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Application of corrosion e-module to improve high-level thinking ability

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Abstract. The media used in learning can be used as an alternative effort to improve the ability of high-level thinking. Therefore, the purpose of this study is to apply corrosion e-module to improve students' high-level thinking ability. The method used is pre-experiment with research subjects as much as 38 students of Chemistry Education second semester. Information is obtained by measuring the improvement of students' high-level thinking ability. The n-gain value in cognitive analyzes is 0.639 with moderate improvement category, the cognitive rate is evaluated at 0.543 with the category of moderate increase and the cognitive level created by 0.73 with the high increase category. Overall n-gain students' high thinking ability is 0.637 with moderate improvement category. This shows the teaching materials in the form of e-module play a role in activating the learning process that impact on learning outcomes. Thus, corrosion learning using e-module can improve students' high-level thinking ability.

1. Introduction

Chemistry is a part of science that is formed through the human understanding of a phenomenon, which provides a narrative explanation and form concepts related to real life [1]. In addition, chemistry studies reactions that take place in nature and its scope must involve thoughtful activities that take place in all individual minds [2]. Through the ability to think, natural processes can be controlled to benefit and increase its benefits for humans.

One of the chemical concepts associated with natural processes and caused by chemical processes is corrosion [3]. Corrosion is part of the concept of science that can change materials such as iron, silver and the like from a good condition to a less favourable condition [2]. This concept is not efficiently understood by the dimensions of low-level thinking process, its application is widely used in line with the development of science and technology, so it takes the development of high-level thinking process in learning [4, 5].

Revised taxonomy, high-level thinking indicators involve analyzing, evaluating and creating processes [6]. This ability can bring up ideas during individual learning or tasks to assist in solving corrosion problems that adversely affect human life if not prevented [3]. Therefore, it is important to be introduced and developed during the learning process as well as impact on the learning outcomes, especially students, including students who study the concept of corrosion.

The results of class observations conducted for 2 months by following the basic chemistry II learning, effort to improve students' high-level thinking ability have been done, including by providing the problems that require high-level cognitive dimensions that analyze, evaluate and create. But this effort has not been successful optimally, this is because passive students in learning and tend to memorizing the concept.

Based on the problems that have been proposed, it is necessary learning strategies that can improve the ability of high-level thinking. High-level thinking ability as learning goals will be constrained on time allocation if not using appropriate teaching materials [7]. The use of appropriate teaching materials such as multimedia can minimize time and can facilitate information and learning content to be more dynamic, effective, and fun [8]. Such use should include part of the problem solving as reference material related to the concept being studied

Teaching and learning around the world have gone through a transformation towards the use of information and communication technology [9]. This makes the e-module as a choice of the use of technology-based teaching materials in the learning process to improve high level thinking ability. The e-module used is a problem-based corrosion e-module developed in previous research by Subarkah et al. [10]. E-module has advantages over the printed module that is interactive, loading images, audio, video and animation, can visualize the context of learning so that it can support active, effective and efficient learning [11]. Several studies have shown that using e-module can improve students' learning outcomes. Because of the subject matter, the issues related to the materials and tasks that must be done have been prepared completely in e-module [12].

This research focuses on discovering how "Application of Corrosion E-Module in Improving High-Level Thinking Ability".

2. Methods

This research applies pre-experiment method with one-group pretest and posttest research design, that is research conducted in one class only without comparative class by giving pretest before given treatment, and the last is posttest after applying problem-based learning using corrosion e-module [13]. During the learning process students study the corrosion material presented through E-module equipped with worksheets. The test questions used refers to revised Bloom's taxonomy of high-level thinking ability, those are analyze, evaluate and create. The determination of the increase in test results is based on the normal gain (n-gain) category with the equation:

$$d = = \frac{score\ of\ posttest - score\ pretest}{ideal\ score - score\ of\ pretest} \quad (1)$$

After the n-gain is obtained, the test scores obtained are then interpreted against the nine n-gain interpretation categories based on Table 1.

Table 1. N-Gain Index Interpretation [14].

N	Interpretation
d <0.3	Low
0.3 ≤ d ≤ 0.7	Medium
d ≥ 0.7	High

3. Results and Discussion

The higher level of thinking ability can be known from the pretest and posttest results of the students analyzed by using the n-gain formula and hypothesis test results.

Table 2. N-gain analysis results on each Dimension of High Level Cognitive.

Cognitive Dimension	Average Score		N-Gain	Interpretation
	Pretest	Posttest		
Analyze	47	81	0.639	Medium
Evaluate	47	79	0.543	Medium
Create	35	82	0.73	High
Average			0.637	Medium

Table 3. Improvement of High-Level Thinking Ability for Each Achievement Group.

Achievement Group	N-gain of Each High-Level Thinking Indicator			Average of N-gain	Average of N-gain
	C4[a]	C5[b]	C6[c]		
Top Group	0.76	0.73	0.85	0.78	High
Medium Group	0.64	0.59	0.712	0.64	Medium
Bottom Group	0.48	0.28	0.57	0.47	Medium
Average of N-gain	0.639	0.543	0.73	0.637	Medium
Interpretation	Medium	Medium	High		

[a] Analyze; [b] Evaluate; [c] Creating

Questions that measured cognitive analyzes have indicators outlining the mechanisms of corrosion that can be analyzed through video presented in the e-module and outlining the corrosion causing factors. Analyze involves the ability to elaborate on solving a problem into the units and determining linkages between the units so as to form a clear link [15].

Based on Table 2, the n-gains in cognitive analyzes were 0.639 and categorized as moderate increase. The use of e-module affected the improvement of learning outcomes, especially in the cognitive domain [16]. The effect of using e-module was seen in the results of students' answers that were able to clearly explain the cause of corrosion. This was indicated by the corresponding student answer criteria. Analytical abilities were needed to break the material into major parts [17]. The improvement of students' analytical ability on the corrosion concept was achieved because at the beginning of learning it was oriented with the presentation of corrosion problem. This problem was used to tie the students' curiosity in learning to think to produce a question [18]. Students were able to ask questions, analyze data and think to find solutions of problems presented during learning, those activities could improve the ability to analyze [19].

Studying in discussions using e-module was also done by students in investigating corrosion problems. Discussion could encourage students to think and improve the ability of underachieving students who were average or less to participate in the learning process [20]. Discussion could be used as a forum to reflect and share knowledge among students about the issues being studied and related to the topics covered [21]. Learning strategies done could organize the learning times, complete the understanding of each member of the group and discipline in learning [22].

Table 3 showed the use values of n-gain cognitive analyzing on top achievement group included the category with high improvement, while the medium and bottom achievement groups included the category of medium improvement. This showed that the top achievement group had the improvement in cognitive analyzes higher than the medium and bottom groups. Students with higher academic ability would achieve the ability to think better than the lower one, due to the ability to think was useful as a capital in further troubleshooting and could affect the intellectual level of the student [23].

The bottom achievement group obtained a moderate n-gain due to less use of discussion results when learning using e-module. Available facilities should be utilized to enhance learning independence and

initiative to initiate change [24]. Nevertheless, bottom achievement students continue to experience improved thinking ability in analyzing.

Questions that measured the ability to evaluate had an indicator assessing the metallic characteristics that could be used to control the corrosion rate based on electrochemical principles. Evaluation ability increased with n- other 0,543. This showed that the videos and explanations contained in the e-module could improve students' understanding of the corrosion prevention process based on electrochemical principles. Videos could help the thinking process of students in learning a concept [25]. Limitations of explanation in textbooks could be complemented through learning using technology-based media such as e-modules [26]. In addition, the presentation of problems in learning could stimulate the ability to assess students in finding solutions presented, so that the results of learning better. While learning, students actively read the discourse, because the discourse presented in the worksheet and e-module. E-module as a teaching material used during learning proved to be very functional and influential as a learning medium that is physically used in conveying the content of teaching materials [4].

The top achievement group had a higher cognitive evaluation rate than the middle and bottom groups. Medium and bottom achievement groups belonged to the moderate improvement category because the posttest answers were less able to asses any metals that fit the criteria on the given problem. The ability to asses was included in the cognitive dimension of evaluating that could be obtained by both understanding in reading and analyzing each reading well too, so that high-level thinking ability can be achieved [27]. Therefore, the ability to asses was less due to poor reading comprehension.

Questions that measured creation cognitive ability had indicators of designing corrosion prevention procedures based on electrochemical principles. The ability to create increased with n gain 0.73 and belonged to the category of high improvement. This corresponded to the n-gain of the two achievement groups that obtain the high-cognitive enhancement categories created except for bottom achievement groups with moderate improvement category. High category enhancement was obtained because at the previous cognitive level, the majority of students had a good improvement in answering questions. The cognitive processes involved in creation categories were generally in line with previous learning experiences [6]. As the results of research Subarkah, et al shows that the ability to create reached the category of high enhancement because it is supported by good ability in analyzing and evaluating [17].

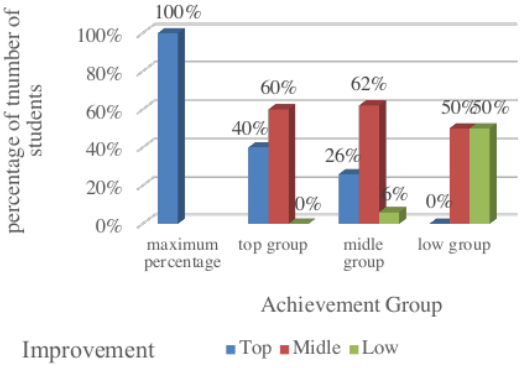

Figure 1. Percentage of Number of Students in Each Category of High-Level Thinking Ability Improvement

Based on Figure 1, there are overall students who were in the category of high improvement coming from the top and bottom achievement groups. Medium achievement group students were able to achieve high category improvement due to the heterogeneous learning grouping during the learning process. It showed that heterogeneous learning grouping can improve students' thinking ability. Grouping greatly helped each member in mastery of the subject matter with a variety of cooperative procedures and

provide academic support [23]. This was evident from the results of posttest, students were able to answer appropriate criteria almost every question.

Students belonging to the low improvement category come from medium and bottom achievement groups. The students were members of the group whose use of their laptops did not have an adobe flash application at the time of learning, as the result of doing the worksheet in the same group obtained the lowest score. This caused the video contained in the e-module could not be served. From the incident showed that video played an important role in helping the understanding of students who had weaknesses in thinking [26]. Animations in the video can visualize the chemistry content learned [28]. Unlike the case with students who had the ability to think better, the results of improvement were included in the medium category. This has been overcome by giving explanations at the time of presentation and question and answer, so that the students' understanding also influences the result of the improvement of high-level thinking ability.

Students belonging to the low improvement category were visible from the result of posttest answers; there were answers that did not get the maximum results. One of them in answering questions that include in creating cognitive that is not appropriate the criteria. The answers did not describe the arrangement of unclear parts. Creation involves the ability to combine elements of a coherent. It has become one of the causes of the low improvement category [15].

In general, students' high-level thinking ability on corrosion concepts experienced a moderate gain with n-gain of 0.6 37 obtained based on n-gain pretest-posttest analysis. The existence of this high level of thinking ability improvement in accordance with the hypothesis test conducted by using *t paired* sample. The statistical test using the *t paired* sample is determined based on prerequisite tests that have been done that were normality test and homogeneity test. Normality test results showed pretest and posttest data were normally distributed which meant that the data obtained has a uniform distribution of the population. Homogeneity test results had homogeneous variance which meant that the data distribution was relatively small.

Results of t paired sample test obtained t_{value} amounted to 17.9815, and t_{table} of 1.687. The results of the t paired sample test shows that $t_{count} > t_{table}$, which meant that Ho was rejected, so it can be concluded that the application of problem-based learning using corrosion e-module can improve students' high-level thinking ability. The results of this study were in accordance with the opinion of Setiarini et al. [29] which states that the use of e-module can improve the cognitive abilities of students. In addition, Noma, et al [5], also states that PBM can improve high level thinking ability. The problem presented proved to be one of the factors that can stimulate students' curiosity so that it can help students to think.

4. Conclusion

E-modules corrosion can be used as teaching materials to improve high level thinking ability. Overall, the cognitive dimensions of analyzing, evaluating, and creating tend to increase. Medium and bottom achievement groups tend to increase in learning outcomes.

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