

The use of Multimedia of geometry Based on Van Hiele Thinking Theory: An Alternative to Improve Critical Thinking Skill of Elementary School Students

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Abstract—This research was aimed to explore the learning process and the perception of student toward multimedia of geometric based on Van Hiele’s thinking theory and to inspect the effectiveness of multimedia of geometry based on Van Hiele’s thinking theory used in the process of mathematics learning. This research was implemented in SDN Mojoroto 6 Kediri City, Indonesia in 2021/2022 academic year. The samples were 33 at the age of 11-12 years old. This study was designed with mixed research. The data were collected through the instruments of observation, interview, and critical thinking sheets. The results of this research have indicated that the implementation of multimedia of geometry based on Van Hiele’s thinking theory was running properly. Multimedia of geometry based on Van Hiele’s thinking theory can be received in the mathematics learning process. The students became more motivated in learning, the learning process was more interesting and meaningful, while the results of the critical thinking skill of students have indicated significant improvement after the implementation of multimedia of geometry based on Van Hiele’s thinking theory compared to the prior condition.

Keywords—Multimedia; geometry; thinking theory; van Hiele; critical thinking

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I. INTRODUCTION

The utilization of Information and Communication Technology in the education world is called as ‘Teaching Enhanced Learning (TEL)’ (Kirkwood & Price, 2014; Nagendrababu et al., 2019). TEL can include hardware such as cellular phone, laptop, computer, tablet, and other devices while the software includes learning game, interactive multimedia, learning management system application, application of discussion in education and training programs (Goodyear & Retalis, 2010; Scott et al., 2017). Computer can be used to change texts and images, manipulate color and audio and use other computer effects to create dynamic and representative information animation (Goodyear & Retalis, 2010; Scott et al., 2017), including static texts and images through the application of powerpoint or animation and audio by using media player or flash (Kassim, 2013). Therefore, the impacts of communication technology in transforming education and the way people teach and learn are immense.

Multimedia is the media which involve every sense during the learning process (Pribadi, 2017). Multimedia has to be “trendy” and designed for students so that the students are capable of exploring the knowledge through the media (Primasatya & Jatmiko, 2019). Therefore, multimedia is not only the tool to transfer information but also to generate critical thinking. In improving the critical thinking skill of students, the learning which allows students to conduct exploration to discover a certain concept. Students not only have to receive an information, on the other hand, they have to be able of criticize the acquired information. For instance, students not only provided with the formula for area of circle but why and how the formula is obtained and the way to implement it to the daily life.

The study results have revealed that most of the teachers experience difficulties in delivering some concepts of geometry (Sariyasa, 2017). The problem which also occurs in teaching and learning process of geometry is that the students are lacking the basic skill of mathematics, thus, they unable to solve the problem even when examples were given (Adolphus, 2011). In that order, the deep conceptual understanding and the skill to visualize the geometric properties at the fundamental level which most required by students to step into higher learning of geometry (Abu et al., 2012; Hardianti et al., 2017).

The learning theory which specifically developed in a geometric learning that correlates topics and concepts as well as the positive implications that have been received in the geometric thinking process is van Hiele theory (Andini, Fitriana, et al., 2018; Primasatya & Ahdhianto, 2017; Primasatya & Jatmiko, 2018). According to the theory of van Hiele, individuals will pass five stages in the development of thought in geometric learning, namely 1 (Visualization), 2 (Analysis),

3 (Informal Deduction), 4 (Deduction), and 5 (Rigor) (Crowley, 1987; Erdoğan & Durmuş, 2009). Some studies about the thinking theory of van Hiele have been conducted (Andini, Budiyo, et al., 2018; Ma et al., 2015; Primasatya & Ahdhianto, 2017; Solaiman et al., 2017; Tieng, 2014) which conclude that the theory of thinking of van Hiele is relevant in improving the critical thinking ability of students.

The development of multimedia which uses technologies can help enhance the basic geometric skill of students (Andini, Budiyo, et al., 2018). The application of this multimedia has more advantages than manipulative media, such as display, practicality, and media update (Primasatya & Ahdhianto, 2017). Because multimedia could balance and integrate audio, graphic, image, animation, and film presentation. The integration of technology in the education sector has shown that the use of computer in classes is beneficial for students who learn mathematics (Gecü & Özdener, 2010; Isiksal & Askar, 2005; Olkun et al., 2005). The use of animation is more interesting for students, especially the elementary school students. Besides working as the motivation for students, the use of animation can be used as well to visualize the forms of geometry, thus, this effort will facilitate the students in conducting observation.

Considering those conditions, the we wanted to inspect the effectiveness of multimedia of geometry based on van Hiele's thinking theory in mathematics learning on materials of circumference formula and area of circle of V grade, SDN Mojoroto 6 Kediri – Indonesia.

II. RESEARCH METHOD

This research is the part of wider study about the development of multimedia of geometry based on van Hiele's thinking theory to improve the critical thinking skill of V grade students. In this article, the author was focusing on the implementation of multimedia of geometry based on van Hiele's thinking theory, the author wanted to explore further the learning process and perception of students toward multimedia of geometry based on van Hiele's thinking theory used in the classes. The mixed research was the method used in this study. A qualitative approach through the application quasi-experimental study was used to see the effectiveness of the utilization of media in learning. A qualitative approach with the design of case study was used to see the learning process as well as exploring the perception of students toward the utilization of multimedia of geometry based on van Hiele's thinking theory.

This research was conducted in SDN Mojoroto 6 Kediri, Indonesia in 2021/2022 academic year. The sample was V (fifth) grade students who aged between 11-12 years old that consist of 33 students. The data collecting instruments were observation, interview, and critical thinking skill sheets. Observation was implemented to see the learning process through the utilization of media, interview to discover the perception of students regarding the learning process through the

utilized media while test was used to discover the critical thinking skill of students. The problem-solving skill of mathematics is the learning results which will be measured in this research. While the effectiveness of multimedia of geometry based on van Hiele's thinking theory was seen from the results of the final test after the utilization of media has been completely done.

III. RESULT AND DISCUSSION

The learning through the application of multimedia of geometry based on van Hiele's thinking theory was performed in the class. The learning process with the materials of finding the circumference formula and area of circle was started by providing information, this effort was in accordance with the stages that implemented in van Hiele's thinking theory. From this early information, the students recalling the definition and properties of circle through the prepared multimedia. Through multimedia, students discover the circumference along with the formulation as well as finding the difference between the concepts of circumference. Until this stage, students seem to be confused with the provided materials. The students were confused in finding the concept of circumference by themselves. They asked for teachers to repeat the method to find the concept of circumference. Due to that matter, the teachers have to repeat the materials and explain them with full details to be completely understood by the students. After the students become comprehended with the provided materials, they asked to do some assignments in the form of problem solving questions. Students wrote down the summary or the conclusion of the materials and the attempts they performed on the multimedia.

During the next meeting, the students were getting used with the multimedia of geometry based on van Hiele's thinking theory, students began to understand the method to discover the circumference formula through different ways and how to calculate the circumference independently without any helps from the teachers and friends. In this second meeting, students become really enthusiastic to follow the learning process. This condition can be seen from the high number of question occurred during the learning process through the application of multimedia of geometry. These questions have been heading toward the concepts of circumference. The learning process was fun as well which seen from a lot of funny words, therefore, the atmosphere of the class was relaxing and not tense. Therefore, this second learning process can be determined as good. The third and next learning processes were running properly as well.

The utilization of multimedia of geometry based on van Hiele's thinking theory was performed on each meeting on the materials of circumference and area of circle. Especially on the exercises, students were obligated to check their work results of multimedia of geometry.

After four meetings or when the materials of circumference and area of circle have been provided, students were given with evaluation test.

The responses of students toward the utilization of the multimedia of geometry varied. Some of them praised the media but there were also some who gave bad comments. Negative comments were commonly made regarding the provided materials starting from the difficulties in finding the concept of circumferences. Good comments were made more about the utilization of multimedia of geometry and the presented application.

In relation to the utilization of multimedia of geometry, most of the students gave good comments. The positive comments of students could be seen from the results of student answers during the interview after the learning process had been conducted, such as statements like “this media is good and interesting”, “this media is helping me so much Sir...!”, and also “this media is really fun”. These statements showed that multimedia of geometry helped students in exploring the materials and improved the learning motivation of students.

The students also gave their responses regarding the display/presentation of multimedia of geometry that being used. They admire the interesting display, the animation which being used is good, and the color has made them to look at it continuously. Through the utilization of multimedia of geometry, the students become more enthusiastic in following the learning process.

The results of critical thinking skill of students as the part of final evaluation of mathematics learning through the application of multimedia of geometry based on van Hiele’s thinking theory. The t-test showed that the multimedia of geometry based on van Hiele’s thinking theory was effective to be used in the experimental class (p value of 0.000), thus, independent sample t test was used.

Thus, significant improvement of critical thinking skill of students has occurred after the application of multimedia of geometry based on van Hiele’s thinking theory.

After the significant improvement on critical thinking of students have been discovered after the implementation of multimedia of geometry based on van Hiele’s thinking theory, thus, the effectiveness of the implementation of multimedia of geometry based on van Hiele’s thinking theory can be known through the mean score values of Pre-Test and Post-Test in before and after the implementation was conducted.

Table 2. Data Description of Critical Thinking Skill of Students

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Pre	55,12	33	9,72	1,693
	Post	73,64	33	10,34	1,801

The mean and std score before the application of multimedia of geometry in learning was 55.12 ± 9.72 while after the learning after the learning was conducted through multimedia of geometry. it increased to 73.64 ± 10.34 (Table 2). It means that there was an improvement of critical thinking of students in before and after the utilization of multimedia of geometry. Independent sample t test will be used to achieve more detail results.

Based on qualitative or quantitative findings of this research, the utilization of multimedia of geometry based on van Hiele's thinking theory has provided positive impact either in the learning process or in the results of students' critical thinking skill, it means that the implementation of multimedia of geometry based on van Hiele's thinking theory was effective in the mathematics learning on the materials of circumference and area of circle of V grade, SDN Mojoroto 6 Kediri in 2021/2022 academic year.

This research is consistent with the previous research which mentioned the relevancy of thinking theory of van Hiele in improving the critical thinking skill of students (Primasatya & Ahdhianto, 2017; Primasatya & Jatmiko, 2019; Solaiman et al., 2017; Tieng, 2014), and the benefits of computer as the media in learning process (Goodyear & Retalis, 2010; Jatmiko & Fiantika, 2017; Scott, Baur & Barrett, 2017). The implementation of free and easy-to-use interactive multimedia in mathematics learning. The learning multimedia can be used to deliver the message and stimulate the intention to learn (Ariani & Haryanto, 2010). To improve the quality of learning, teachers should be able to develop themselves to master various skills in various electronic learning media. Seeing the big enthusiasm of students toward the implementation of multimedia of geometry based on van Hiele's thinking theory, teachers should consider that the implementation of multimedia in mathematics learning is not a difficult thing (Wawan et al., 2018). The enthusiasm of children in the implementation of media can be utilized by teachers to enhance the learning results and motivation of students.

Reviewing from the entire results of this research, there are some issues that have to be solved. We can see in the beginning of learning process, students were still find difficulties in following the process. The students were confused with the learning through the implementation of multimedia of geometry. This condition has indicated that they were not accustomed to the kind of learning which uses interactive multimedia. The lack of skill of the students should become the consideration for teachers in programming the learning process. The lack of skill and competency of students is indeed become the factor which inhibits the learning process (Le et al., 2018). In that order, teachers should put their attention on each learning process by conducting better preparation for students, providing more contribution toward the students to implement multimedia of computer-based media. Through these efforts, the efficacy of students in learning process will improve. According to social cognitive theory, efficacy could influence the learning

results of students (Schunk, 2011). Giving opportunities for students will become the meaningful experience for them. Improving the intention to learn and high motivation.

IV. CONCLUSION

Reviewing from the results of interview toward students, it can be said that the implementation of multimedia of geometry based on van Hiele's thinking theory has been passable. Multimedia of geometry can be accepted in the learning process of mathematics. Suitable application of animation and color has become a unique attraction to make students focus and listen to materials properly. Answer check menu has also become a particular value. This menu has made students become enthusiastic in solving the exercises. Students were always curious whether their answers were correct or not. While the results of the critical thinking skill of students have indicate a significant improvement after the implementation of multimedia of geometry based on van Hiele's thinking theory. In overall, the implementation of multimedia of geometry based on van Hiele's thinking theory has been effective in mathematics learning on the materials of circumference and area of circle formulas of V grade of SDN Mojoroto 6 Kediri in 2021/2022 academic year.

REFERENCES

- Abu, M. S., Ali, M. B., & Hock, T. T. (2012). Assisting Primary School Children to Progress through Their van Hiele's Levels of Geometry Thinking using Google SketchUp. *Procedia - Social and Behavioral Sciences*, 64, 75–84. <https://doi.org/10.1016/J.SBSPRO.2012.11.010>
- Adolphus, T. (2011). Problems of Teaching and Learning of Geometry in Secondary Schools in Rivers State, Nigeria. *International Journal of Emerging Sciences*, 1(2), 143–152. <https://doi.org/http://hdl.handle.net/1893/26189>
- Andini, S., Budiyo, & Fitriana, L. (2018). Developing Flipbook Multimedia: The Achievement of Informal Deductive Thinking Level. *Journal on Mathematics Education*, 9(2), 227–238. <https://eric.ed.gov/?id=EJ1193653>
- Andini, S., Fitriana, L., & Budiyo. (2018). Geometry in flipbook multimedia: a role of technology to improve mathematics learning quality: the case in madiun, east java. *Journal of Physics: Conference Series*, 1008(1), 012077. <https://doi.org/10.1088/1742-6596/1008/1/012077>
- Ariani, N., & Haryanto, D. (2010). *Pembelajaran multimedia di sekolah: Pedoman pembelajaran inspiratif, konstruktif, dan prospektif*. Prestasi Pustaka Publisher.

- Crowley, M. . (1987). The van Hiele model of the development of geometric thought. *Yearbook of National Council of Teachers of Mathematics*, 1–16. [http://www.csmate.colostate.edu/docs/math/mathactivities/june2007/The van Hiele Model of the Development of Geometric Thought.pdf](http://www.csmate.colostate.edu/docs/math/mathactivities/june2007/The_van_Hiele_Model_of_the_Development_of_Geometric_Thought.pdf)
- Erdoğan, T., & Durmuş, S. (2009). The effect of the instruction based on Van Hiele model on the geometrical thinking levels of preservice elementary school teachers. *Procedia - Social and Behavioral Sciences*, 1(1), 154–159. <https://doi.org/10.1016/J.SBSPRO.2009.01.029>
- Gecü, Z., & Özdener, N. (2010). The effects of using geometry software supported by digital daily life photographs on geometry learning. *Procedia - Social and Behavioral Sciences*, 2(2), 2824–2828. <https://doi.org/10.1016/J.SBSPRO.2010.03.422>
- Goodyear, P., & Retalis, S. (2010). *Technology-Enhanced Learning*. Sense Publishers. <https://www.sensepublishers.com/media/1037-technology-enhanced-learning.pdf>
- Hardianti, D., Priatna, N., & Priatna, B. A. (2017). Analysis of Geometric Thinking Students' and Process-Guided Inquiry Learning Model. *Journal of Physics: Conference Series*, 895((1):012088), 012088. <https://doi.org/10.1088/1742-6596/895/1/012088>
- Isiksal, M., & Askar, P. (2005). The effect of spreadsheet and dynamic geometry software on the achievement and self-efficacy of 7th-grade students. *Educational Research*, 47(3), 333–350. <https://doi.org/10.1080/00131880500287815>
- Jatmiko, & Fiantika, F. R. (2017). Perangkat Pembelajaran 4D Sebuah Rekam Jejak Proses Pembuatan Perangkat Pembelajaran Berbasis Video Animasi 3D Portofolio. *Jurnal Math Educator Nusantara: Wahana Publikasi Karya Tulis Ilmiah Di Bidang Pendidikan Matematika*, 3(1), 8–10. <http://ojs.unpkediri.ac.id/index.php/matematika/article/view/780>
- Kassim, H. (2013). The Relationship between Learning Styles, Creative Thinking Performance and Multimedia Learning Materials. *Procedia - Social and Behavioral Sciences*, 97, 229–237. <https://doi.org/10.1016/J.SBSPRO.2013.10.227>
- Kirkwood, A., & Price, L. (2014). Technology-enhanced learning and teaching in higher education: what is “enhanced” and how do we know? A critical literature review. *Learning, Media and Technology*, 39(1), 6–36. <https://doi.org/10.1080/17439884.2013.770404>
- Le, H., Janssen, J., & Wubbels, T. (2018). Collaborative learning practices: teacher and student perceived obstacles to effective student collaboration. *Cambridge Journal of Education*, 48(1), 103–122. <https://doi.org/10.1080/0305764X.2016.1259389>

- Ma, H.-L., Lee, D.-C., Lin, S.-H., & Wu, D.-B. (2015). A Study of Van Hiele of Geometric Thinking among 1st through 6th Graders. *EURASIA Journal of Mathematics, Science & Technology Education*, 11(5), 1181–1196. <https://doi.org/10.12973/eurasia.2015.1412a>
- Nagendrababu, V., Pulikkotil, S. J., Sultan, O. S., Jayaraman, J., Soh, J. A., & Dummer, P. M. H. (2019). Effectiveness of technology-enhanced learning in Endodontic education: a systematic review and meta-analysis. *International Endodontic Journal*, 52(2), 181–192. <https://doi.org/10.1111/iej.12995>
- Olkun, S., Altun, A., & Smith, G. (2005). Computers and 2D geometric learning of Turkish fourth and fifth graders. *British Journal of Educational Technology*, 36(2), 317–326. <https://doi.org/10.1111/j.1467-8535.2005.00460.x>
- Pribadi, B. A. (2017). *Media dan Teknologi dalam Pembelajaran*. Kencana.
- Primasatya, N., & Ahdhianto, E. (2017). Pengembangan modul geometri berbasis teori berpikir van hiele guna meningkatkan kemampuan berpikir kritis siswa kelas V. *Ed-Humanistics : Jurnal Ilmu Pendidikan*, 2(2). <http://ejournal.unhasy.ac.id/index.php/ed-humanistics/article/view/209>
- Primasatya, N., & Jatmiko, J. (2018). Pengembangan multimedia geometri berbasis teori berpikir van hiele guna meningkatkan kemampuan berpikir kritis siswa kelas V. *JIPMat*, 3(2), 115–121. <https://doi.org/10.26877/jipmat.v3i2.2745>
- Primasatya, N., & Jatmiko, J. (2019). Implementation of Geometry Multimedia Based on Van Hiele's Thinking Theory for Enhancing Critical Thinking Ability for Grade V Students. *International Journal of Trends in Mathematics Education Research*, 1(2), 56–59. <https://doi.org/10.33122/ijtmer.v1i2.40>
- Sariyasa. (2017). Creating Dynamic Learning Environment to Enhance Students' Engagement in Learning Geometry. *Journal of Physics: Conference Series*, 824(1), 012057. <https://doi.org/10.1088/1742-6596/824/1/012057>
- Schunk, D. H. (2011). *Learning Theories: An Educational Perspective, 6th Edition*. Addison Wesley. <https://doi.org/10.1017/CBO9781107415324.004>
- Scott, K. M., Baur, L., & Barrett, J. (2017). Evidence-Based Principles for Using Technology-Enhanced Learning in the Continuing Professional Development of Health Professionals. *Journal of Continuing Education in the Health Professions*, 37(1), 61–66. <https://doi.org/10.1097/CEH.0000000000000146>

- Solaiman, M. N. P., Magno, S. N., & Aman, J. P. (2017). Assessment of the Third Year High School Students' Van Hiele Levels of Geometric Conceptual Understanding in Selected Secondary Public Schools in Lanao del Sur. *Journal of Social Sciences (COES&RJ-JSS)*, 6(3), 603–609. <https://doi.org/10.25255/jss.2017.6.3.603.609>
- Tieng, P. G. L. K. (2014). Improving Students' Van Hiele Level of Geometric Thinking Using Geometer's Sketchpad. *Malaysian Online Journal of Educational Technology*, 2(3), 20–31. <https://eric.ed.gov/?id=EJ1086363>
- Wawan, W., Marsigit, M., Fitria Ningsih, E., Widyawati, S., Kusumaningtyas, W., Mahmudi, M., Suhono, S., Mukhlisin, A., Putra, F. G., & Setiawan, A. (2018). Technology-Integrated Collaborative Learning: Convenient AI-ternative in Developing the Problem Solving Capability and Positive Attitude towards Mathematics Eka Fitria Ningsih Institut Agama Islam Ma'arif NU Metro Lampung Technology-Integrated Collaborative Learning: Convenient AI-ternative in Developing the Problem Solving Capability and Positive Attitude towards Mathematics. *International Journal of Engineering & Technology*, 7(2), 737–740. <https://doi.org/10.14419/ijet.v7i3.2.18739>