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Development of scientific approach-based interactive multimedia for elementary school dyscalculia children

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Abstract: Difficulties in learning Mathematics for children are rarely understood by parents, even parents sometimes do not understand dyscalculia for children. In fact, dyscalculia children need special motivation and guidance. Interactive multimedia can be used as an alternative in giving special guidance for dyscalculia children. The objective of developing this interactive multimedia was to produce a product for elementary school dyscalculia children using android application suitable for a scientific approach. This development research employed four-D models development model which was developed by Thiagarajan. In this design, the researchers tested the validity level, practicality level, and also the effectiveness of the developed multimedia. The research subject was elementary school dyscalculia children especially the third graders. Based on the result of the validity test conducted by three validators, it was shown that the overall average was 3.20 where it was categorized as valid to be used. The result of the practicality test showed that the overall average was 3.09 where it was categorized as practical to be used. The result of effectiveness test showed that the overall average was 3.36 where it was categorized as effective to be used. The conclusion of this research was that the developed scientific approach-based interactive multimedia was practical and effective to be used as a learning source.

Keywords: Android, Application, Multimedia

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Introduction

Children development is not automatic, it is affected by how the environment plays the role in treating them. When the children start to enter the school environment, they have bigger opportunity to interact. Stimulation effect given by the teachers has big influence in the process of children development. To become a good teacher for children means he/she has to be able to recognize and understand who their students are. Each student has their own characteristic so that the knowing of child's characteristic is the most important thing (Larson & Corrigan, 2008, p. 88; Setiawan, 2019).

In fact, there are a lot of teachers who do not pay attention to children's characteristics. It is easier for the teachers to give the same and fair treatment so it can be said that the teachers less pay attention to the children's need. Hasibuan (2018, p. 25) stated that basically teachers tend to demand their students to obey to behave nicely according to the teacher so that stimulations received by the children are not suitable to what they need, and at the end it leads to development problems.

Children development has tight connection to the children's learning style. In the learning process of children, sometimes the children experience various problems in learning in the daily life. A child who has learning disability will find it difficult to understand or even use verbal language and writing. In addition, children with learning disability also have problems in thinking, writing, listening, or even spelling. The disability in solving problems in mathematics is also included in learning disability. Thus, basically, children learning disability in academic aspect is children's disability in reading (dyslecsia) (Shaywitz & Shaywitz, 2005), children's disability in writing (dysgrafisia) (Chung & Patel, 2015), and children's disability in mathematics (dyscalculia) (Amelia, 2016, p. 55; Passolunghi & Siegel, 2004).

Learning disability of mathematics on children is rarely understood by the parents, even parents sometimes do not now about dyscalculia on children. Even though there are a lot of parents nowadays who presume that mathematics is a subject which has to be mastered by the children, but basically the

parents do not know how much the children's ability in solving mathematical problems. In fact, special motivation and guidance are pretty much needed by dyscalculia children. Dyscalculia children need solving problems practice which is expected to help them to overcome their disability in solving mathematics problem (Hidayatulloh et al., 2015).

Previous study on dyscalculia highlighted more on the method and instrument in the learning process as stated by Arisandi (2014, p. 481) that the ability of dyscalculia children in multiplication operations which the number result was two numbers could be improved using garismatika method. Furthermore, Dewi and Ratu (2018, p. 3) stated that developing instrument in the form of division board without remainders 1-30 may help children who have special disability that was dyscalculia in understanding division concept. Therefore, interactive multimedia to help dyscalculia children to understand the concept of calculation operation was developed.

Interactive multimedia can be used as an alternative in giving special guidance for dyscalculia children. According to Badan Standar Nasional Pendidikan (2006), generally the characteristics of the developed interactive multimedia are: (1) self-instructional where children are able to learn independently without other parties; (2) interactive multimedia which is developed without depending on other media or does not need to be used simultaneously with other media; (3) user friendly which means the interactive multimedia used meets the aspect of easy to be used; (4) interactive multimedia developed has the consistency in terms of font, space, and margin; (5) the entire learning material from one competence unit or sub-competence studied exists in the whole interactive multimedia. The specifications of the developed interactive multimedia are: (1) interactive multimedia can encourage children to be more active and creative in learning mathematics subject; (2) the presented material is in the form of problems which are put interestingly; (3) this interactive multimedia has been validated from the experts of media, material, and practice; (4) this interactive multimedia is simple where it does not need various media or complicated instrument to be learned by the children; (5) is complete where it is equipped by the manual of how to use, how to solve the problems, the answers key, and also the assessment indicators gotten by the children; (6) children's response level, children's learning result completeness, and the activity shown by the children reflect that the children are very enthusiastic in solving problems and studying the given materials. Compared to other media, the advantages of this multimedia are this multimedia can cover various media such as audio, text, picture, and animation media. Thus, it is expected that this multimedia can help dyscalculia children in giving stimulations visually in understanding the correlation between numbers (mathematical operations such as addition, subtraction, division, or multiplication), solving story problems, understanding about numbering, and using the appropriate calculation strategies.

Teachers in elementary school in teaching mathematics subject have applied Curriculum 2013, where Curriculum 2013 emphasizes more on the modern pedagogical dimension in learning process; that is using scientific approach. According to BPSMPK-PMP (2013), the referred approach is scientific approach which includes learning where it covers three areas they are attitude, knowledge, and skill. The mentioned scientific approach includes observing, asking, trying, rationalizing, and summarizing. In fact, there are a lot of teachers who still use conventional methods in teaching. Therefore, the researchers developed an interactive multimedia which was presented in a complete package including the materials, simulation/the example of the problem, practice questions, answer key, and the assessment guidance.

Generally, 5% and 8% of the children in the school ages experiences dyscalculia learning disability (Geary, 2004, p. 68). According to Satrianawati (2012), dyscalculia on children where children have cognitive and neuropsychological deficiencies, in this case including the poor ability in processing memory, special visual ability, and visual perception. Some kinds of dyscalculia according to Nfon (2016, p. 442) are as follow: (1) quantitative dyscalculia where children experience disabilities in calculation skill; (2) qualitative dyscalculia where children experience disability in mastering the skill which later is used to solve operations including the addition, subtraction, multiplication, division, and square root; (3) intermediate dyscalculia is children's disability in operating numbers or symbols. For example the symbols of <,>, +, -, x, ÷, √. When the number is bigger than 100,000,000, children will need the help to manipulate or read it; (4) verbal dyscalculia where children can read and write numbers, but children cannot understand the meaning of the numbers, recognize the numbers when they are articulated by other people, or remember the numbers' name; (5) practognostic dyscalculia where children experience disability in manipulating things mathematically, for example comparing some

objects to see which one is bigger or smaller and children experience disability in solving problems related to quantity, volume, or equation practically; (6) lexical dyscalculia where children can read single digit, but they cannot remember their place in bigger number; (7) graphic dyscalculia where children where children experience disability in writing mathematical symbols and numbers; (8) indiagnostic dyscalculia is children's disability in remembering mathematical idea or concept that has been learned; (9) operational dyscalculia where children experience disability in doing the arithmetical operation and calculation, having the disability to do the calculation which needs mathematical numbers and symbols manipulation.

WISC (*Wechsler Intelligence Scale for Children*) is one of the intelligence tests which can be used to measure children's intelligence level aged 5-15 years (Nanik, 2007, p. 20). This test is used as the reference in categorizing dyscalculia on children. In the previous October, WISC test was conducted in 4 elementary schools in Malang city and interview to the teachers was conducted as the support of the test. The result attained from third graders in elementary school found that there were a lot of problems in the calculation of mathematics subject especially the calculation operation material. This could be seen from the development of the mathematics basic competence such as calculation, numbers, and arithmetic. Thus, earlier treatment for dyscalculia children is necessary to help their future development.

In this development of interactive multimedia, the emphasis was on the children who had the disability in calculation skill where it was categorized as quantitative dyscalculia. Quantitative discalculia has the characteristics of children having disability in calculating object's numbers, for example the teacher asked the children to take three markers and put them on the table, but children took as many as markers that they could take. In addition, children were disable to understand the duration of time, for example a student complained that he had been in a queue for hours while in fact he was only in queue for 15 minutes. These were the background of the researchers in designing scientific approach-based interactive multimedia for dyscalculia children generally for third graders of elementary school level.

Method

This development used Research and Development design. The Research and Development method is a research method where a particular product is produced and will be tested in the effectiveness-wise. In this case, the produced product was in the form of hardware or software

This development model was designing and making interactive multimedia in the form of android-based application. This scientific approach-based interactive multimedia for dyscalculia children was based on the result of survey on elementary school students where the samples were third graders of elementary school level and the interview on the classroom teachers and mathematics teacher of the third graders. This development employed android application. Basically, android would start the process if there were application components which needed to be run, then stopped the process if it was no more necessary or if the system had to restore the memory to be used by other applications. This way, android system implemented the minimum privilege principal. This means that in default the application only has the access to the needed components to do the work and no more than that. This resulted the very safe environment so that the application cannot access the system parts which did not have the permission.

This development employed four-D development model which was developed by Thiagarajan which has been modified by Muchayat (2011, p. 204). The four-D development model consisted of four stages, they are: define, design, develop, and disseminate.

The objective of this data collection was to figure out the effectiveness of the developed multimedia. As the preliminary stage, the children were given the WISC test to know whether or not the children were categorized as dyscalculia. Then, field try-out was conducted which consisted of small group subject (readability test) where three children were tested that included a child with poor competence level, where the student's achievement criteria were seen from WISC test result and big group subject that were taken from dyscalculia children who attended mathematics subject in classroom.

This research used descriptive data analysis technique. According to Rochmad (2012), to gain the prototype of a teaching instrument with certain quality, quality test is necessary to be conducted and it can be done by using validity test, practicality test, and effectiveness test. The analysis process in this

research consisted of three parts, they were the validity analysis of scientific approach-based interactive multimedia using android application, the practicality analysis of scientific approach-based interactive multimedia using android application, and the effectiveness analysis of android-based interactive multimedia.

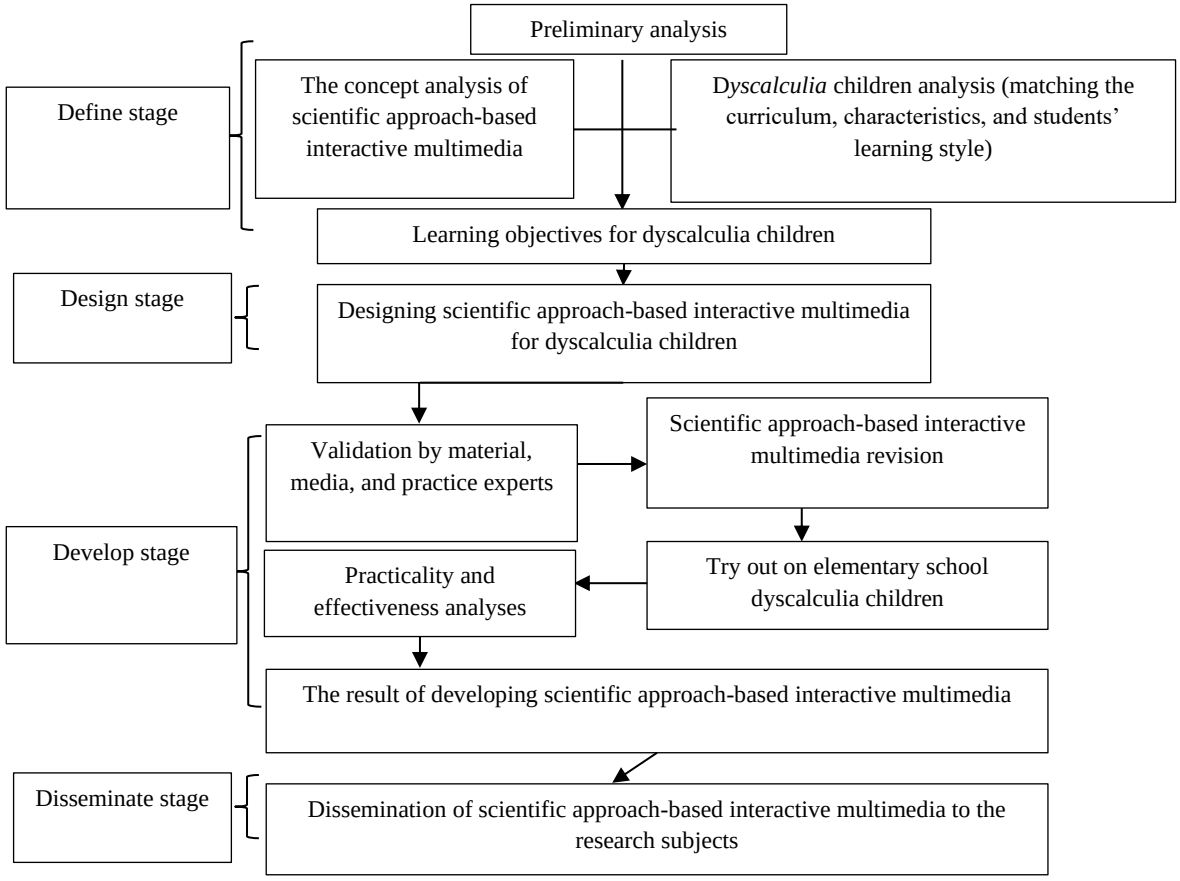

Figure 1. Research Procedure Using Four-D Model

The first analysis was the validity of scientific approach-based interactive multimedia using android application. According to Parta (2009), the validity is a compulsory requirement to be fulfilled because it is related to the theory which later will become the foundation of the development and the validity of reasoning chart of the developed product. The assessment scale of the validity of scientific approach-based interactive multimedia using android application consisted of four scales, they were score 1 (invalid), score 2 (less valid), score 3 (valid), and score 4 (very valid). The result of validity data were analyzed descriptively using the following procedure: recapping the score of each aspect from the validators, then calculating the average score of each aspect and calculating the overall average and concluding on the validity of the android-based interactive multimedia.

The second analysis was the practicality and the third analysis was the effectiveness of scientific approach-based interactive multimedia using android application. The results of the practicality and effectiveness data were analyzed descriptively through the following procedure: recapping the score of each activity aspect, then calculating the average score of each aspect and then calculating the overall average and making conclusion on the practicality and effectiveness of the scientific approach-based interactive multimedia using android application. In making the criteria of multimedia practicality and effectiveness, this interval was divided into three equal sub-interval because the feasibility opportunity of each aspect is the same, that was $1 \leq \bar{x} < 2$, $2 \leq \bar{x} < 3$, and $3 \leq \bar{x} \leq 4$ (Parta, 2009, p. 72).

Result and Discussion

Result

The stages of interactive multimedia development were as follow: (1) Define stage. The first step was doing the preliminary analysis. In this step, the researchers examined the types of teaching materials

used by the children at school and collected the information by showing that the teachers in elementary school level had been able to operate android well. Then, the second step was analyzing the children. In this step, the researchers analyzed the characteristics of dyscalculia children. They observed the curriculum and the children's learning style at school. The third step was materials analysis where this analysis aimed at choosing and determining and also organizing the relevant materials to be given to dyscalculia children and the need of scientific approach-based interactive multimedia on mathematics subject. The chosen materials were sorting numbers, addition and subtraction, and also recognizing thousands, hundreds, tens, and ones; (2) Design stage. Based on the attained result in the define stage, the researchers designed the interactive multimedia on mathematics subject which was suitable to scientific approach for dyscalculia children. The steps were as follow: (1) arranging the lesson plan(s), (2) determining the used media, (3) determining the format of the teaching instruments which are related to the content design, (4) the initial design of the media. The development design of the interactive multimedia on mathematics subject which was suitable to scientific approach for dyscalculia approach were as follow: (a) interactive media design was started from overviewing the used curriculum; (b) thematic-based of the third graders' curriculum, generally the theme was related to animals; (c) then the theme was considered to arrange the design of interactive multimedia which was suitable to scientific approach produced in the form of mathematics game; (d) the arranged game design covered the materials presented by question items and animation. This multimedia was also equipped by the simulation, question item example, question practice, answer key, and the score from the evaluation to know the final competence of teaching and learning process; (e) this interactive multimedia contained scientific approach where the contents were on the process of observation so that numbers operation material simulation was attached within this multimedia where children would examine the process of number operation. In the process of asking, this interactive multimedia also included question items example related to addition or subtraction so that the children were able to ask questions if they did not understand the process of number operation yet. In the process of trying, this multimedia included question practice which would be done by the children. In the process of reasoning, this multimedia gave the answer key so that children would process the information if their answer was wrong and why it happened so that the children would understand how to get the right answer. In the process of making conclusion, this multimedia was equipped by the result of assessment of the given evaluation question items to see how practical and effective this multimedia was.

The design of menu display on the android application in general was as follow:

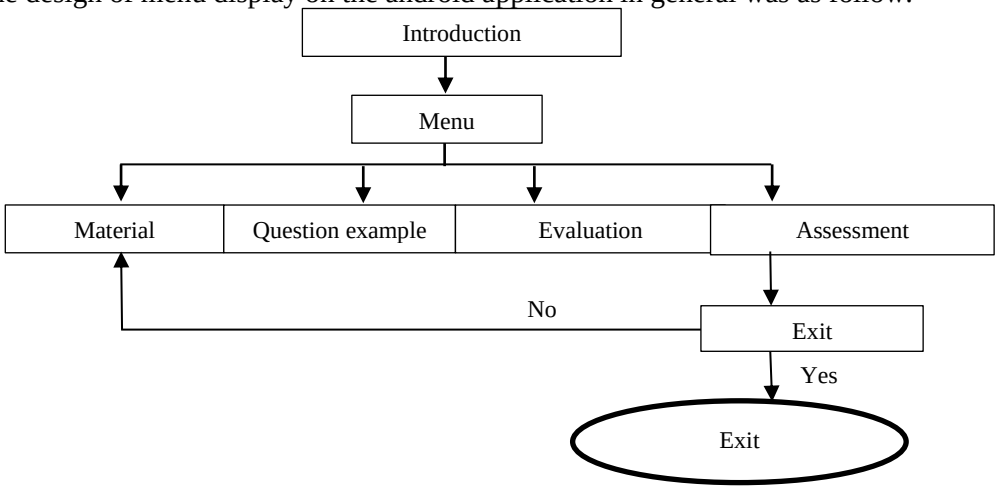

Figure 2. The Design of Android Application Menu

The design result of interactive multimedia which was suitable to scientific approach was as follow: The introduction page was where the page was equipped with interesting animation, audio, and also pictures (Figure 3). There was a 'start' button to begin or enter the main menu page.

Figure 3. Introduction Page

Main menu page (Figure 4). In the main menu page, the initial display when we enter the media was presented. The main menu page was completed by button feature which functioned to choose the wanted page.

Figure 4. Main Menu Page

Materials page (Figure 5). Materials page contained materials which were about to be studied in this android application. The choice of the materials was based on Curriculum 2013 for elementary school and had been suitable for scientific approach.

Figure 5. Materials Page

Question item example page (Figure 6). In this question item example page, the users were given the guidance on how to solve the problems. Therefore, it was expected that the students would ask if they did not understand yet.

Figure 6. Question Example

Evaluation page (Figure 7 and 8). In this evaluation page, evaluation questions were presented so that children could try and to know how far the students' understanding on the given materials.

Figure 7. Evaluation Page

Evaluation page. In this evaluation page, evaluation on whether or not the questions answered by the children were right were displayed. This aimed at knowing how practical and effective this scientific approach-based interactive multimedia was.

Figure 8. Evaluation Page

Assessment page (Figure 9). In this assessment page, the total score gotten by the children was presented.

Figure 9. Assessment Page

Develop stage. In this stage, the development of interactive multimedia using android-based application for dyscalculia children occurred by matching to the scientific approach. In addition, this stage also determined the supporting system such as class setting and instruments which would be used in the process of teaching and learning. This development stage was also a process to collect, process, and analyze information systematically which aimed at evaluating the developed solution. Thus, it can be concluded that this stage determined whether or not the design of this scientific approach-based interactive multimedia had been fulfilled. So, this development stage included two activities, they were validation activity and field try-out of the scientific approach-based interactive multimedia based on the result of the validation; (4) Disseminate stage. This dissemination stage was limited to distributing the multimedia to the related schools. It was because the researchers developed scientific approach-based interactive multimedia to be used as the reference for the teachers to help dyscalculia children in learning and understanding mathematics subject.

Discussion

Based on the design of scientific approach-based interactive multimedia especially for dyscalculia children using android application which was appropriate to be used in mathematics teaching and learning, it had to be tested in term of validity and tried out on students regarding the practicality and effectiveness. Validity test was conducted by three validators, they were lecturer, teacher, and media expert. The assessed aspects were material content, teaching design, and visual display.

Table 1. Validators' Result Recapitulation

Aspect		Indicator	Validator			$\bar{x}_i$	$\bar{x}$
			1	2	3		
Content Appropriateness	1.	The suitability of mathematics material for elementary school third graders	3	4	3	3.3	3.20
	2.	Displaying thematic problems suited to scientific approach	4	4	3	3.7	
	3.	Problems displayed on the media gives stimulus or stimulation for dyscalculia children to identify mathematics subject	3	3	3	3	
	4.	Media is able to give guidance to dyscalculia children to understand mathematics subject	3	3	3	3	
Display Appropriateness	6.	Media is easy to operate	4	4	4	4	
	7.	Smoothness in changing slides	3	3	4	3.3	
	8.	Suitability of the size and position of pictures and writings	3	3	3	3	
	9.	Suitability of color, writing, and picture combination	3	3	3	3	
	10.	Sentences used are clear	3	3	3	3	
	11.	Media display attracts the attention	3	3	3	3	

The overall average of result from the three validators was 3.20 so that it was categorized into valid to be used. The aspects and indicator used referred to game multimedia theory and multimedia development theory according to Alessi and Trollip (2001, p. 441) where the developed multimedia was suited to the characteristics of the students in operating the multimedia.

The assessed aspects in practicality test were how to use the multimedia easily, the effectiveness of the teaching time, and the significance offered. The practicality test used the excellence sheet of interactive multimedia.

Table 2. Observer Assessment Result Recapitulation

No.	Indicator	Observer's Assessment in Meeting				$\bar{x}_i$	$\bar{x}$
		1		2			
		1	2	1	2		
1.	Children do not experience disability in using scientific approach-based interactive multimedia.	3	3	4	4	3.5	3.09
2.	Children do the required activities based on the steps included in the scientific approach-based interactive multimedia.	3	3	3	4	3.25	
3.	Children do the entire activities instructed in the scientific approach-based interactive multimedia.	3	3	3	3	3	
4.	Children are able to conclude a concept based on the activities done.	3	3	3	3	3	
5.	Children are able to make summary of the activities done.	3	3	3	3	3	
6.	The language used in scientific approach-based interactive multimedia is communicative and appropriate to children's thinking level.	3	3	3	4	3.25	
7.	Question exercise in the scientific approach-based interactive multimedia is difficult to be solved by the children.	2	2	2	2	2	
8.	The activities that have to be done by the children are coherent.	3	3	3	4	3.25	
9.	Overall, the scientific approach-based interactive multimedia can be used in the teaching and learning process.	3	4	4	3	3.5	

Overall, the average result of practicality test was 3.09 which was categorized as practical to be used so that it could be concluded that the developed interactive multimedia was in the good criteria so that the interactive multimedia was said to be practical.

The aspect assessed in the effectiveness test was children's interest level in the teaching and learning process. These data was attained based on children's response questionnaire data. The result of the children's assessment was then recapped and analyzed further.

Table 3. Children's Response Questionnaire Indicator

No.	The Assessed Aspect
1.	I feel interested and curious while learning using this scientific approach-based interactive multimedia.
2.	Activities in this scientific approach-based interactive multimedia give me the opportunity to find mathematical concept.
3.	The manual of using this scientific approach-based interactive multimedia helps me in the learning process.
4.	This scientific approach-based interactive multimedia gives me the opportunity to check whether or not my answers are right.
5.	Activities in this scientific approach-based interactive multimedia give me the opportunity to interact and discuss with my peer.
6.	I feel happy with this scientific approach-based interactive multimedia because the display is interesting.
7.	Overall, I feel at ease in using this scientific approach-based interactive multimedia.

Table 4. Recapitulation of Children's Assessment Result on Interactive Multimedia

Student	Indicator							$\overline{x_i}$	SR
	1	2	3	4	5	6	7		
Student 1	4	2	4	3	3	4	3	3.37	3.36
Student 2	2	4	3	3	4	3	2	3.12	
Student 3	3	4	3	2	4	4	4	3.5	
Student 4	2	3	3	4	4	3	2	3.12	
Student 5	4	3	4	3	4	4	3	3.57	
Student 6	4	2	4	4	3	3	3	3.37	
Student 7	2	3	3	4	4	3	2	3.12	
Student 8	4	4	3	4	3	3	3	3.5	
Student 9	3	3	3	4	4	2	2	3.12	
Student 10	4	2	4	4	3	3	3	3.37	
Student 11	4	4	4	3	3	4	3	3.57	
Student 12	3	4	3	4	3	3	4	3.5	

Overall, the average result of children's response questionnaire test was 3.36, therefore, based on the determined criteria, it could be concluded that the developed interactive multimedia was effective to be used by dyscalculia children in the teaching and learning process.

In this section, the findings and discussion would be explained on the product development and also the practicality and effectiveness of the developed product. The results were as follow: (1) The suitability of the interactive multimedia with the objective of the development. The objective of this research was to develop scientific approach-based interactive multimedia on the numbers operation material for elementary school dyscalculia children that was complete and interesting which included materials, animation, question items example, question exercise, answer key, and the gained result or score so that it was able to solve children's disability in learning numbers operation and give motivation to elementary school teachers especially to increase the effectiveness and creativity in the teaching and learning process. This is in line with the statement of Akbar (2017, p. 681) that presenting materials in the form of interactive learning multimedia equipped with pictures, animation, and problem simulation indirectly makes the students are involved acoustically and visually so that the received information is easy to be understood by the students. Purnomo et al. (2017, p. 497) in his research also pronounced that there were a lot of students who like game more compared to studying so that when they were given a game-based calculation concept, 100% of the students gave the assessment of easy to be played and 62% thought that the given material was easy to be understood.

Some advantages of scientific approach-based interactive multimedia were: (1) the numbers operation material which was considered as difficult to be understood especially by dyscalculia children was visualized using android interestingly through animation, pictures, and voice video; (2) the menu display was arranged systematically to aid dyscalculia children in accessing the materials included in this multimedia; (3) this scientific approach-based interactive multimedia was packed in the form of android application so that it could be directly played on any android-based smartphone. Some of the mentioned advantages were in line with the statement of Daryanto (2013, p. 7) that was the function of teaching media was as the aid in teaching and learning process in the classroom. Without the existence of the media, children would find it difficult to learn and understand the learning materials especially for dyscalculia children. Materials presented in this interactive multimedia were suited to dyscalculia children's potential difficulty area according to Chinn and Ashcroft (2006, p. 17). This interactive multimedia was arranged according to children development level that is classified according to dyscalculia children's potential difficulty area. This was the implementation of cognitive learning theory. In addition, by using this multimedia, children were able to build their own knowledge through the attained experience which was in line with constructivism learning theory. (2) The practicality and effectiveness of scientific approach-based interactive multimedia. After the practicality test was conducted, it was found that the overall average result of practicality test was 3.09 which was categorized as practical to be used. This was suitable to the expected aspect of the researchers to test the practicality, they were: (1) simple where children did not need a lot of media or instruments which were difficult to be learned by the children; (2) this scientific approach-based interactive multimedia was complete where it contained simulation, question items example, question exercise, answer key, and result score of the assessment to know the final competence of teaching and learning process.

The overall result of effectiveness test showed the average result of children's response questionnaire test was 3.36; so based on the determined criteria, it could be concluded that the developed scientific approach-based interactive multimedia was effective to be used by dyscalculia children in the teaching and learning process. In line with the statement of Fredy and Soenarto (2013) in a research of the use of interactive multimedia showed that in the teaching and learning process the use of interactive multimedia was effective in giving material reinforcement and minimizing the students' disability in learning mathematics. The results of this practicality and effectiveness tests were in line with the gained benefits of teaching and learning process using multimedia as stated by Pranata and Wardani (2015) that was multimedia could be used as an instructional aid for the students, interactive tutorial like simulation, and as the learning source so that the students had the opportunity to learn independently and were able to express learning styles which were suitable to their interest and competence. In the field try-out, there were several problems, such as: children were not accustomed to use scientific approach-based interactive multimedia so that the children found the difficulty in operating it, and also several children were used to get information from the teachers and teachers became the main source so that children felt uncomfortable of independent learning in solving problems.

Conclusion

Based on the above description, the used data analysis, and interactive multimedia design for dyscalculia using android application, it can be concluded that: (1) scientific approach-based interactive multimedia was produced for dyscalculia children in elementary school level; (2) validity test results conducted by three validators showed that the overall average was 3.20 which was categorized as valid to be used; (3) practicality test result reflected that the overall average was 3.09 which was categorized as practical to be used; (4) effectiveness test result showed that the overall average was 3.36 which was categorized as effective. In general, scientific approach-based interactive multimedia for dyscalculia in elementary school was practical and effective to be used in the teaching and learning process.

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