determine the effectiveness of the learning tools developed. The results of expert validity, readability tests, and device trials are described as follows: (1) Validator Assessment Results. At this stage, expert validation was carried out by three experts consisting of one lecturer of Mathematics Education at FKIP Pattimura University (CM), one mathematics teacher at SMP Negeri 3 Ambon (MS), and one mathematics teacher at SMP Negeri 9 Ambon (FW). The results of expert validation include a general assessment of learning tools and validation of each LIP, TM, and WS. The evaluation of the three validators on learning devices (draft I), presented in Table 5, follows.

Table 5. Validator general assessment of learning tools

Validated devices	Xv	Classification
LIP	3.7	Very good
TM	3.7	Very good
SW	3.7	Very good
Average score (As)	**3.7**	**Very good**

Based on the table above, the average LIP assessment score of 3.7 was obtained, the average TM assessment was 3.7, the average SW score was 3.7, and the average general score against learning devices was 3.7. The results of LIP validation by the three validators are presented in Table 6 below.

Table 6. LIP validation results

Aspects	Xv	Classification
LIP Format	3.8	Very good
Prerequisite Materials	3.8	Very good
Subject Matter	4	Very good
Assessment	3.7	Very good
Learning Activities	3.9	Very good
Language and Writings	4	Very good
Time Allocation	4	Very good
Benefits/Uses of LIP	4	Very good
Average score (As)	**3.9**	**Very good**

Based on Table 6, the average validator assessment of the LIP was processed to be very good. It shows that the LIP developed is very good in the format of LIP, prerequisite material, subject matter, assessment, learning activities, language and writing, time allocation, and the usefulness of LIP can be used in learning geometry on tube material. From the results of the LIP validation of each validator, there is a suggestion from the CM validator, namely, to create a guide for teachers and students containing examples of making problems and solving problems using the GeoGebra classroom. Based on these suggestions, the researchers added a GeoGebra classroom user guide for students and teachers.

The results of validation against TM by the three validators are presented in Table 7 below.

Table 7. TM validation results

Aspects	Xv	Classification
TM Format	3.6	Very good
Contents of TM	3.6	Very good
Language and Writings	3.5	Very good
Illustrations, Image Layout, and Graphics	3.7	Very good
Benefits/Uses of LIP	3.3	Good
Average score (As)	**3.5**	**Very good**

Based on Table 7, the average validator assessment of TM in the four aspects, namely TM format, contents of TM, language, writings, illustrations, images layout, and graphs, got a very good category, while in the aspect of the benefits of teaching materials got a good category. Thus, when viewed from the overall average of the TM developed, it gets a score of 3.5 with a very good category and can be used in learning geometry on tube materials. From the results of TM validation by each validator, suggestions are given for determining the image code used in teaching materials and the learning process with the GeoGebra classroom. These suggestions are presented in Table 8 below.

Table 8. Revision of teaching materials validation results

Revised Aspects	Revision based on the validators' suggestion
Image code specifier on TM 02	1. Figure a. Definition of Bamboo 2. Figure b. Bamboo Shape
Figure 1 on TM 04	1. The words "Fanta" were replaced with fresh Drink 2. The brand "Fanta" is made blurry 3. The use of images is made a diverse problem

Based on the suggestions of these validators, revisions were made to both the typing of the image code and the brand that was avoided in using the image. The validation results against SW by the three validators are presented in Table 9 below.

Table 9. SW validation results

Aspects	Xv	Classification
SW Format	3.4	Good
Contents of SW	3.9	Very good
Language and Writings	3.6	Very good
Illustrations, Image Layout, and Graphics	3.4	Good
Benefits/Uses of LIP	4	Very Good
Average score (As)	**3.7**	**Very good**

Based on Table 9, the average validator assessment of SW was obtained in three aspects, namely contents of SW, language, and writings, and the usefulness of SW got a very good category. In contrast, image layout and graphics got a good category in SW format and illustrations. Thus, when viewed from the average of the overall SW developed, it gets a score of 3.7 with an excellent category, and SW can be used in geometry learning on tube material. From the results of SW validation by each validator, there are suggestions related to letter determination and the use of SW in the GeoGebra classroom. These suggestions are presented in Table 10 below.

Table 10. SW Revision based on revised results

Revised aspects	Revisions based on validator suggestions
Determination	Enlarged font size
SW on GeoGebra classroom	Created GeoGebra classroom user guide

The readability test by the teacher (AS) and three students (FL, IS, and FP) found that there were no words, sentences, or terms that needed to be understood. Moreover, based on the readability test results from each validator's validation results (draft II), it would then be used for trials of learning tools in the learning process in the GeoGebra classroom (field trials). The results of partner teacher activities on learning tools carried out by observers (RN) during four meetings are seen in Table 11 below.

Table 11. Teacher activity observation results

Meeting	Learning Implementation (%)
I	100
II	83.3
III	100
IV	91.7
Average score (%)	**93.8**

Based on Table 11, the average percentage of teacher activity at meeting I was 100%, meeting II was 83.3%, meeting III was 100%, meeting IV was 91.7%, and the average percentage of teacher implementation acts as a whole of 93.8%. The results of student activities on learning tools carried out by observers (JN, ST, and EPL) to five groups during four meetings are seen in Table 12 below.

Table 12. Student activity observation results

Meeting	Learning Implementation (%)
I	87.83
II	86.00
III	89.67
IV	84.78
Average score (%)	**87.07**

Table 12 shows the percentage of student activity implementation at meeting I at 87.83%, meeting II at 86%, meeting III at 89.67%, meeting IV at 87.07%, and the average percentage of implementation of student activity as a whole of 87.07%. Based on the filling of the teacher's response questionnaire to the RME-based geometry learning device in the context of crazy bamboo dance assisted by GeoGebra classroom. The average percentage of teacher and student responses to learning tools (LIP, TM, you SW) is presented in Table 13 below.

Table 13. Teacher and student response results

Subject	**Teacher's Response (%)**			
	Strongly Agreed	**Agreed**	**Disagree**	**Strongly Disagree**
Teacher	81.8	18.2	0	0
Student	88.9	11.1	0	0

Based on Table 13, it was obtained that the average percentage of teacher responses for the strongly agreed category was 81.8% and for the agreeing category was 18.2%. While in the disagree and strongly disagree categories, the average percentage of teacher responses was 0%. The average percentage of student responses in the strongly agreed category was 88.9%, and in the agreeing category was 11.1%. The average percentage of student responses in the disagree and strongly disagree categories was 0%.

Student learning outcomes are obtained by giving tests to students after learning for four meetings. In this study, the learning process and tests were carried out in experimental and control classes. In the experimental class, in this case, class IX-7 used an RME-based learning device in the context of crazy bamboo dance assisted by the GeoGebra classroom. While the control class, in this case, class IX-14, used a cooperative learning model. The normality test is used to determine whether the student's learning outcomes in both classes are normally distributed or not. The normality test in this study used the Lilifors Test with the help of SPSS 26. The results of the experimental and control class normality test are presented in the following Table 14.

Table 14. Normality test results

Class Type	Sig.	α	Conclusion
Experiment	0.095	0.05	Receive H_0
Control	0.200	0.05	Receive H_0

Based on Table 14, obtained for the experimental class, the sig value by 0.095 and the control class by 0.200. The Sig value for both classes is greater than the value of α=0.05 thus that both classes are normally distributed. The homogeneity test determines whether the two classes' data are homogeneous. The homogeneity test in this study used the Levene Test with the help of SPSS 26. The results of the homogeneity test are presented in Table 15 below.

Table 15. Homogeneity test results

Class	Sig.	α	Conclusion
Experiment and Control	0.055	0.05	Receive H_0

Based on Table 15, the sig value obtained. by 0.055 is greater than the value of α=0.05 thus that the combined data of the two classes are homogeneous. The hypothesis test is used to determine whether the two classes' learning outcomes have differences. This aims to evaluate the effectiveness of learning tools after being tested. If there are differences in student learning outcomes, then it is said that the developed devices are effective. Test the hypothesis in this study using the t-test of free samples with the help of SPSS 26. The results of the t-Test are presented in the following Table 16.

Table 16. T-test results

Class	Sig.	α	Conclusion
Experiment and Control	0.000	0.05	Reject H_0

Based on Table 16. it is obtained that the sig value of 0.000 is less than the value of α=0.05. This shows that H_0 is rejected; in other words, there are differences in student learning outcomes in experimental and control classes.

Referring to the results of research and data analysis presented in the previous section, the quality of learning tools can be detailed, including the validity, practicality, and effectiveness shown in Table 17 below.

Table 17. Quality of learning tools

Aspects	Criterion		Achievements	Decision
Validity	Average validator rating (x) "**Minimal Good**"	$Rs \geq 2.5$	LIP: 3.9 (Very good) TM: 3.5 (Very good) SW: 3.7 (Very good) General Assessment: 3.7 (Very good)	**Valid**

Aspects	Criterion		Achievements	Decision
Practicality	Percentage of positive responses from educators and learners	$Pr \geq 70\%$	Teacher: 81.8% Student: 88.9%	**Practical**
Effectiveness	T-test	$Sig < \alpha$	$0.000 < 0.05$ (there is a difference)	**Effective**

Discussion

Development of geometry learning with realistic mathematics education context of crazy bamboo dance assisted by GeoGebra classroom

In this study, geometry learning is intended to develop learning tools like LIP, TM, and SW. The development model used is 4-D, but it is limited to the development stage. The initial phase of the defining part carried out by the researcher is the final preliminary analysis. The purpose of the initial definitive study was to identify the learning problems faced by teachers at SMP Negeri 9 Ambon and discuss with teachers about crazy bamboo dances and GeoGebra classrooms that have never been used in the learning process, even though the use of mathematical software acts as a catalyst will have several positive impacts, including work to be more effective, precise, and efficient (Nur'aini et al., 2017). The context of crazy bamboo dance is a culture that students often encounter at SMP Negeri 9 Ambon, so it is used as a context for studying tubes. Ranti (2022) states that mathematics learning is associated with students' condition; the daily environment and the previously owned provisions will be more enjoyable learning. In the next stage, the researcher conducts a concept analysis, task analysis, and learning objective specifications, so that the material to be used is obtained, namely building a curved side room in the form of a tube.

At this stage, researchers chose media and formats in designing learning tools that include LIP, TM, and SW according to the needs of RME-based geometry learning in the context of crazy bamboo dance assisted by GeoGebra classrooms. Selecting suitable media for learning results in high motivation and can positively impact student learning outcomes (Rosiyanti et al., 2020). After selecting media and formats, researchers began to design learning tools. The design of LIP, TM, and SW are based on the characteristics and steps of RME, namely using real-world contexts, models, student contributions, interactivity, and interrelationships (Sholihatun et al., 2021) with the help of GeoGebra classroom.

At the development stage, learning tools, readability tests, and learning device trials are validated to obtain valid learning tools (Widiyasari et al., 2020). After analyzing the results of the validator assessment and meeting the validity criteria with a slight revision, a readability test was carried out on partner teachers and three students with high, medium, and low abilities. The readability test results show that all learning tools, namely LIP, TM, and SW, are understood. Furthermore, a trial of a learning device was carried out in class IX-7, which was a sample in this study through a sample selection process. Mathematics learning on tube material is also carried out in class IX-14 as a control class to determine the effectiveness of learning devices later. After four learning meetings, tests were carried out in classes IX-7 and IX-14 to assess student learning outcomes.

Quality of learning tools which include validity, practicality, and effectiveness

Learning tools are a preparation prepared by the teacher so that the implementation and evaluation of learning can be carried out systematically and obtain the desired results (Sinaga, 2020). It shows that learning tools are the most important thing teachers must prepare. To get the desired results or the achievement of learning by students, the primary thing that the teacher must consider is the validity of the learning device so that in the process of developing learning devices, the criteria for validity cannot be separated. It is reinforced by the opinion of Rohati (2015). That the learning tools developed must meet valid standards, this is intended to ensure that learning devices have the validity of content and construction. The results of the validity of the RME-based geometry learning device context of crazy bamboo dance assisted by GeoGebra classroom on the tube material after being developed meet the criteria for validity.

The criteria for the practicality of learning device tools are determined based on the positive responses of educators and learners who must achieve a score of >70%. Learning tools used by students and teachers must make learning activities in the classroom more active and run smoothly. Prasetyo et al. (2013) also state that a learning device is a tool or equipment to carry out processes that allow teachers and students to carry out learning activities. From the learning process four times, the percentage of activities and responses from teachers and students was obtained by more than 70%, meaning that the learning tools developed were practical in classroom learning.

In this study, the criteria for the effectiveness of the device were seen based on the results of the t-test for student learning outcomes in the experiment and control classes using a cooperative learning model. Based on the t-test result, the value of the sig. of 0.000 is less than the value of α=0.05. It means that there is a difference in the learning outcomes of students of the experimental and control classes on the tube material.

The t-test result also showed that mathematics learning for tube materials in experimental classes was better than learning in control classes. Using the RME approach in a crazy bamboo dance context provides a learning experience for students closer to daily life. According to Shoimin (Ranti, 2022), real problems that correspond to the environment and characteristics of students can be used as a starting point for the development of mathematical ideas and concepts. On the other hand, using GeoGebra classrooms in learning creates more interactive learning. The GeoGebra classroom is exciting and provides a new experience for students in learning mathematics (Sutopo & Ratu, 2022).

The results of previous research also support the results of this study, including research conducted by Nursyahidah and Albab (2021) showing that mathematics learning with the context of putu cakes with the help of GeoGebra classroom helps students understand the relationship between surface area, height, and radius with tube volume. The results of research by Nuswantari (2020) show that RME-based learning assisted by GeoGebra software has met the criteria for effectiveness and can improve students' ability to solve mathematical problems.

The results of research by Nurlisna and Subianto (2020) showed that as many as 24 students out of 28 existing students obtained learning outcomes that met the standards of completion, or around 85% of students received complete learning outcomes using SW based on the RME approach with the help of GeoGebra software that had been developed.

Previous studies showed no research on developing learning tools that use traditional dances integrated with GeoGebra classrooms. So this development research with the crazy bamboo dance combined with GeoGebra is new research that has been carried out.

Conclusion

This research produced a realistic mathematics education based on the tube material in the context of crazy bamboo dance assisted by the GeoGebra classroom. They are classified as valid, practical, and effective in learning implementation plans (LIP), teaching materials (TM), and student worksheets (SW) using a 4-D model modification development model until the development stage.

The researchers advise teachers or prospective teachers to design culture-based mathematics learning tools that are integrated with mathematics software so that classroom learning becomes more interactive. The limitations of this research are that development research only reaches development and has yet to reach the spreading stage.

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Conflicts of Interest

The authors declare no conflict of interest regarding the publication of this manuscript. In addition, the ethical issues, including plagiarism, misconduct, data fabrication and/or falsification, double publication and/or submission, and redundancies, have been completed by the authors.

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Author Contributions

Wilmintjie Mataheru: Conceptualization, writing - original draft; **Theresia Laurens:** Formal analysis, and methodology; **Sisilia Marcelina Taihuttu:** Validation and supervision.

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