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RESEARCH ARTICLE

EFFECTIVENESS OF HEAT AND TRANSFER E-BOOKBASED ON DYNAMIC MULTIREPRESENTATION TO IMPROVE STUDENTS' CRITICAL THINKING SKILLS

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Abstract

The development of E-book teaching materials for heat and displacement based on dynamic multi-representation has been carried out to improve students' critical thinking skills. The development was carried out using the ADDIE model with the One Group Pretest-Posttest experimental design method. The problem discussed in this case is how effective the E-book teaching material is heat and displacement based on dynamic multirepresentation to improve students' critical thinking skills. The research was conducted in class VII E of SMPN 10 Jember for the 2022/2023 academic year, which consisted of 32 students. Data was collected using pretest and posttest questions. The effectiveness of the E-book is measured through the pretest and posttest given to students and analyzed using the n-gain test. The results showed an increase in pretest and posttest scores and an n-gain of 0.65. Due to the acquisition of n_{gain} $0.3 \leq g < 0.7$, it can be concluded that the E-book teaching material based on dynamic multi-representation heat and displacement is effective in improving students' critical thinking skills with moderate improvement categories.

Introduction:-

Education in the 21st century is education in the era of the industrial revolution 4.0 which cannot be separated from digital technology. Implementation of learning will be more effective and efficient with the help of technology. Science is a scientific discipline that teaches science that is systematic and universally applicable which discusses a set of data regarding natural phenomena obtained based on the results of observations, experiments, conclusions, and theory development [1]. Science learning has a concrete role in advancing science and technology because science learning contains processes that can build students' interest in science and technology and improve critical thinking skills [2].

One of the skills students must have in the industrial revolution era is critical thinking skills. Critical thinking skills are one of students' cognitive abilities [3]. Critical thinking skills are very important for students to be able to compete with human resources around the world [4]. In fact, students' critical thinking skills in Indonesia are still low, seen from the 2018 PISA score of 396 for science abilities and is ranked 71 out of 79 countries [5]. This low critical thinking ability can be caused by the way the teacher conveys the material and teaching materials used by students that are still not in accordance with the indicators of critical thinking ability [6]. Another reason is the use

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of teaching materials that are not yet technology-based which are still focused on presenting material so that students have not been facilitated in training and honing their critical thinking skills in learning.

Teaching materials are all types of teaching materials that provide information to assist teachers/lecturers/teaching in carrying out learning [7]. One example of teaching materials is textbooks. Textbooks can be compiled and developed in digital or electronic formats with the help of online accessible technology called e-books. E-books contain text, images, animations and other digital information with an attractive presentation to achieve the expected learning objectives. Adding learning videos to E-books can eliminate boredom and keep students focused on learning [8].

The multi-representational approach that is applied in a teaching material can be used as a way to improve critical thinking skills in learning [9]. Multirepresentation is an approach to restate a concept in several ways or delivery formats, namely verbal, pictorial, graphic and mathematical representations. The multi-representation approach makes the appearance of the E-book more interesting and rich in context, making it easier for students to understand and improve their mastery of concepts in various forms of representation [10], [11]. Learning with multiple representations can improve students' abilities and cognitive skills in thinking and reasoning and solving problems[10], [12]. The multi-representational approach in the E-book can be presented dynamically. Teaching materials based on dynamic multi-representation make students able to understand concepts in more depth with their multi-representational abilities, so that they can make students have skill to think critically.

Methods:-

This research based on development research using the ADDIE model that is the development of heat and transfer E-bookbased on dynamic multi-representation to improve the critical thinking skills of grade VII junior high school students. The design used in this study was experimental research with the One Group Pretest-Posttest design. Conducting research in class VII E of SMPN 10 Jember for the 2022/2023 academic year consisting of 32 students. This school was chosen because it has never used E-book teaching materials in its learning. Data collection was carried out using a test instrument. The tests used in this study were the initial test (pretest) and the final test (posttest) in the form of 15 description questions that had been adapted to indicators of critical thinking skills. The effectiveness of the E-book is measured through the results of the pretest and posttest which are analyzed using the n_{gain} test with the following equation.

$$N_g = \frac{(Spost) - (Sp)}{(Smax) - (Sp)}$$

The calculation results obtained are then interpreted according to the n_{gain} criteria, that is$g \geq 0.7$is in the high category, $0.3 \leq g < 0.7$is in the medium category, and $g < 0.3$is in the low category [13].

Results and Discussion:-

The teaching material used is the result of the development of an e-book on heat and displacement based on dynamic multi-representation. E-book contains concepts of temperature, expansion, heat, heat transfer, and their application in everyday life. Before being tested for its effectiveness in improving critical thinking skills, the e-book has been validated by 3 validators. The validation obtained from validator 1 is 87, from validator 2 is 91, and from validator 3 is 89, with an average validity score of 89 with a very valid category so that it is suitable for use as teaching material and can be applied in learning.The test sheet used to test the level of students' critical thinking skills before and after using the E-book was also validated first with a result of 91.94% with very valid criteria. After the product and test instrument are said to be valid, they are feasible to be implemented in the field.The effectiveness of the E-book is obtained by distributing pretest and posttest questions which consist of 15 essay questions that have been adapted to indicators of critical thinking skills. The results of pretest and posttest questions from the students then analyzed using the n_{gain} calculation to determine the effectiveness of the heat and transfer E-book based on dynamic multi-representation. Descriptions of pretest and posttest scores are shown in the following table.

Table 1:- Pretest and posttest scores.

Description	Score		N_g	Category
	Pretest	Posttest		
Average score	41,99	80,22	0,65	Medium
Highest score	70,31	92,19		
Lowest score	26,56	60,94		

Table 1 shows the average pretest score obtained before using the E-book of 41.99 with the highest score of 70.31 and the lowest score of 26.56. The posttest average score obtained after using the E-book was 80.22 with the highest score of 92.19 and the lowest score of 60.94. The average value of the final test has increased compared to the average score obtained by students in the initial test, namely with a difference of 38.23. These results indicate that there has been an increase in students' understanding of heat and its displacement material so that teaching materials are said to be effective. The n_{gain} value is 0.65 and is included in the medium category. It can be concluded that the E-book of heat and transfer based on dynamic multi-representation is effectively used in learning to improve students' critical thinking skills with medium improvement. In accordance with Santoso et al. that the increase in student learning outcomes using e-books is higher than students using printed books[14]. Supported by the opinion of Reizal et al. that effective teaching materials can improve students' abilities and learning outcomes so that the quality of learning becomes better[15].

Table 2:- The results of achieving indicators of critical thinking skills.

Indicators of critical thinking skills	Average score		N-gain	Kategori
	Pretest	Posttest		
Interpretation	55,46	87,5	0,72	High
Analysis	44,53	78,38	0,61	Medium
Inference	21,87	83,2	0,78	High
Evaluation	29,68	66,79	0,53	Medium
Explanation	49,6	83,59	0,67	Medium
Self regulation	47,65	91,4	0,84	High

Table 2 shows the average pretest and posttest scores and the n_{gain} value for each indicator has increased. The self-regulation indicator has the highest n_{gain} value of 0.84 in the high category while the evaluation indicator has the lowest n-gain value of 0.53 in the medium category. The existence of a dynamic multi-representation display is another advantage in this E-book. Presentation of material in the E-book has been prepared using a multi-representational approach or dynamic representation of material including: 1) Representation of text, images, graphics, and mathematics with a moving (dynamic) display; 2) audio visual representation through learning videos from YouTube contained in the E-book; 3) detailed and clear visualization of material makes it easier for students to understand the material; 4) the animated videos presented are easy to play back so they can adjust the level of student understanding. The multi-representation-based E-book that was developed is feasible to implement because it succeeds in making students understand the concept of the material by providing dynamic visualization[16]. The effectiveness of multi-representational dynamic E-book teaching materials based on heat and displacement is also supported by relevant studies. Research conducted by Asda& Andromeda also states that the use of integrated multi-representational teaching materials is effective in improving student learning outcomes with a high level of effectiveness category[17].

Conclusion:-

The e-book of heat and transfer based on dynamic multi-representation is effective for improving students' critical thinking skills based on an n_{gain} of 0.65 which is included in the medium category. These results indicate that there has been an increase in students' understanding of heat and displacement material so that the E-book of dynamic multi-representation based heat and displacement teaching materials is said to be effective and can be used in learning.

References:-

[1] D. Harefa and M. Sarumaha, Teori Pengenalan Ilmu Pengetahuan Alam pada Anak Usia Dini. Banyumas: PM Publisher, 2020.

[2] F. Fidiantara, Kusmiyati, and I. W. Merta, "PENGARUH PENGGUNAAN BAHAN AJAR IPA MATERI SISTEM EKSKRESI BERBASIS INKUIRI TERHADAP PENINGKATAN LITERASI SAINS," Pijar MIPA, vol. 15, no. 1, pp. 88–92, 2020, doi: 10.29303/jpm.v15i1.

[3] I. K. Mahardika et al., "the Level of Content Feasibility of Vgm Representation-Based Physics Textbook After Being Used in the Learning Process.," Int. J. Adv. Res., vol. 6, no. 1, pp. 1539–1543, 2018, doi: 10.21474/ijar01/6386.

[4] I. K. Mahardika et al., "Content and Language Feasibility Component of Physics Textbook Based on Ivm Representation To Train Critical Thinking Skill of Vocational Students.," Int. J. Adv. Res., vol. 6, no. 1, pp. 1549–1555, 2018, doi: 10.21474/ijar01/6388.

[5] L. Hewi and M. Shaleh, "Refleksi Hasil PISA (The Programme For International Student Assesment): Upaya Perbaikan Bertumpu Pada Pendidikan Anak Usia Dini)," J. Golden Age, vol. 4, no. 01, pp. 30–41, 2020, doi: 10.29408/jga.v4i01.2018.
[6] M. Rizkika, P. Dwi, and N. Ahmad, "Development of E-LKPD Based on STEM on Substance Pressure Materials to Improve Critical Thinking Skills for Junior High School Student," Pancasakti Sci. Educ. J. PSEJ, vol. 7, no. 1, pp. 41–48, 2022, doi: 10.4905/psej.v7i1.142.
[7] I. K. Mahardika, Representasi Mekanika dalam Pembahasan: Sebuah Teori dan Hasil Penelitian Pengembangan Bahan Ajar Mekanika. Jember: UPT Penerbitan Unej, 2012.
[8] N. Ahmad, P. D. A. Putra, and S. Wahyuni, "Analisis Produksi Video Pembelajaran Pada Tugas Proyek Mata Kuliah Cahaya Dan Penglihatan Tema Fenomena Optik," Educ. J. J. Educ. Res. Dev., vol. 5, no. 2, pp. 203–214, 2021, doi: 10.31537/ej.v5i2.516.
[9] U. Kalsum, Saefuddin, and M. A. Marhadi, "Penerapan Model Discovery Learning Berbasis Multirepresentasi Untuk Meningkatkan Keterampilan Berpikir Kritis Dan Penguasaan Konsep Ikatan Kimia," J. Pendidik. Kim. Univ. halu oleo, vol. 4, no. 2, pp. 177–182, 2019.
[10] D. Setyowati, I. K. Mahardika, and S. Hariyadi, "Analysis of the Need for the Development Multi-Representation Modules To Foster Creative Thinking Skills of Junior High School Students During the Covid-19 Pandemic," Int. J. Adv. Res., vol. 9, no. 06, pp. 812–815, 2021, doi: 10.21474/ijar01/13082.
[11] T. Kurniasari and I. K. Mahardika, "the Effectiveness of the Advance Project Learning (Apl) Model To Improve Students Multirepresentation Ability in Chemistry Learning At Public High School," Int. J. Adv. Res., vol. 10, no. 07, pp. 458–462, 2022, doi: 10.21474/ijar01/15057.
[12] R. Indrianingrum, I. K. Mahardika, D. Wahyuni, Sutarto, Indrawati, and S. Hariyadi, "Effectiveness of Stem-Based Science Student Worksheet in Improving Multiple Representation Ability of Junior High School Students," Int. J. Adv. Res., vol. 6, no. 4, pp. 1366–1369, 2018, doi: 10.21474/ijar01/6995.
[13] Y. Lestari and Mujib, "Kemampuan Berpikir Kritis Matematis Melalui Model Education Coins of Mathematics Competition (E-COC)," Desimal J. Mat., vol. 1, no. 3, pp. 265–274, 2018, [Online]. Available: http://ejournal.radenintan.ac.id/index.php/desimal/index
[14] T. N. B. Santoso, S. Siswandari, and H. Sawiji, "The Effectiveness of eBook versus Printed Books in the Rural Schools in Indonesia at the Modern Learning Era," Int. J. Educ. Res. Rev., vol. 3, no. 4, pp. 77–84, 2018, doi: 10.24331/ijere.453512.
[15] H. Reizal, A. Agustiningsih, and F. S. Hutama, "Pengembangan Buku Ajar Berbasis Infografis Pada Tema Ekosistem Untuk Meningkatkan Hasil Belajar Siswa Kelas V Sd," Muallimuna J. Madrasah Ibtidaiyah, vol. 5, no. 2, p. 1, 2020, doi: 10.31602/muallimuna.v5i2.2879.
[16] R. Rasmawan, "Development of multi-representation based electronic book on inter molecular forces (IMFs) concept for prospective chemistry teachers," Int. J. Instr., vol. 13, no. 4, pp. 747–762, 2020, doi: 10.29333/iji.2020.13446a.
[17] V. D. Asda and A. Andromeda, "Efektivitas E-modul Berbasis Guided Inquiry Learning Terintegrasi Virlabs dan Multirepresentasi pada Materi Larutan Elektrolit dan Nonelektrolit terhadap Hasil Belajar Siswa," Edukatif J. Ilmu Pendidik., vol. 3, no. 3, pp. 710–716, 2021, doi: 10.31004/edukatif.v3i3.423.