E.ISSN.2614-6061
P.ISSN.2527-4295 Vol.8 No.2 Edisi Mei 2020

THE EFFECTIVENESS OF LEARNING DEVICES THROUGH THE STEM APPROACHES TO TRAIN STUDENTS' CRITICAL THINKING SKILLS

Oleh:
Winda Rachman Putri[1)] , Z. A. Imam Supardi[2)], Elok Sudibyo[3)]
[1,2,3]Universitas Negeri Surabaya
[1]winda.17070795034@mhs.unesa.ac.id,
[2]zainularifin@unesa.ac.id,
[3]eloksudibyo@unesa.ac.id

Abstrak

Penelitian ini bertujuan untuk mendeskripsikan keefektifan perangkat pembelajaran dengan pendekatan *STEM* untuk melatihkan keterampilan berpikir kritis peserta didik. Keefektifan perangkat pembelajaran dianalisis berdasarkan hasil tes keterampilan berpikir kritis dan respons peserta didik terhadap pembelajaran. Teknik pengumpulan data dilakukan dengan metode tes dan metode angket. Metode tes digunakan untuk mengetahui ketercapaian keterampilan berpikir kritis peserta didik, sedangkan metode angket digunakan untuk mengetahui respons peserta didik terhadap perangkat pembelajaran yang digunakan. Uji coba terhadap perangkat pembelajaran dilakukan pada 75 peserta didik kelas XI SMAN 3 Sidoarjo menggunakan metode *one grup pre-test post-test design experimental.* Hasil analisis data menunjukkan bahwa skor keterampilan berpikir kritis peserta didik mengalami peningkatan setelah diterapkannya pembelajaran *STEM* dengan kategori tinggi. Selain itu, sebagian besar peserta didik memberikan respons positif terhadap komponen pembelajaran dan menunjukkan minat yang baik untuk mengulangi pembelajaran dengan pendekatan *STEM*. Berdasarkan hasil analisis data, dapat disimpulkan bahwa perangkat pembelajaran dengan pendekatan STEM efektif digunakan untuk melatihkan keterampilan berpikir kritis peserta didik .

Kata Kunci : Pendekatan STEM, keterampilan berpikir kritis

1. INTRODUCTION

Mastery of critical thinking skills which is a fundamental skill is one of the demands of 21st century skills known as 4C, which includes *critical thinking and problem solving skills*, *creativity and innovation* (creative and innovative), and *communication and collaboration* (communication and collaboration skills in groups) (Bialik, et al., 2015). Critical thinking is a process of thinking in which a person tests and evaluates several ideas based on the knowledge he has before to make a decision on a matter (University, 2018). In the era of digital literacy where the flow of information is very abundant, a person needs to have critical thinking skills including interpretation, analysis, evaluation, *inference*, explanation and self-regulation (regulation), to choose relevant sources and information, find quality sources, and conduct an assessment of the sources of aspects of objectivity, reliability, and updating (Facione, 2015).

The results of the 2015 PISA Mapping published by the *Organization for Economic Co-Operation and Development* (OECD) showed that more than 50% of participants from Indonesia were at level 1b, level 1a, and level 2 (OECD, 2016). Students who fail to reach level 2 in PISA mapping are considered to have not mastered the skills and knowledge to compete and participate in the 21st century work world (Thomson, *et al.*, 2013). Preliminary studies conducted in twelfth grade MIA 5 of SMA Negeri 3 Sidoarjo also showed the same thing. As many as 81.80% of students are in the category of very less critical, with evaluation and explanation being the two indicators that are the least mastered, namely 18.18% and 15.60%.

Based on the description above, one of the initial steps that can be taken is to improve science learning in schools. This is consistent with what was conveyed by Redhana (2019), that efforts to meet human resources who master 21st century skills will be very effective if pursued through education. Today, learning with the approach of *Science, Technology, Engineering, and Mathematics (STEM)* is adopted by several countries as an educational innovation to bridge the gap between the needs and availability of expertise needed by the 21st century work world. *STEM* is learning that integrates knowledge in science, technology, techniques, and mathematics as the core, and focus on systematic problem solving that enables students to utilize knowledge for everyday life (Oonsim, *et al*., 2017). Organizing learning activities in *STEM* helps students develop problem solving skills, critical thinking skills, and creative thinking skills (Jindanurak, 2016). This is similar to the results of research conducted by Oonsim which shows that *STEM* learning can develop critical thinking skills of secondary school students on electrostatic material because it provides a situation

that challenges the thinking of individual students (Oonsim, *et al*., 2017).

In learning, the use of approaches and learning models must be adjusted to the characteristics of the material so that the results obtained can be maximized. The *STEM* approach which contains elements of technology in accordance with one of the basic competencies in Physics at the High School level, namely dynamic fluid. The intended basic competency is basic competency 3.4 which reads "Applying the principle of dynamic fluid in technology" (Kemendikbud, 2016). In addition, the basic competency 4.4 which reads "Creating and testing a simple project that applies the principle of dynamic fluid" can also be achieved with the *Technology and Engineering* steps that are part of the *STEM* approach (Kemendikbud, 2016).

Based on the description above, the aims of this study is to describe the effectiveness of learning devices through the STEM approach to train students' critical thinking skills.

2. RESEARCH METHODS

This research was conducted using learning devices that are arranged following the ADDIE development model flow with steps of analysis, *design*, *develop*, implementation, and evaluation (Muruganantham, 2015). At the implementation stage, a trial run is carried out using the *experimental one group pre-test post-test design method*. The trial was conducted on 75 eleventh grade students at SMAN 3 Sidoarjo. The trial scheme for the implementation phase is:

O_1	**X**	**O_2**

Figure 1. *One Grup Pre-Test Post-Test Design Experimental* Scheme

Source: (Sugiyono, 2013)

Note:

O1 : Initial test (pre-test) conducted before being given treatment in the form of the use of learning devices that were developed.

X : The treatment is carried out by applying the developed learning devices.

O2 : The final test (post-test) conducted after the treatment is given.

Data collection techniques were carried out using the questionnaire and test methods. The data analysis technique used is the effectiveness analysis of learning tools in terms of the achievement of critical thinking skills and students' responses.

3. RESULTS AND DISCUSSIONS

Results

The results of this study in the form of effectiveness of learning tools can be seen from the results of students 'critical thinking skills tests and students' responses to learning conducted using devices with the *STEM* approach. The following are presented the results of the effectiveness of learning devices for each of these aspects.

1. Critical Thinking Skills

The effectiveness of the data is taken through *pre-test* and *post-test* activities using questions arranged to measure students' critical thinking skills with indicators of interpretation, analysis, *inference*, evaluation, and explanation (Facione, 2015). The results of students' critical thinking skills can be presented in Table 2.

Table 2. N-Gain Test Results for Every Critical Thinking Skil Indicator

No.	Indicators of Critical Thinking Skills	*N-Gain*			Category		
		XI MIA 6	XI MIA 7	XI MIA 9	XI MIA 6	XI MIA 7	XI MIA 9
1.	Interpretation	0,92	0,86	0,96	T	T	T
2.	Analysis	0,87	0,88	0,88	T	T	T
3.	*Inference*	0,87	0,87	0,81	T	T	T
4.	Evaluation	0,57	0,77	0,70	S	T	T
5.	Eksplanation	0,51	0,51	0,52	S	S	S

Note:
T= High S= Average

Based on Table 2 above, students in the three classes experienced an increase in critical thinking skills mastery for each indicator, with explanatory indicators being the indicators with the lowest category of improvement compared to the other indicators, which are of the average category.

2. Student's Response

The effectiveness of the learning devices developed can also be viewed from the students' responses to learning. Data on students' responses are obtained through a questionnaire filled out by students after doing all the learning phases. Students in all three classes show identical responses, where they respond positively to the attractiveness of the learning component.

Most of the students also felt that the learning carried out had a positive impact on their critical thinking skills. Students feel that after learning, critical thinking skills which include the ability to interpret, analyze, *inference* (make alternative assumptions and conclude), evaluation (assess the credibility of a statement), and explanation (confirm a procedure) becomes easier to do and achieve.

Discussion

1. Critical Thinking Skills

Based on the *N-Gain* analysis it can be seen that students' critical thinking skills have improved after the implementation of *STEM* learning, both in class XI MIA 6, XI MIA 7, and XI MIA 9. Such results are consistent with the research of Oonsim, *et al* (2017), where the application of STEM learning on electrostatic material can improve critical thinking skills of 81% of students. Research conducted by Tungsombatsanti, et al (2018) with the title *"The Results of STEM Education Methods in Physics at the 11th Grade Level: Light and Visual Equipment Lesson"* also shows that STEM learning is very efficiently applied to improve students' critical thinking skills.

In this study, two of the three classes experienced an increase in critical thinking skills with the Critical category, while one other class experienced an increase in the Very Critical category. This can be caused by several things namely, (1) It is possible that students in the class do not support certain learning activities because of individual learning preferences, as stated in Howard Gardner's multiple intelligence theory (Musfiroh, 2014), (2) Intrinsic motivation each student is different, students with higher intrinsic motivation will more easily absorb new things and try to be able to solve problems by exerting critical thinking skills, whereas students with low intrinsic motivation only follow modest learning (Khoiriyah , *et al*., 2018), (3) It is possible that some students need more learning time to handle activities effectively (Oonsim, *et al*., 2017), (4) According to cognitive theory, different individuals can build understanding differ even when they interact with identical environmental conditions (Moreno, 20 10).

2. Student's Response

Students in all three classes show identical responses, where they respond positively to the attractiveness of the learning component. This shows that most students have a high attention towards learning activities using the *STEM* approach. Learners' attention to learning activities and learning components are very important for the achievement of learning objectives. This is in accordance with what was said by Bandura, that students need to be interested in something in learning in order to be able to learn optimally (Moreno, 2010). Good teaching materials should attract interest and as much as possible motivate students to learn it further, so that he can develop his abilities (Toharudin, *et al*., 2011). High attention also causes students to be interested in participating in learning activities with the *STEM* approach at the next meeting.

Most of the students also felt that the learning that was carried out had a positive impact on their critical thinking skills. This was also in line with the increase in the results of the *pre-test* that had been conducted. The stages of *STEM* learning provide an opportunity for students to develop their critical thinking skills. This is in accordance with research conducted by Khoiriyah, *et al* (2018), which shows that the *STEM* approach applied to sound wave material can improve the critical thinking skills of participants.

4. CONCLUSION

Based on the results of the research that has been done, it can be concluded that the learning devices developed using the *STEM* approach are effective for training students' critical thinking skills.

5. SUGGESTION

The evaluation and explanation indicators are still the indicators with the lowest mastery in this study, so for further research it needs to be considered to focus on these two indicators of critical thinking skills.

6. REFERENCES

Bassham, G., Irwin, W., Nardone, H., & Wallace, J. M. (2018). *Critical Thinking: A Student's Introduction sixth Edition.* New York: The McGraw-Hill Companies.

Bialik, M., & Fadel, C. (2015). *Skills for the 21st Century: What Should Student Learn.* Boston: Center for Curriculum Redesign.

Facione, P. A. (2015). Critical Thinking: What It Is and Why It counts.

Firman, H. (2015). Pendidikan Sains Berbasis STEM: Konsep, Pengembangan, dan Peranan Riset Pascasarjana. *Seminar Nasional Pendidikan IPA dan PKLH.* Bogor.

Jindanurak, T. (2016). Professional Science Teachers.

Kemendikbud. (2016). *Lampiran 8 Permendikbud no 24 tahun 2016.* Jakarta: Kemendikbud R1.

Khoiriyah, N., Abdurrahman, & Wahyudi, I. (2018). Implementasi Pendekatan Pembelajaran STEM untuk Meningkatkan Kemampuan Berpikir Kritis Siswa SMA pada Materi Gelombang Bunyi. *5*.

Moreno, R. (2010). *Education Psychology.* Mexico: University of New Mexico.

Muruganantham, G. (2015). Developing of E-Content Package by Using ADDIE Model. *1(3)* .

Musfiroh, T. (2014). *pPengembangan kecerdasan Majemuk.* Jakarta: Universitas Terbuka.

OECD. (2016). *PISA 2015 Assessment.* Paris: OECD.

Oonsim, W., & Chanprasert, K. (2017). Developing Critical Thinking Skills of Grade 11 Students by STEM Education: A Focus on Electrostatic in Physics. *Vol.4, No.1, pp. 54-59* (ISSN 2408-1809).

Painprasert, N., & Jeerungsuwan, N. (2015). Factors Supporting the STEM education Learning Management of Leader Teachers in the STEM Education Network of Thailand. *International Conference on elearning for Knowledge Based Society.* Bangkok.

Redhana, I. W. (2019). Mengembangkan Keterampilan Abad 21 Dalam Pembelajaran Kimia. *Vol 13, No 1*.

Sugiyono. (2013). *Metode Penelitian Kuantitatif, Kualitatif, R&D.* Bandung: Alfabeta.

Thomson, S., Bortoli, L. D., & Sarah, B. (2013). *PISA in Brief: Highlights from the full*

Australian report. Australia: Australia Council for Education Research.

Toharudin, U., Hendrawati, S., & Rustaman, A. (2011). *Membangun Literasi Sains Peserta Didik.* Bandung: Humaniora.

Tungsombatsanti, A., Ponkham, K., & Somtoa, T. (2018). The Results of STEM Education Methods in Physics at the 11th Grade Level: Light and Visual Equipment Lesson. *AIP conference proceedings. 978-0-7354-1615-4.* American Institute of Physics.

University, T. O. (2018). *Thingking Critically.* Milton Keynes: Thanet Press.