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The Implementation of Protein Metabolism E-Modules in Biochemistry Learning to Increase Students' Critical Thinking Skills

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Abstract

Appropriate media and learning resources can optimize learning innovations in the 21st century. The use of technology has become an efficient alternative in the implementation of learning. This research aims to implement the protein metabolism electronic modules (e-modules) as biochemistry teaching materials to improve students' critical thinking (CT) skills. This research refers to comparative quantitative nonparametric methods by comparing measurements of CT skills before applying e-modules during the lesson with the height of CT skills after using the e-module. The e-modules include videos, images, animations, links to various primary sources, and formative tests that follow the learning outcomes. As the result, the advancement of CT skills from the final measurements illustrated a reduction in the number of students categorized as bad and poor and an increasing number of students categorized as good and excellent. Furthermore, the skill improvement can also be seen through the Two Tail T-Test, with a t_{count} of 4.7752, while the t_{table} value for the Two Tail T-Test of 2.0262. Since $t_{count} > t_{table}$ suggests a significant difference between the initial and final measurement scores test, H_0 is rejected, and H_1 is accepted. This research concludes that there is an increase in students' CT skills after participating in biochemistry learning using this protein metabolism e-module.

Keywords: biochemistry, electronic module, protein metabolism

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1. Introduction

The 21st century requires creativity, critical thinking (CT), communication, and collaboration (4C) (Trilling & Fadel, 2009). However, the essential skills that everyone should acquire at a decent level is CT skills, notably in this disruption era. Critical thinking is associated with giving reasons for rational thinking (Paul & Elder, 2006). Critical thinking is reasoned and reflective thinking by emphasizes making decisions about what to believe or do. The following are examples of critical thinking skills, for example (1) comparing and contrasting, (2) making categories, (3) examining small parts and the whole, (4) explaining causes, (5) making sequences, (6) determining trusted sources, and (7) making predictions (Mustaji, 2009). Thus, CT skills is one of the skills necessary for students to possess. In addition, teaching CT has various methods; it begins with the explicit curricula that aim to identify and practice the skills. On the other hand, higher-order thinking skills (HOTS) require content-based projects that involve interpreting, analyzing, evaluating evidence, taking multiple perspectives, distinguishing patterns, and understanding abstract ideas (Griffin et al., 2012). Furthermore, the purpose of developing CT skills is to have superior quality of thinking, which is needed both inside and outside of school (Dwiyogo, 2013).

On the other hand, the development requires learning resources applicable anywhere and

anytime. Learning resources allow students to understand the material in a shorter and more enjoyable period (Arsyad, 2013). In addition, the development of science and technology has increasingly encouraged reformation in exploiting technological results in the learning process (Bybee et al., 2006). One of the expandable learning resources is the electronic module (e-module). E-module is one of the teaching materials used to support students in learning. Therefore, it is necessary to develop modules that can facilitate learners' skills (Irwansyah et al., 2017). Learning that emphasizes students' direct involvement and appropriate media use during learning is known to improve understanding and memory (Saleh et al., 2018). As a result, students will flexibly review what they have learned in class anywhere and anytime so that it can improve students learning outcomes.

In addition, applying e-modules is more effective and efficient when using the right learning approach. The Engage, Explore, Explain, Elaborate, and Evaluate (5E) Learning Cycle approach may hopefully facilitate students to understand problems and natural phenomena and develop CT skills and scientific attitudes (Faizin et al., 2018). Moreover, learning with the 5E model can increase success and make the learning atmosphere less dull (Ulaş et al., 2012). Employing science learning tools integrated with the 5E learning cycle model can improve students' CT skills (Faizin et al., 2018). Based on the explanation above, the researchers conducted further research to implement the protein metabolism e-module to improve CT.

2. Research Method

This study employs comparative quantitative nonparametric methods. The comparative method is a method to equate the existence of a variable or more of two or more different samples (Sugiyono, 2012). Consequently, this study compared the measurement of CT skills before and after learning to use e-modules through Learning Cycle 5E. Further, a similar study has been conducted in Chemistry Education Department, the Faculty of Mathematics and Natural Sciences, Jakarta State University. Another thing to note is the protein metabolism e-modules implementation was occupied from May to July 2020 and was concurred during Mass-Social Restriction (*Pembatasan Sosial Berskala Besar/ PSBB*); as a result, the study was conducted online.

3. Result and Discussion

The Protein Metabolism E-module implemented in this study is an e-module that has been tested for feasibility by experts and students in small and large groups. The feasibility test results have been revised based on the suggestions given during the feasibility test. To specify, the implementation of this e-module is carried out in biochemistry courses. The learning model used in enforcing this e-module is 5E Learning Cycle, which is in line with the preparation of the e-module of protein metabolism based on 5E Learning Cycle. In addition, the implementation phase of this e-module was carried out online, and the pre-test was given because this learning took place during the Covid-19 pandemic. The lesson utilized the Zoom application, Google Classroom, and WhatsApp group.

After the pre-test questions were distributed via WhatsApp group, students did the pre-test from their respective residences and sent their answers via Google Drive. Later, the improvement of students' CT skills can be seen in the pre-test and post-test results. Before learning with e-modules, students are taught about protein metabolism using power points and biochemistry books on printed media. After the initial learning process, students are given pre-test questions that have been adapted to CT indicators. The result of the initial measurement before implementing e-modules can be seen in Table 1.

In the test, students' CT skills were distributed into five categories, ranging from bad to excellent. However, the pre-test results present the poor and enough categories as the most dominant category for students' CT skills.

Table 1. The Analysis of Initial Measurement on Students' CT Skills

Respondents	Total Score	Percentage (%)	Category
1	16	57,14	Enough
2	18	64,29	Enough
3	19	67,86	Enough
4	13	46,43	Poor
5	17	60,71	Enough
6	14	50,00	Poor
7	18	64,29	Enough
8	19	67,86	Enough
9	13	46,43	Poor
10	21	75,00	Good
11	19	67,86	Enough
12	15	53,57	Poor
13	16	57,14	Enough
14	17	60,71	Enough
15	10	35,71	Bad
16	11	39,29	Bad
17	14	50,00	Poor
18	20	71,43	Enough
19	21	75,00	Good
20	12	42,86	Poor
21	12	42,86	Poor
22	18	64,29	Enough
23	8	28,57	Bad
24	13	46,43	Poor
25	17	60,71	Enough
26	11	39,29	Bad
27	14	50,00	Poor
28	17	60,71	Enough
29	8	28,57	Bad
30	12	42,86	Poor
31	13	46,43	Poor
32	9	32,14	Bad
33	14	50,00	Poor
34	20	71,43	Enough
35	13	46,43	Poor
36	15	53,57	Poor
37	17	60,71	Enough
38	13	46,43	Poor

A total of 15 respondents were in the enough category, 15 were in the poor category, six were in a bad category, and only two students were categorized as good. In addition, the analysis results were obtained from the students' answers to the pre-test questions. Many students do not get a CT score because they leave answers on indicators blank, identify criteria to consider possible answers, and indicators reveal problems and formulate alternative solutions.

The following learning activity is based on the 5E Learning Cycle learning steps, which are carried out online using the Zoom, Google Classroom, and WhatsApp Groups. E-modules are utilized as a medium so that students shall solve problems that are more directed to follow lesson learning outcomes (*Capaian Pembelajaran Mata Kuliah/ CPMK*), sub-lesson learning outcomes, and CT indicators. With the preparation of the Protein Metabolism E-module based on the 5E Learning Cycle, students used the e-module as a guide and followed the learning steps. The first learning step is Engagement. Students read articles or watch introductory videos before discussing the topic of the problem. This introductory article and video are already available in the e-module. From the introductory article or video, students learn to relate things in everyday life to the material topics to be discussed. In line with the research conducted by Childs et al. (2015), the best approach to learning chemistry is to include examples of everyday chemistry into different topics, use them to introduce the topic, and illustrate the theory to be taught. Learning is not just an activity of transferring knowledge from teachers to students, but how students are able to interpret what they learn (Kadir, 2013). At the end of the introductory article or video, students are directed to focus on the learning sub-achievements of the subject to be studied. Figure 1 shows the students of Biochemistry class during the e-module implementation.

Figure 1. Students of Biochemistry Class during E-Module Implementation

The second stage is Explore. At this stage, students and their groups solve the problems that have been given according to the topic of

the material that has been distributed. The form of problem-solving was presented using PowerPoint. The students presentation can be seen in Figure 2.

The third stage is Explain. At this stage, students explain the results of their group discussions to their classmates. The topic of the problem is given differently for each group. The division of groups is adjusted to the learning activities listed in the e-module. When students present the results of their discussions, the researchers observe their CT abilities according to CT indicators.

Figure 2. Students' Online Presentations

In this explanation stage, there is also a discussion session. In this discussion session, the CT ability of each student was more visible in asking and answering questions. The discussion sessions can be seen in Figure 3.

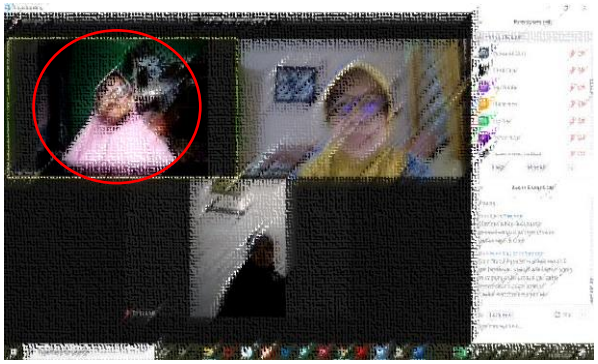

Figure 3. The Discussion Session: A student (upper left) was answering questions from another group written in the question section.

The next stage is Elaboration. At this stage, students are accompanied by the direction of the lecturer to review and analyze the material that has been presented and focus on the topic of the material being discussed. The last stage is Evaluation. This stage is used to test students' abilities by taking quizzes contained in the Protein Metabolism E-module.

Table 2. The Analysis of Final Measurement on Students' CT Skills

Respondents	Total Score	Percentage (%)	Category
1	24	85,71	Good
2	25	89,29	Good
3	26	92,86	Excellent
4	21	75,00	Good
5	26	92,86	Excellent
6	22	78,57	Good
7	26	92,86	Excellent
8	25	89,29	Good
9	15	53,57	Poor
10	24	85,71	Good
11	26	92,86	Excellent
12	26	92,86	Excellent
13	24	85,71	Good
14	24	85,71	Good
15	11	39,29	Bad
16	12	42,86	Poor
17	23	82,14	Good
18	23	82,14	Good
19	25	89,29	Good
20	16	57,14	Enough
21	12	42,86	Poor
22	17	60,71	Enough
23	14	50,00	Poor
24	14	50,00	Poor
25	16	57,14	Enough
26	16	57,14	Enough
27	17	60,71	Enough
28	11	39,29	Bad
29	6	21,43	Bad
30	14	50,00	Poor
31	11	39,29	Bad
33	18	64,29	Enough
34	14	50,00	Poor
35	13	46,43	Poor
36	18	64,29	Enough
37	18	64,29	Enough
38	10	35,71	Bad

After all stages of 5E Learning Cycle have been completed in learning. The meeting was closed with a post-test in the form of an essay made following lesson learning outcomes, sub-lesson learning outcomes, and CT indicators. The final measurement results can be seen in Table 2.

The final measurement showed an increase in students' CT category, indicated by a boost in the number of students categorized as excellent and a reduced number of students in the enough and poor categories. These analysis results were obtained from the students' answers to the post-test questions. Students identified as excellent have met the criteria for CT by complying with indicators such as focusing on questions, solving problems in questions, and decision-making. Meanwhile, students categorized as enough have not met the CT skills due to inadequacy on the following indicators: solving the problem in question and decision-making. Finally, students categorized as poor did not fill in the answers when the post-test was carried out.

During learning activities, students were more active in expressing opinions, constructing critical ideas, and fabricating their knowledge based on the materials explained in the e-module. During the discussion session on Zoom, students were trained to find solutions to the problems given and analyze the solutions obtained. As the time wore off, the discussion was moved to the WhatsApp group. They gave each other analysis of the arguments presented between group members. This learning process shall train students to construct knowledge appropriately and improve their CT skills.

This is in line with Garrison's opinion about the five stages of critical thinking: (1) defining the problem clearly, (2) exploring problems, (3) suggesting possible solutions, (4) evaluating its application, (5) integrating understanding with existing knowledge (Filsaime, 2008). The activeness of students in discussing shows their high enthusiasm for learning using e-modules. The use of technology in learning media can improve the quality of learning (Afrila & Yarmayani, 2018). This is supported by Sadiman (2011) who states that the use of learning media plays a role in generating student enthusiasm for learning. The use of innovative technology-based learning media such as e-modules has great potential to improve the quality of learning because it is an effective and efficient way of conveying information (Imansari & Sunaryantiningsih, 2017).

4. Conclusion

The effectiveness of the use of the protein metabolism e-module seen in the final measurement results of CT skills shows a reduction in the number of students in the poor category and an increase in the number of students in the moderate or even excellent category. The initial measurement of students' CT skills showed students categorized as bad at 15.79%, less with a percentage of 39.47%, and enough with a percentage of 39.47%. Meanwhile, the category of students with CT skills is only 5.26%.

On the other hand, the final measurement results show very significant changes from the initial measurement results. The data of students in the bad category underwent a reduction, while students categorized as good increased in number. Based on this, the percentage of students in the bad category is 13.15%, 23.68% are in the poor category, 21.05% are in the enough category, 28.94% are in a good category, and another 13.16% are in the excellent category.

Increased CT skills can also be observed through the Two Tail T-Test. Based on the calculation results, the t_{count} value is 4.7752, while the t_{table} value for the Two Tail T-Test is 2.0262. Since $t_{count} > t_{table}$ indicates a significant difference between the pre-test and post-test scores, H_0 is rejected, and H_1 is accepted. Based on these results, we concluded that there is an increase in students' CT skills from the initial to the final measurement after following the biomolecular metabolism course through the 5E Learning Cycle approach with protein metabolism e-module media.

References

Afrila, D. & Yarmayani, A. (2018). Pengembangan media pembelajaran modul interaktif dengan software Adibe Flash pada mata kuliah matematika ekonomi di Universitas Batanghari Jambi. *Jurnal Ilmiah Universitas Batanghari Jambi, 18*(3), 539-551. https://doi.org/10.33087/jiubj.v18i3.521

Arsyad, A. (2013). *Media pembelajaran*. Jakarta: Rajawali Grafindo Persada.

Bybee, R. W., Taylor, J. A., Gardner, A., Van Scotter, P., Powell, J. C., Westbrook, A., & Landes, N. (2006). The BSCS 5E instructional model: Origins and effectiveness. Colorado Springs: BSCS. Retrieved from https://bscs.org/reports/the-bscs-5e-instructional-model-origins-and-effectiveness/

Childs, P. E., Hayes, S. M., O'dwyer, A. (2015). Chemistry and everyday life: Relating secondary school chemistry to the current and future lives of students. In Eilks, I., Hofstein, A. (Eds.), *Relevant Chemistry Education*. SensePublishers, Rotterdam. https://doi.org/10.1007/978-94-6300-175-5_3

Dwiyogo, W. D. (2013). *Media Pembelajaran*. Malang: Wineka media.

Faizin, Jufri, A. W., & Jamaluddin. (2018). 5E learning cycle model to improve students' scientific attitude, *IOSR Journal of Research & Method in Education*, *8*(3), 1–3. Retrieved from https://www.iosrjournals.org/iosr-jrme/papers/Vol-8%20Issue-3/Version-1/A0803010103.pdf

Filsaime, D. K. (2008). *Menguak rahasia berpikir kritis dan kreatif.* Jakarta: Prestasi Pustaka.

Griffin, P., McGaw, B., & Care, E. (2012). *Assessment and teaching of 21st century skills.* Netherlands: Springer Dordrecht. https://doi.org/10.1007/978-94-017-9395-7

Imansari, N., & Sunaryantiningsih, I. (2017). Pengaruh penggunaan e-modul interaktif terhadap hasil belajar mahasiswa pada materi kesehatan dan keselamatan kerja. *Jurnal Ilmiah Pendidikan Teknik Elektro, 2*(1), 11-16. https://doi.org/10.30870/volt.v2i1.1478

Irwansyah, F. S., Lubab, I., Farida, I., & Ramdhani, M. A. (2017). Designing interactive electronic module in chemistry lessons. *Journal of Physics: Conference Series*, 895, 012009. https://doi.org/10.1088/1742-6596/895/1/012009

Kadir, A. (2013). Konsep pembelajaran kontekstual di sekolah. *Dinamika Ilmu, 13*(3), 17-38. Retrieved from https://journal.uinsi.ac.id/index.php/dinamika_ilmu/article/view/20

Mustaji, 2009. Pengembangan kemampuan berpikir kritis dan kreatif dalam pembelajaran di sekolah. *Pendidikan Sekolah Dasar, 5*(5). Retrieved from http://ejournal.unesa.ac.id/index.php/jurnal_wacana/article/view/5682

Paul, R., & Elder, L. (2006). *The miniatur guide to critical thinking concepts and tools.* Foundation for Critical Thinking. Retrieved from https://www.criticalthinking.org/files/Concepts_Tools.pdf

Sadiman. (2011). *Media pendidikan: Pengertian, pengembangan, dan pemanfaatannya*. Jakarta: PT Grafindo Persada.

Saleh, M., Prahmana, R. C. I., Isa, M., & Murni (2018). Improving the reasoning ability of elementary school student through the Indonesian realistic mathematics education. *Journal on Mathematics Education, 9*(1), 41–54.

https://doi.org/10.22342/jme.9.1.5049.41-54

Sugiyono. (2012). *Metode penelitian bisnis.* Bandung: Alfabeta.

Trilling, B., & Fadel, C. (2009). *21st century skills: Learning for life in our times.* San Francisco: John Wiley & Sons, Inc. Retrieved from https://www.wiley.com/en-us/21st+Century+Skills%3A+Learning+for+Life+in+Our+Times-p-9780470553916

Ulaş, A. H., Sevim, O., & Tan, E. (2012). The effect of worksheet based upon 5e learning cycle model on student success in teaching of adjectives as grammatical componen. *Procedia - Social and Behavioral Sciences*, *31*, 391–398. https://doi.org/10.1016/j.sbspro.2011.12.072