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Uno stacko based on realistic mathematics: A developing learning media of trigonometry

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Abstract. This research aimed to develop a media uno stacko mathematics based on a realistic mathematical approach to improve students' understanding of mathematical concepts. The development model used was ADDIE with the pretest and posttest research designs in the control and experimental classes. The instruments used in this study were documentation, tests, and questionnaires. The analysis showed that students have problems in understanding the concepts and need engaging learning media. Then we think to design a media uno stacko mathematics. After that, media and learning tools that have been made subsequently validated by media experts, material experts, and learning design experts, each of whom with an average validation result in the very high category. In its implementation in the field shows that this media is effectively used for learning by obtaining an average N-Gain in the experimental higher than the control class with a significant difference. Furthermore, the practicality questionnaire showed that the media unomat based on a realistic approach to practical mathematics was used to obtain very good results. Based on data obtained, it was concluded that the uno stacko mathematics media was valid, effective, and practical.

1. Introduction

Science is currently advancing—similarly, the science of technology, which is increasingly advanced and rapidly following the times. Especially in the era of globalization, emerging competition in various sectors of life that is being experienced, one of which is competition in the field of Science and Technology (Science and Technology). With the development of science and technology also affects the learning process in which teachers are required to be able to keep abreast of the times. It is hoped that this will form professional teachers through government programs. The government's desire to be able to improve the quality of education through the professionalism of teachers still programs is not in line with what is expected [1]. New methods are introduced and used to make learning more memorable and meaningful [2].

Implementation of appropriate and useful learning is one of the formal education in Indonesia. The learning process is as comfortable as possible and as much as possible so that both teachers and students can both get the maximum results both in teaching and learning outcomes received by students when learning in class. An essential factor in the implementation of learning is students themselves. Students must have motivation or enthusiasm to follow the teaching itself because motivation plays a vital role in influencing learning and achievement [3].

One of the problems students have when learning mathematics is the difficulty of students in understanding mathematical concepts. Each student has different characteristics with other students in

understanding mathematical concepts that include the reception, organizing, and processing of information received [4]. The mathematics teacher at SMAN 1 Juwana gave information that most of the students did not understand mathematical concepts. Students only understand type 1. But he still didn't understand a type 2 question that is almost similar. He could not provide other examples besides the ones already exemplified. That's the way most problems are experienced by students when learning in class. Mathematics is meaningless if only memorized. The first thing that must be mastered is the concept because understanding concepts is a type of learning outcome that is higher than knowledge [5]. According to Suraji [6], a realistic mathematical approach has three indicators, namely 1) Restate a concept and classify objects according to the concept, 2) Present concepts in forms in various forms of mathematical representation, and 3) Use, utilize, and choose specific procedures or operations and apply the concept. Concept understanding is not only knowing the definitions and rules in mathematics, but concept knowledge must be done by abstracting and generalizing specific examples [7].

So that the quality of learning can improve, teachers must be able to pay more attention to the components of learning, one of which is learning media. Learning media can be used as a learning resource in addition to learning materials because it is a type of information that can be used by students to solve problems [8]. According to Divjak [9] said that one of the suitable media is game media because games are the best motivation for learning and doing activities. Uno-Stacko is a deconstructive game using colored blocks, which have symbols and numbers on the sides. The game starts when the blocks are neatly arranged and stacked, and then released one by one according to specific rules. The game ends when the pile of blocks collapses [10]. Uno means one, while the principle of this game is to equalize colors or numbers so that the Uno Stacko game is a game consisting of blocks that prioritize the equality of colors and numbers printed on the blocks [11]. Uno Stacko is a learning media in the form of a game so that it can increase the motivation of students. In the media, some questions must be made by students to increase the responsibilities of students [12].

In learning, which will later use Uno Stacko Mathematics media, the approach to be used is a realistic mathematical approach. In learning, mathematics must use the experiences possessed by students so students must be actively involved when the learning is ongoing. Because according to (Ministry of National Education, 2003), the principles of learning are centered on the students themselves, learning by doing, developing curiosity, and lifelong learning (long-life education). Therefore, one approach that can be used to make students actively participate during learning is the realistic mathematics approach. The goal of a realistic mathematics approach is to make mathematics learning more exciting and meaningful for students by introducing lessons through contextual problems where the problem lies in the students' knowledge and experience [13]. RME can also help students develop comprehensive, unique concepts in mathematics and apply mathematical concepts to new fields and real-world problems [14].

The Realistic Mathematics approach to learning mathematics, the process is more on understanding concepts than the context in which they are used [15]. The characteristics of a realistic mathematical approach are: 1) Can produce contextual and realistic problems when in class, 2) Learning is developed from the easy to the difficult, 3) Learning can provide or provide media that is concrete, and 4) This learning approach allows students to be able to rediscover mathematical concepts, not only from the teacher's explanation.

From previous research that has been done, the development of Uno Stacko Mathematics media with a realistic mathematical approach with the aim of the problems experienced by students can be overcome to improve the ability to understand mathematical concepts in learning mathematics. The material in this study was a comparison of trigonometry in the right angles. The research model that will be used in this study is the ADDIE model, which has five stages, namely Analysis, Design, Development, Implementation, and Evaluation. The five phases must be done systematically [16].

Based on the description above, it can be concluded that we need a learning media that can be used by teachers to make learning better than before. So it can be supposed that researchers will research the title "Uno stacko mathematics for students: Mathematical concepts in a realistic approach." This

research was conducted to determine whether the uno stacko mathematics media is a valid, practical, and effective media.

2. Methods

In this study, the population used was students from SMA 1 Juwana. Samples taken came from two classes chosen randomly, namely class X IPS 2 as an experimental class and class X IPS 3 as a control class. This study was conducted from May 6-21, 2020 at the researcher's home by taking each class of 15 students. It was all caused by the impact of the COVID-19 virus that made schools closed.

The research method used in this research is the research and development method, or in English, it is called Research and Development (R&D). According to [17], research and development methods can be interpreted as a scientific way to research, design, produce, and test the validity of products that have been created. The research model used is the ADDIE development model. The ADDIE development model consists of 5 main stages, namely, Analysis, Design, Development, Implementation, and Evaluation. According to [16], the five steps must be carried out systematically as follows.

2.1. Analysis

The analysis phase is used to analyze problems related to mathematics learning that occurs in schools at this time. There are several analyzes conducted, including the analysis of student needs, curriculum analysis, and material analysis. These problems can be overcome by providing attractive and effective media so that later it can improve the understanding of concepts possessed by students.

2.2. Design

The design phase is carried out to compile learning tools that will be carried out in research, such as syllabus, lesson plans, and materials that refer to the 2013 curriculum. In addition, do not forget to design and design a media uno stacko mathematics based on a realistic mathematical approach.

2.3. Development

This development phase is carried out to test the feasibility of a media uno stacko mathematics (unomat) based on a realistic mathematical approach. This feasibility test was conducted by three experts, namely media experts, material experts, and learning design experts. Suggestions and criticisms given by experts can be used as consideration for making improvements or revisions to the media.

2.4. Implementation

After experts have validated the media, the next step is the trial phase. Researchers conduct learning directly to the experimental class so that later the purpose of this study will be seen to improve students' understanding of mathematical concepts.

2.5. Evaluation

The last stage is the evaluation stage, wherefrom this stage. It will be known whether the media uno stacko mathematics based on a realistic mathematical approach is appropriate for general use or not. To assess this feasibility, the researchers used a practicality questionnaire given to the experimental class.

According to Sugiyono [17], data collection is carried out through several settings, sources, and various ways. In this study, data collection techniques were taken through documentation, tests, and questionnaires. This documentation can be in the form of photographs, while the research is in progress. Then the tests used are pretest and posttest. The pretest is done before the study, while for the posttest is done after the research. The questionnaire used was a questionnaire for experts, namely media experts, material experts, as well as learning design experts, and there was also a practical questionnaire given to students.

Then there are the data analysis techniques. Data analysis is a way of processing research data to get a conclusion. This data analysis is performed to test the hypotheses that have been set for later conclusions drawn to achieve research objectives. Data analysis is divided into two, namely initial data

analysis and final data analysis. Initial data analysis consisted of a normality test, a homogeneity test, and a two-party t-test. Then, the final data analysis consists of a normality test, homogeneity test, one-party t-test, and N-Gain test.

3. Result and discussion

This research uses research and development (R&D) research methods. The ADDIE development model consists of 5 stages, namely, Analysis, Design, Development, Implementation, and Evaluation. Analysis of students' needs is done through direct observation at SMA 1 Juwana to collect data about what is needed by students during the mathematics learning process. Lack of learning media that is interesting is one of the problems when learning. Even though they have used the 2013 curriculum, the conventional learning model is still being carried out. The traditional model of learning that is usually used makes students feel less excited when participating in the learning activities themselves. A media is needed that can foster student enthusiasm so that later, students will be enthusiastic when participating in learning. That way, if students are passionate about learning automatically, the goal of learning will be achieved in this case is to foster an understanding of concepts in students. With the results of observations that have been made, the researchers developed Uno Stacko Mathematic based on the Realistic Mathematics Approach to be able to increase student enthusiasm during learning and also improve the ability to grasp concepts owned by students.

The media used is adapted to the material to be taught, namely the trigonometric comparison material on right triangles precisely in class X semester 2. Uno Stacko Mathematics is a game consisting of blocks arranged upward, which the sides, in this case, contain about Trigonometry material is about particular angles, and there are also dice and cards to play this Uno Stacko Mathematics game. The Uno Stacko Mathematics Card has questions about understanding concepts in the trigonometric comparison material on right triangles so that it is expected that students' mathematical concept understanding abilities can be improved. In addition to preparing the media, researchers also designed learning tools in the form of syllabi and lesson plans that refer to the 2013 curriculum on trigonometry material.

After the media, learning materials, and tools are finished, the next step is validation. Validation includes validation of media experts, validation of material experts, and validation of learning design experts. Each validation has two validators where the validator for media validation comes from a lecturer in information technology education at the PGRI University in Semarang and the second expert is a mathematics teacher from SMA Negeri 1 Juwana. Whereas the validator for the material expert and the learning design expert both have two validators where one validator is from the mathematics education lecturer at PGRI Semarang University and one validator is from the mathematics teacher of SMA 1 Juwana.

From the three validations, the advantages and disadvantages of the media that have been made will be known. If there are suggestions and criticisms, they will be considered to revise Uno Stacko Mathematics media. After being fixed, it will produce media that is feasible and ready to be used for learning. The results of the validation that has been done can be seen in table 1.

Table 1. Expert validation results.

Validator	Media Validation	Material Validation	Learning Design Validation
1	64	51	39
2	64	52	35
Total Score	128	103	74
Score Maksimum	150	120	80
Percentage	85.3%	85.8%	92.5%
Criteria	Very good	Very good	Very good

From table 1 can be concluded that the Uno Stacko Mathematics based realistic mathematical approach is valid and feasible to use for research in very good categories where successive percentages of media validation, material validation, and learning design validation are 85.3%, 85.8%, and 92.5%.

The next stage is the implementation or trial phase, which is a continuation of the development phase. After the product has been made valid and is feasible to use, the researcher embodies it directly by applying the Uno Stacko Mathematics based mathematics-realistic approach to learning in the classroom now in the experimental class. Researchers will guide students to achieve learning objectives, namely improving students' understanding of concepts. In the trial, there are two data analyzes, namely initial data analysis and final data analysis. Initial data analysis was performed using 15 student pretest data in both the experimental class and the control class. In the initial data analysis, there is a normality test, a homogeneity test, and a two-party t-test. The results of the initial data analysis can be seen in table 2.

Table 2. Preliminary data analysis.

Test	Experimental class	Control class
Normality	0.181	0.202
Homogeinity	1.045	
Two-party t-test	−0.6377	

From table 2, it can be seen that the normality test of the experimental class and the control class are 0.181 and 0.202, respectively. The table of normality test above is 0.220. So it can be concluded that the population of both classes is normally distributed because Lo < L_table is 0.181 < 0.220 and 0.202 < 0.220. For the homogeneity test with the calculation of the similarity test of two variants obtained F_count = 1.045. At the same time, the value of F_table = 2.48, so it can be concluded that the data is homogeneous because F_count < F_table is 1.045 < 2.48. For the two-party t-test obtained t-count = -0.6377 and t-table = 2.0484, so it can be concluded that the average learning outcomes of the two classes are the same (no difference) because of t-count < t-table.

After completing the initial data analysis calculation, a final data analysis calculation is performed—final data analysis using 15 students' posttest data both from the experimental class and the control class. In the final data analysis, there are normality tests, homogeneity tests, and one-party t-tests, and there is also an N-gain test. The final data analysis can be seen in table 3.

Table 3. Final data analysis.

Test	Experimental class	Control class
Normality	0.132	0.210
Homogeinity	1.116	
One party t-test	2.4052	

From table 3, it can be seen that the normality test of the experimental class and the control class are 0.132 and 0.210, respectively. The table of normality test above is 0.220. So it can be concluded that the population of the two classes is normally distributed because Lo < L_table is 0.132 < 0.220 and 0.210 < 0.220. For homogeneity test with the calculation of the similarity test of two variants obtained F_count = 1.116, while the value of F_table = 2.48 so it can be concluded that the data is homogeneous because $F_o < F_{table}$ is 1.116 < 2.48. For the one-party t-test obtained t_count = 2.4052 and t_tabel = 1.7011, so it can be concluded that the average student learning outcomes using uno stacko mathematics (unomat) media based on the Realistic Mathematics approach are better than the average student learning outcomes by using conventional learning because t_count > t_table is 2.4052 > 1.7011.

Then to calculate the effectiveness of increasing students' understanding of mathematical concepts, the N-Gain test is calculated. There are three indicators that exist in understanding the concept. The examples of student answers from each indicator can be seen in figure 1 and figure 2.
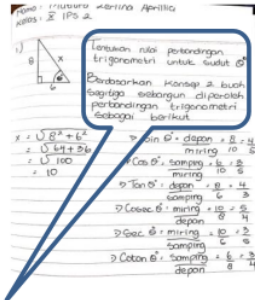
Determine   the   trigonometric comparison value for the angle.

Based on the concept of 2 similar triangles, the following trigonometric comparisons are obtained

Figure 1. Examples of answers to indicator height indicators 1 form high criteria.
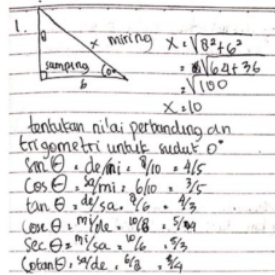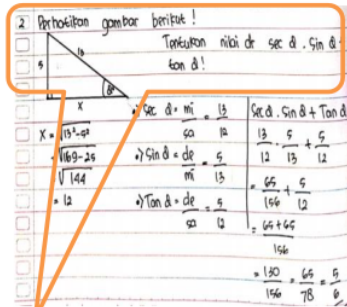
Figure 2. Examples of answers to criteria being indicator 1 from medium crteria.

In figure 1 shows that students know that the concept of trigonometric comparison comes from the idea of two similar triangles so that the understanding of the concept has high criteria. Figure 2 shows that students can only do it directly, not writing comes from the idea of whether the comparison of trigonometry so that the understanding of the idea is moderate. Furthermore, an example of a student answer in indicator two can be seen in figure 3 and figure 4.

consider the following picture! Determine the value of sec $\theta \cdot$ sin θ + tan θ !

Figure 3. Examples of answers to indicator height indicators 2 from high criteria.
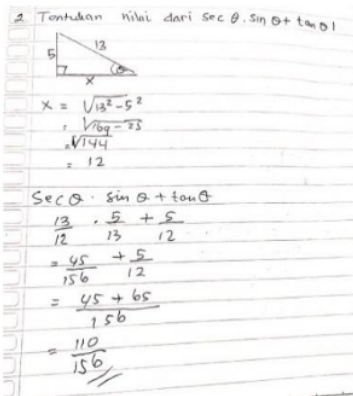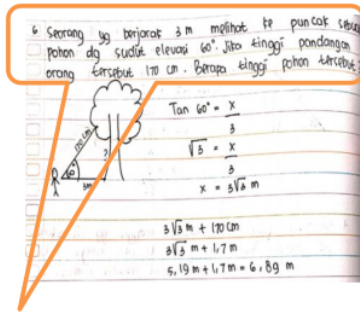
Figure 4. Examples of answers to criteria being indicators 2 from medium criteria.

In figure 3 question is shown that students write the answers to trigonometric problems correctly and coherently from a triangle image so that the understanding of the concept is of high criteria. Figure 4

shows that students can write the idea correctly but with the wrong answer results so that the understanding of the idea is moderate. Furthermore, an example of a student answer in indicator three can be seen in figure 5 and figure 6.

a person who is 3m away looks at the top of a tree with an elevation angle of $60°$. If the person's height is 170cm. How tall is the tree!

Figure 5. Examples of answers to indicator height indicators 3 from high criteria.
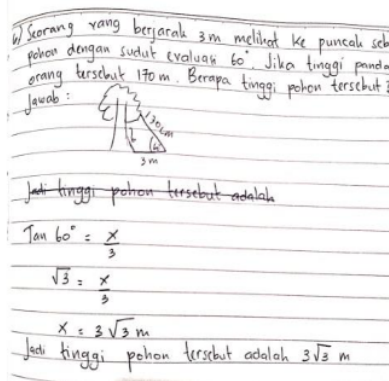
Figure 6. Examples of answers to criteria being indicators 3 from medium criteria.

In figure 5 shows that students know the concept of trigonometric comparisons in daily life by writing down the answers correctly where after the x results are known, it adds to the height of the person so that understanding of the concept has high criteria. Figure 6 shows that students can find the value of x, but he can not find the height of the tree correctly because he did not add to the size of the person so that understanding of the concept is of medium criteria.

The following are the data from the results of the complete N-Gain test calculations that have been done using data from the effects of 6 pretest and posttest questions from both the experimental class and the control class totaling 15 students, can be seen at figure 7.
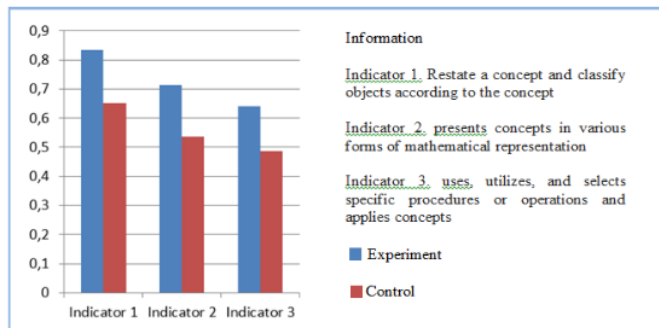
Figure 7. Improvement of concept understanding ability indicators.

From figure 7, it can be seen that students' understanding of mathematical concepts in the experimental class using Uno Stacko Mathematics media is better than the control class that only uses conventional learning. The percentage of each indicator can be seen in table 4.

Table 4. The percentage value of N-Gain concept understanding indicators.

Indicator	N-Gain	
	Experiment	Control
1	0,833 (High)	0,652 (Medium)
2	0,722 (High)	0,536 (Medium)
3	0,642 (Medium)	0,487 (Medium)

From table 4, it can be seen that the N-gain percentage of the experimental class is better when compared to the control class. These results show that the Uno Stacko Mathematics media is effectively used for learning mathematics.

The next stage is evaluating, intending to find out whether Uno Stacko Mathematics media is practically used or not. To measure this practicality, the researchers used an assessment questionnaire given to the experimental class students. The students' responses will later be analyzed so that it will be seen whether the resulting media is practical or not. The practicality questionnaire made by the researcher contained ten criteria. Based on the results of calculations that have been made on the student practicality questionnaire obtained a value of 86.8%, which is a very high category so it can be concluded that the Uno Stacko Mathematics media is practical to use.

This research is also supported by [12], which said that if Uno Stacko is a learning media in the form of games so that it can increase students 'motivation, in the media, there are questions that students have to do so that they can improve students' responsibilities. In this research, the experimental class n-gain increased by 82.9%. Another study conducted by [11] also said that the media uno stacko is one of the media that is suitable for students because this media is a type of game that can be used as exercises. The strategies used by the teacher are mostly monotonous practice questions and questions continuously to make students feel bored with such learning, so we need a free game media without intimidating students; one of them is uno stacko. In his research obtained a practicality value of 92,33%.

Based on the discussion, it shows that the uno stacko mathematics for students: Mathematical concepts in a realistic approach is appropriate for use in learning according to media experts, material experts, as well as from the responses of students who have used this media. It also shows that learning using uno stacko mathematics based on a realistic mathematics approach is better than conventional learning, especially in increasing students' mathematical understanding of concepts. This result is in line with the previous study that applying a realistic mathematics approach using media can support students understanding of concepts learned as well as problem-solving ability [18][19][20][21][22].

4. Conclusions

Based on the results of the analysis and discussion in this study, the conclusions are mathematical concepts in a realistic approach is declared valid for use because it gets an assessment percentage from media experts at 85.3%, which is included in the excellent category, and obtains an assessment percentage from material experts 85.8%, which is also included in the excellent category. Mathematical concepts in a realistic approach is practical to be used because it obtains an assessment of the practicality questionnaire that has been filled out by students by 86.8%, where the percentage shows that the practicality value included in very well. Based on the results of field trials conducted by researchers, the average student learning outcomes of the experimental class using uno stacko mathematics media are better than the average value of the control class using conventional learning. Besides that, the improvement of students' mathematical concept understanding ability of the experimental study is also better than the control class. It shows that the development of Uno Stacko Mathematics based on a realistic mathematics approach is effective.

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