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Development of Web-Based Interactive Learning Multimedia with Contextual Approach to Facilitate Mathematical Critical Thinking Ability

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Abstract

Digital learning resources were indispensable in today's mathematics learning, both offline and online, to support abstract mathematical concepts and train critical thinking skills. This research was intended to produce web-based learning multimedia products with a contextual approach using Adobe Flash CS6 software to facilitate XI grade high school students' critical thinking skills and determine its feasibility. The research method was research and development (RnD) using the ADDIE (analysis, design, development, implementation, evaluation) model. The validation results of multimedia development products by material experts and media experts meet the valid criteria with an average score of 4.09. The practicality test by two teachers and six students showed an average score of 4.48 and was categorized as very practical. Evaluation of the practicality of implementing multimedia products found that the average critical thinking ability of students had exceeded the minimum completion limit, namely 64, and exceeded 75% of the number of students. The average difference test and the comparative proportion test showed that the students' critical thinking ability in the experimental class was better than in the control class. The results of this multimedia development could be feasible as a learning media because it meets the criteria of being valid, practical, and effective. Students' critical thinking skills increased after using multimedia with an average gain of 0.47. Web-based interactive multimedia learning is effective in facilitating students' critical thinking skills.

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INTRODUCTION

Entering the era of the fourth or 4.0 generation industrial revolution has an impact on the world of education. So that the educational curriculum must be able to form students' hard skills and soft skills such as critical thinking, creativity, innovation, interpersonal, global thinking, ready to face challenges, and focus on the fields of Science, Technology, Engineering, and Mathematics (STEM) (Mukhlasin, 2019). One of them is by integrating online technology and more flexible learning strategies, to provide a broader and more effective learning experience, and affect better learning outcomes (Tham, 2011). Current technology is not only an additional tool but has become an integral or inseparable part of the learning process (Putra, 2019). So that combining offline and online learning resources needs to be done by the teacher (Dwiyoga, 2018). As has been developed by Gibson, Aldrich, and Prensky (2007), the form of educational "games" that were integrated into online learning, were very helpful in learning and fun (Putra, 2019).

Mathematics was still considered difficult by some students. Therefore, in the learning process, the teacher should provide illustrations, learning resources, and learning media that are able to stimulate students to be active, discovery-based, and contextual, so that learning will be felt meaningful. One way that can be done is by providing interactive multimedia learning in accordance with the characteristics of the material and students. Interactive media is a media system with the aim of presenting material in the form of video using computers to students where students can also respond actively with audio-visual elements, including animation (Arsyad, 2011). The provision of interactive multimedia learning provides very positive results, provides motivation to learn, teamwork, and can increase understanding (Neo et al., 2012).

Students also need other sources for learning such as digital libraries that can be accessed online. However, its availability is still questionable whether the resource has been designed pedagogically and can facilitate students in understanding the concept (Borba et al., 2016). One thing that can be done is by using the web as a learning resource in learning. The web can create a learning environment, help in the development of critical thinking processes, creativity and motivate students. However, in its integration, you must pay attention to the content or content of the subject matter (Seitkazy et al., 2016). Besides, web-based learning (weblog) with a problem-solving approach has a positive effect on students' logical thinking skills (Moayeri, 2014).

One of the abilities that must be possessed to face a super-smart society is the ability to think critically. A person with critical thinking can clarify, look for and assess the background of a view, provide conclusions wisely, think and integrate with imagination, and have a sensitivity to the things around them (Ennis, 2015). According to Alison (2010), the definition of critical thinking can be explained in stages, namely: mathematical description skills, mathematical analysis skills, and mathematical evaluation skills.

The average critical thinking ability of 11th-grade students of SMAIT Bina Amal in the preliminary research is still low. This is because students have not been accustomed to practicing solving problems of critical thinking skills so that it is still difficult if they are given a question model that requires high-level reasoning or Higher Order Thinking Skills (HOTS). Therefore, it is necessary to create learning conditions that can facilitate increased understanding of concepts and critical thinking skills. Teachers should facilitate students to help them improve conceptual understanding skills by encouraging them to construct their knowledge (Rahayu et al., 2018). One that can be applied is Contextual Teaching and Learning (CTL) or contextual learning, which can stimulate the brain in making patterns that can connect the concept of learning material with the context of everyday life (Rusman, 2012). Besides, learning with CTL influences students' mathematical critical thinking skills (Kadarsono et al., 2019).

Based on the description above, this study aims to: 1) Produce interactive web-based learning multimedia products with a contextual approach to facilitate critical thinking skills, and 2) Test the validity, practicality, and effectiveness of multimedia development products. The results of this multimedia development product are expected to contribute to train students' mathematical critical thinking skills processes.

METHOD

This research was included in the type of development research (development research). The media was compiled following the development stage of the ADDIE development model (analysis, design, development, implementation, evaluation). The analysis stage was carried out by analyzing the needs of mathematics learning media through questionnaires and interviews. In the design stage, a blueprint was made which contains the formulation of learning objectives, storyboards, flowcharts, device designs for learning media (syllabus and lesson plans), material design or learning materials, and learning outcome evaluation tools. The development stage is the stage of making multimedia based on blueprints that have been created using predetermined software. Media that has been developed was then displayed on the web blog, namely through blogger coherently according to the learning scenario that has been made.

The multimedia product trial stage was carried out in 2 stages, namely the validation test by material and media experts, and limited practicality testing by users. Media repairs and modifications are carried out according to the suggestions given. The next stage of multimedia products is implemented in learning, and after that, tests of their effects on students' critical thinking abilities were carried out. In addition, data on student responses to the use of multimedia products were also taken using questionnaires. The last stage was the evaluation stage of multimedia products.

Subjects and samples in this study were 11th-grade students and mathematics subject teachers at SMAIT Bina Amal. The qualitative data analysis technique was carried out by using the Miles and Huberman model analysis method, whereafter the data was obtained, data reduction, data presentation, and conclusion drawing were carried out.

The data analysis for the validation of multimedia products was carried out by looking for the average validation score of the validators then converted by looking at Table 1.

Table 1. Validation Criteria

Average Value	Criteria
$1{,}00 < x \leq 1{,}80$	Not good
$1{,}80 < x \leq 2{,}60$	Less good
$2{,}60 < x \leq 3{,}40$	Enough
$3{,}40 < x \leq 4{,}20$	Good
$4{,}20 < x \leq 5{,}00$	Very good

Practical data analysis was carried out by giving questionnaires and interviews to a small group of students and teachers of mathematics. Teacher and student response data were then converted quantitatively and categorized according to Table 2.

Table 2. Criteria for Percentage of Response Score

Presentase Skor	Kriteria
$85\% \leq R \leq 100\%$	Very practical
$70\% \leq R \leq 84.9\%$	Practical
$60\% \leq R \leq 69.9\ \%$	Enough practical
$50\ \% \leq R \leq 59.9\%$	Less practical
$< 50\%$	Not practical

After the revision was made, the multimedia product was implemented in learning in the experimental class, and then an evaluation was made of the effectiveness of multimedia on students' critical thinking skills. The hypothesis in this study is that web-based interactive multimedia learning with a contextual approach to Linear Program material is effective in facilitating students' critical thinking skills. To test this hypothesis, a statistical test was carried out with data obtained from the results of the critical thinking skills test given to the experimental and control classes, both before and after implementation.

The average completeness test is used to find out whether the average score of students' critical thinking skills in the experimental class is above the minimum completeness limit, namely 64 or not. To test the average completeness used the t-test or by using the one-sample t-test on SPSS with a real level of 5% (Sudjana, 2010). The classical completeness test was used to determine the number of students in the experimental class, who have reached the KKM. The KKM was more than 75% of the number of students in the class. The test used is the test of the proportion of the left side (z test)(Sudjana, 2010).

The test for the difference between the two means uses the t-test to determine whether there is a difference in the mean of students in the experimental class and the control class (Sudjana, 2010). By using SPSS, the average difference test can use the Independent T-Test with the help of SPSS 20.0 with a real level of 5% (Sukestiyarno, 2013). A comparative test of two proportions was conducted to determine the difference in the proportion of students who achieved critical thinking skills in mathematics in the experimental class and the control class. This confidence level is 95% or (1– α) = 0.95 and using the z test with a significant level of 5%.

The criteria for the percentage of student responses to the use of multimedia products can be determined by looking at Table 3.

Table 3. Response Assessment Criteria

Percentage (%)	Criteria
$76-100$	Very interesting
$51-75$	Interesting
$26-50$	Less interesting
$1-25$	Not interesting

The increase in students' critical thinking skills after using multimedia products can be calculated by the formula:

$$gain = \frac{postest\ score - \ pretest\ score}{maximum\ possible\ score - pretest\ score}$$

The criteria for the gain value can be seen in Table 4 below:

Table 4. Criteria for Gain Value

Interval	Criteria
$g > 0{,}7$	High
$0{,}3 \leq g \leq 0{,}7$	Moderate
$g < 0{,}3$	Low

RESULTS AND DISCUSSIONS

This study produces a web-based interactive learning multimedia product with a contextual approach. Interactive multimedia products are made using the main software Adobe Flash CS6 and Geogebra. The interactive media products from Adobe Flash are packaged in * .swf format and video is then attached to the blog so that students can access them online via a browser. This multimedia development product was developed by following the ADDIE model development stage (analysis, design, development, implementation, evaluation).

Analysis Stage

Researchers carried out curriculum analysis, analyzed student characteristics, and analyzed the use of technology as a learning medium. Curriculum analysis refers to the 2013 curriculum, researchers analyzed mathematics material for grade 11 senior high school for multimedia product development. Based on the results of questionnaires given to students and teachers and interviews, it can be concluded that most students still have difficulty learning mathematics, especially about algebra material. The learning media provided by teachers at this time have not helped them in understanding mathematical concepts, especially those related to contextual problems. Students consider it necessary to use media that can show how to work, pictures, or material in more detail / real accompanied by animations and simulations that are very interesting and fun. From the analysis of the use of technology, various ICT tools can be used for learning media, including interactive whiteboards (IWB), software applications, web 2.0, and social media (Hidayat & Khotimah, 2019). However, some teachers have not used computer information technology-based learning media, especially the web or blog. Even though teachers can maximize blogs as a medium for learning, as a solution to the lack of print media facilities, as well as the lack of learning media that is attractive to students in the current digital era (Sulasmianti, 2019). The result of the analysis the researcher took the Linear Program material, namely the material for grade 11 senior high school odd semesters to be used as web-based multimedia development material with a contextual approach.

Planning Stage

Researchers carry out planning that begins with making a blueprint containing the formulation of learning objectives, media content outline, flowcharts and storyboards, device design in the form of syllabus and learning devices, design of learning materials, and evaluation tools adapted to the 2013 curriculum and indicators of critical thinking skills, and determine the supporting software used in making multimedia products.

Development Stage

The multimedia product development stage resulted in two products, namely interactive flash media and video. Interactive flash is created using the main software, namely Adobe Flash CS6 and other supporting software such as Adobe Photoshop CS6, Powerpoint, Geogebra, Audacity, Camtasia 7.0 recorder, and Camtasia 7.0 studio. Meanwhile, to make a learning video using Geogebra software, screen recording is done using the Camtasia recorder and then edited using Camtasia Studio 7.0 with added sound taken through Audacity or Youtube. After the multimedia is finished, the next step is to display the multimedia on the blog www.ngulikmatematika.blogspot.com. The following is a display of interactive flash media as shown in Figure 1.

Figure 1. Display Interactive Flash Media

Validate of Development Products

The results of the evaluation of the validation of interactive learning multimedia by material experts and media experts show that the quality of web-based interactive learning multimedia is obtained by an average score based on the content/material aspect of 4.04, learning aspect 4.07, display aspect 4.09 and programming aspect 4, 15. So that the average score obtained from all aspects is 4.09 and the percentage is 82% with a good validity category.

Practicality of Product Development

Testing on a small group of users is used to determine the practicality of multimedia products. The results of the practicality assessment by 6 students and 2 mathematics subject teachers obtained an average score of 4.56 for learning aspects, 4.45 for material aspects, and 4.23 for multimedia aspects. So that the average score obtained from all aspects is 4.48 with a percentage of 90%. This means that the quality of web-based interactive learning multimedia based on the material, learning, and multimedia aspects is categorized as very practical. The results of interviews with teachers and students also show that multimedia development products meet very practical criteria for use in learning.

Implementation of Multimedia Products

Implementation of multimedia products in learning is carried out online. The results of obtaining a questionnaire showed that the average student response score was 3.18. This value is included in good criteria so that it can be stated that students in the experimental class have a good response to the use of web-based interactive multimedia in learning. Critical thinking skills tests are given to students before and after implementing multimedia products in both the experimental class and the control class. This is done to see the effectiveness of multimedia products on students' critical thinking skills.

The results of the average completeness test of students' critical thinking skills in the experimental class with the help of SPSS, the final data significant value was 0.001. The value of tcount = 4.429 with dk=n-1 = 12-1 = 11, then the obtained ttable = 1.796. So that sig = 0.001 <0.05 and tcount> ttable, 4.429> 1.796. It can be concluded that the average test of children who are given interactive learning media is more than 64 (complete limit). The result of the proportion completeness test shows the value of zcount = 0.67 and ztable = 1.65. So that zcount> - ztable or 0.67> - 1.65. And it can be concluded that the number of students who have reached the completeness limit score of 64 has exceeded 75%.

To test the hypothesis about the effectiveness of multimedia products, the average difference test, and proportion comparison test was carried out. The average difference test with the help of SPSS calculation through the Independent T-Test obtained a significant value of the equal variances assumed (because the data is normally distributed and homogeneous), namely 0.005. So that sig / 2 = 0.0025 <0.05 and the value of tcount = 3.058 with df = 16 + 12-2 = 26, the obtained ttable = 1.706. Because tcount> ttable or 3.058> 1.706 this means that students 'mathematical critical thinking skills using interactive learning media are better than students' mathematical critical thinking skills who do

not use interactive learning media. While the comparative test of the proportion of the experimental class and the control class also obtained the value of zcount = 1.82 and ztable = 1.645, because zcount = 1.82> 1.645 this means that the proportion of students who achieved critical thinking skills in the experimental class was more than the proportion in the control class. So it can be concluded that the mathematical critical thinking skills of students who use web-based interactive learning media are better than students who do not use web-based interactive learning media. From the description above, it can be concluded that the multimedia learning product developed meets the criteria for being effective.

To find out the increase in critical thinking skills after the multimedia learning media product developed is implemented in learning, a gain-test is carried out. The results obtained by the average Gain-score level of critical thinking skills in students who have been given learning using web-based interactive learning multimedia is 0.47 with moderate criteria as shown in Figure 2 below.

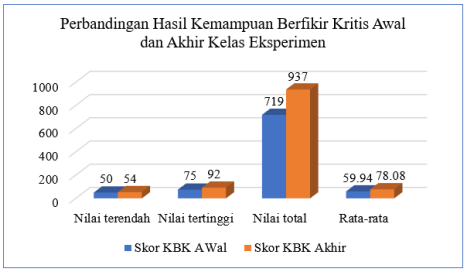

Figure 2. Initial and Final Critical Thinking Ability of Experiment Class

Based on the validity, practicality, and effectiveness of multimedia development products, it can be concluded that the web-based interactive learning multimedia products that have been developed meet the appropriate criteria for use as learning media. Web-based interactive learning multimedia can also facilitate students 'critical thinking skills, this is indicated by an increase in students' critical thinking skills with an average gain-score of 0.47 or an increase of 47%.

Discussion

The result of the development of multimedia web-based interactive learning products for this Linear Program material is in the form of a learning web with the link address www.ngulikmatematika.blogspot.com. The interactive media product development model design used is a combination of a tutorial, simulation, and drill and practice models. This is also in line with the opinion of Daryanto (2010), as well as the opinion of Smaldino, Lowther, and Russell (2011). The presentation of material in multimedia is also in line with that proposed by Ariani and Haryanto (2010), that the presentation format for multimedia is in the form of a tutorial, whereafter the user reads, interprets, and understands the concept then a series of questions or assignments is given in stages. After the user has successfully answered or responded correctly, it will be continued with the next material, but if the response or answer is wrong then the user must repeat it.

The concept built in the development of this multimedia is to use a contextual approach in the presentation of the material, practice questions, and simulation solutions. Interactive multimedia is also equipped with interactive buttons so that it can provide students the opportunity to interact directly with the presentation of material, simulations, and exercises in multimedia. This is in line with the opinion of Munir (2012), that in multimedia applications, users are given the ability to control the elements in multimedia.

Validation of multimedia products includes aspects of content/material, learning, display, and programming. The results of the assessment get an average score of all aspects of 4.09 which indicates that this multimedia product has good quality. While the practicality test of multimedia products by subject teachers and 6 students for the learning, material, and multimedia aspects using a questionnaire obtained an average score of 4.48. The interviews conducted with the teachers and students also showed that this web-based interactive multimedia learning was declared very practical to be used as a learning medium.

Evaluation of the effectiveness of multimedia after implementation in learning gives the result that the average critical thinking ability of students in that class has exceeded the minimum threshold value of 64, and the number of students has exceeded 75%. Through the average difference test and the comparative proportion test, the results also showed

that the mathematical critical thinking skills of students who use web-based interactive learning media are better than students' mathematical critical thinking skills who do not use web-based interactive learning media. The proportion of students who achieved the completeness of students' critical thinking skills in mathematics using contextual web-based interactive learning media was also more than the proportion of students who did not use web-based interactive learning media. It can be concluded that the developed learning multimedia product meets the criteria of being effectively used as a learning medium.

The result of the Gain-score calculation of students' critical thinking ability was 0.47 in the medium category. This means that there is a contribution from the use of web-based interactive learning multimedia to increasing critical thinking skills even though it is at a moderate level. It can be concluded that web-based interactive learning multimedia products with a contextual approach can effectively facilitate students' mathematical critical thinking skills. Contextual problems used in this multimedia help students' learning process by connecting subject matter with problems of everyday life. This is following the research of Kusumadewi, Mariani, and Susilo (2013) which resulted in the conclusion that CTL learning with the help of media can effectively improve critical thinking skills. The completeness of students' mathematical critical thinking skills cannot be separated from the exercises and simulations provided through interactive multimedia learning. This is in line with the opinion of Johnson (2014) which states that for critical thinkers, training is as important as training for a tennis player and musician. Practice will make a habit and become a skill.

Based on the results of interviews with students and teachers as users, several advantages were obtained from this multimedia product, among others, the use of contextual problems which are also equipped with images, animations, tutorials, simulations, and videos so that students can better understand the material slowly and repeatedly. Besides, this multimedia product can be used as an alternative learning resource in face-to-face, blended learning, and online learning, where teachers can make it a presentation medium. This multimedia can also be accessed via the web independently by students anytime and anywhere. The drawback is that some web browsers currently do not provide the adobe flash player extension automatically, so to open the learning web, you have always set up the adobe flash player plugin.

CONCLUSION

Web-based interactive learning multimedia development products with a contextual approach to Linear Program material for class xi high school students packaged in the form of a learning blog www.ngulikmatematics.blogspot.com have met the criteria of validity, practicality, and effectiveness. So that this multimedia is suitable to be used as a learning medium both individually and classically and can be accessed online. This multimedia is also effective in facilitating students' critical thinking skills, this can be seen with an increase in the gain-score of 0.47 after using it in learning. This web-based learning multimedia with a contextual approach can be an alternative digital learning resource in online learning times like today, to train critical thinking skills independently. Critical thinking skills need to be continuously trained, including by using multimedia interactive learning with a contextual approach which is packaged in the form of tutorials and presented online through the learning web.

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