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Application of *Contextual Teaching And Learning* (CTL) Model to Improve Learning Outcomes and Critical Thinking Ability in Redox and Electrochemical Material for Class XII SMA

Surya Firdausy[1], Deni Ainur Rokhim[2], Hayuni Retno Widarti[3*]

[1,3] Pendidikan Kimia, Fakultas Matematika dan Ilmu Pengetahuan Alam, Universitas Negeri Malang
[2] Guru Kimia SMAN 3 Sidoarjo

*Correspondinge-mail: hayuni.retno.fmipa@um.ac.id

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Abstract: application of Contextual Teaching and Learning (CTL) model to Improve Learning Outcome and Critical Thinking Ability in Redox and Electrochemical Topics of Grade XII of SMA. The Contextual Teaching and Learning (CTL) model teaches the steps used in improving critical thinking and this study uses CTL based teaching materials for redox and electrochemical materials. The purpose of this study is to find out; (1) the implementation of CTL and conventional learning (2) the difference in the critical thinking ability of the CTL class with the conventional class, (3) the difference in CTL class learning outcomes with the conventional class, (4) the students' response to the CTL based teaching materials. The research design used was quasi-experimental or Quasi Experimental Design with Posttest Only Control Design. The results showed that: (1) The implementation of CTL learning had an average of 86% and conventional learning was 85%. (2) There is a difference in students' critical thinking skills with the average experimental class (66.93) higher than the control class (51.32). (3) There are differences in student learning outcomes with the average experimental class (64.93) higher than the control class (48.89). (4) Students' responses to CTL based teaching materials based on the results of the assessment of students by 76% to assess the content of teaching materials and for an assessment of its users by 72%. Both are classified as good use in this study although based on comments, obstacles, and suggestions that these teaching materials have strengths and weaknesses that need to be corrected for future users.

Keywords: Contextual Teaching and Learning (CTL), critical thinking skills, learning outcomes, redox reactions and electrochemistry.

Abstrak: Penerapan model Contextual Teaching and Learning (CTL) untuk Meningkatkan Hasil Belajar dan Kemampuan Berpikir Kritis Materi Redoks dan Elektrokimia pada Siswa Kelas XII SMA. Model Contextual Teaching and Learning (CTL) mengajarkan langkah-langkah yang digunakan dalam meningkatkan berpikir kritis dan penelitian ini menggunakan bahan ajar berbasis CTL materi redoks dan elektrokimia. Tujuan penelitian ini yaitu untuk mengetahui; (1) keterlaksanaan pembelajaran CTL dan konvensional(2) perbedaan kemampuan berpikir kritis kelas CTL dengan kelas konvensional, (3) perbedaan hasil belajar kelas CTL dengan kelas konvensional, (4) respon peserta didik terhadap bahan ajar berbasis CTL. Rancangan penelitian yang digunakan adalah eksperimen semu atau Quasi Experimental Design dengan Posttest Only Control Design. Hasil penelitian menunjukkan bahwa: (1) Keterlaksanaan pembelajaran CTL memiliki rata-rata sebesar 86% dan pembelajaran konvensional sebesar 85%. (2) Terdapat perbedaan kemampuan berpikir kritis peserta didik dengan rata-rata kelas eksperimen (66,93) lebih tinggi dibandingkan dengan kelas kontrol (51,32). (3) Terdapat perbedaan hasil belajar peserta didik dengan rata-rata kelas eksperimen (64,93) lebih tinggi dibandingkan dengan kelas kontrol (48,89). (4) Respon pesert didik terhadap bahan ajar berbasis CTL berdasarkan hasil penilaian peserta didik sebesar 76% untuk menilai isi bahan ajar dan untuk penilaian terhadap penggunannya sebesar 72%. Keduanya tergolong baik digunakan dalam penelitian ini walaupun berdasarkan komentar, hambatan, dan saran bahwa bahan ajar tersebut memiliki kelebihan dan kelemahan yang perlu diperbaiki untuk pengguna selanjutnya.

Kata kunci: Contextual Teaching and Learning (CTL), kemampuan berpikir kritis, hasil belajar, reaksi redoks dan elektrokimia

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- **INTRODUCTION**

One of the efforts to develop and improve the quality of Human Resources (HR) is through education, because education is the most important aspect of life as a place to develop human potential (Nabila, et al, 2017: 1310). Government efforts to improve human resources in education continue, one of which is through changing the 2006 curriculum to the 2013 curriculum. The results of Kurniawan & Noviana's research (2017: 396) conclude that using the 2013 curriculum can make students more active and passionate about learning. Recommendations from the results of this study are that teachers are required to enrich their knowledge of innovative and effective learning models. This is to increase enthusiasm, independence, and the level of thinking of students in the learning process as expected in the 2013 curriculum. Effective and innovative learning models also need to be applied to chemistry subjects.

Chemistry is one of the subjects taken by Senior High School (SMA) students majoring in Natural Sciences (IPA). According to Effendy (2016: 1), chemistry studies the structure of substances, the properties of substances, and their changes, and studies the laws, theories and principles that describe the phenomenon of substance change. Matter in chemistry consists of abstract and complex concepts with calculations (Nabila, et al, 2017: 1310). If the teacher teaches students by developing the ability to correctly relate three levels of representation (submicroscopic, macroscopic, and symbolic), it will make it easier for students to understand the material (Guzel & Adadan, 2013: 112). The existence of misunderstanding of students at the three levels of representation resulted in students having difficulty connecting concepts with surrounding phenomena (Jansoon, et al, 2009: 149). Redox and electrochemical materials are materials that are closely related to the phenomena around them (Ziana, 2019: 1). Redox and electrochemical materials are materials that are considered difficult for students (Haryani, et al, 2014: 50). This statement can be supported by one of the studies conducted by Aini (2011) which concluded that students' understanding; (1) the redox reaction is in the moderate category, while the galvani and electrolysis cells are in the low category, (2) the application concept of redox and electrochemical reactions is in the moderate category. From the explanation of the research results, a solution is needed so that there is no misunderstanding that occurs in students, in order to improve the quality of school education. Efforts to improve educational skills through chemistry subjects require an effective learning process by no longer implementing teacher-centered learning (Yulianingsih & Hadisaputro, 2013: 150).

Some students of class XII IPA at SMA Negeri 1 Singosari said that they had difficulty understanding the material in chemistry subjects. This resulted in very little interest in students choosing chemistry as the subject of choice in the national exam, for example in class XII IPA B there were only 3 students out of 35 students who chose chemistry as the chosen subject in the national exam. One of the students said that during learning they could follow well and understand if the teacher gave examples of questions as well as examples of their work. When they have done the practice questions or daily tests whose form is different from the teacher's example, students have difficulty solving them. This statement can be concluded, students tend to be less trained in constructing their own understanding.

Researchers also made observations during the Field Practice Study (KPL) at SMA Negeri 1 Singosari where chemistry learning that was applied to several classes tended to be passive and used conventional methods. Many students in learning are preoccupied with their respective activities until they don't pay attention. This can have an impact on the learning outcomes of students. The effort that needs to be done is to hold an active learning process so that it can create interaction among students and teacher interactions with students. The Student Centered Learning approach or student-centered learning can be used as an approach that can be applied in chemistry subjects so that students don't feel bored and are actively involved in learning (Yulianingsih & Hadisaputro, 2013: 150).

Student-centered learning is learning that fully involves students in learning activities so that students play a major role while the teacher does not play a central role in learning activities but acts as a facilitator (Hamalik, 2005: 201). Contextual Teaching and Learning (CTL) is an example of a student-centered learning model. Johnson (2014: 35) states, "contextual learning and teaching involves students in important activities that help them relate academic learning to the real-life contexts they face."

Based on research conducted by Fadilah, et al. (2017) show that the experimental class has higher learning outcomes than the control class, where the experimental class applies the CTL learning model while the control class applies the conventional method in the colloid system material for class XI SMAN 1 Sunggal. This is also supported by research conducted by Silaban & Simangunsong (2015), concluding that the CTL model has a positive effect in stimulating and motivating students, especially in understanding the material and improving learning outcomes. The CTL learning model not only has an effect on improving learning outcomes, according to Johnson (2014: 182) "To help students develop their intellectual potential, CTL teaches steps that can be used in critical and creative thinking and provides opportunities to use thinking skills at a higher level. this height in the real world ".

Through the steps of CTL learning activities, students compile projects, make choices and accept responsibility for problems found, make decisions, analyze assumptions, draw conclusions, and relate them to surrounding phenomena, so that students can find important meaning in finding something so that there is a clearly directed process in critical thinking (Johnson, 2014: 35). This is supported by research from Wulandari, et al. (2016) which shows that the CTL model can improve students' critical thinking skills on colloid material at Gondangrejo High School where there is an increase in critical thinking skills from cycle I (48%) to cycle II (84%). According to Johnson (2014: 184), if students are accustomed to actively using their critical thinking skills in learning, students will be able and accustomed to dealing with surrounding problems with scientific thinking.

Talking about critical thinking skills, based on the results of Trends in International Mathematics and Science Study (TIMSS), the critical thinking skills of students in Indonesia are still low. Based on the results of the TIMSS study, in 2007 Indonesia was ranked 36th out of 49 countries with a score of 397 from the average international score of 500 and in 2011 Indonesia was ranked 38th out of 45 countries with a score of 386 from the international score of 500 (P4TK , 2011: 1). In 2015, Indonesia was ranked 44 out of 49 countries with a score of 397 from the international average of 500 (Hadi & Novaliyosi, 2019: 563). The questions used in the TIMSS study are of the Higher Order Thinking Skills (HOTS) type so they require a higher level of thinking to solve them (Martyanti & Suhartini, 2018: 35). The results of the 2018 Program for International Students Assessment (PISA) also show that Indonesia has decreased in three competencies, namely reading skills, math skills, and science, ranking 74 out of 79 countries (Detiknews, 03 December 2019). Therefore, researchers are motivated to conduct research by applying the CTL learning model which is expected to be effective in improving critical thinking skills and student learning outcomes in chemistry subjects. The CTL learning model has 7 main components used in the learning process, namely constructivism, finding (Inquiry), asking (Questioning), the learning community (Learning Community), modeling (Modeling), reflection (Reflection), and actual assessment (Authentic). Assesmnent) (Aqib, 2013: 7).

In addition to the learning model, it is necessary to pay attention to the teaching materials used by teachers and students. Teaching materials have been developed by Prihastyanti (2018), namely teaching materials based on Contextual Teaching and Learning (CTL) redox and electrochemical materials to facilitate students' critical thinking skills. The teaching materials consist of student books, teacher books, and learning support videos. The video presents the processes that occur in electrochemical cells macroscopically and submicroscopically. The teaching materials have been validated and legibility tested. The validation results obtained include: student books with a score of 86%, teacher books with a score of 89%, and learning videos with a score of 83%. Based on the score results, the teaching material is categorized as very suitable for use. This research was conducted by implementing these teaching materials and measuring the response of students to CTL-based teaching materials, redox and electrochemical materials in the learning process. The CTL learning applied in this study refers to the learning activities in the teaching material.

Based on some of the problems described, a study entitled "Application of Contextual Teaching and Learning (CTL) Learning Model to Improve Chemistry Learning Outcomes and Critical Thinking Ability in Redox and Electrochemical Materials Class XII SMA Negeri 1 Singosari".

- **METHOD**

The research design used was Quasi Experimental Design. The research design used is the Posttest Only Control Design, so that after being given the treatment, the learning model is carried out by posttest or daily tests after a series of learning processes is completed. The experimental class is a class that is learned by applying the Contextual Teaching and Learning (CTL) learning model with the help of Contextual Teaching and Learning (CTL) -based teaching materials, while the control class is a class that is taught not applying the Contextual Teaching and Learning (CTL) learning model or applying The learning pattern that is usually applied in schools is teacher centered learning. The sample was taken by using cluster random sampling technique. Before doing the research, the sample that has been selected needs to be tested the prerequisite initial ability which aims as the initial condition of the sample before being given a different treatment. The initial ability of the control class and the experimental class must be the same before the research is carried out so that nothing else affects the results after the treatment is given.

The instrument used in this study, there are two types of instruments, namely treatment instruments and measurement instruments. The treatment instruments consisted of a syllabus, lesson plans, control class LKPD, and CTL-based teaching materials, redox and electrochemical materials developed by Prihastyanti (2018). The measurement instruments used were the observation sheet for the implementation of CTL and conventional learning, critical thinking instruments and learning outcomes, and a questionnaire to measure students' responses to the teaching material while using it in the learning process. Critical thinking is measured using an instrument for assessing critical thinking skills developed by Kusumaningrum (2018). The instrument used refers to 5 aspects of critical thinking skills described in 12 indicators of critical thinking according to Ennis, 1985: 46. The following are indicators of critical thinking used in the critical thinking ability assessment instrument developed by Kusumaningrum (2018) according to Ennis, 1985: 46 can be seen in table 1.

Table 1. Critical Thinking Indicators according to Ennis, 1985: 46 on the Assessment Instrument for Critical Thinking Ability Development Results of Kusumaningrum (2018)

No.	Aspect of Critical Thinking Ability	Critical Thinking Indicators
1.	Provide a Simple Explanation	Focusing questions Analyze arguments Ask and answer questions that require answers
2.	Build basic skills	Assess the credibility of a source Assess the results of observations
3.	Give a conclusion	Perform deductions Perform induction Make and consider the value of decisions
4.	Make a further explanation	Define terms and consider definitions Identify assumptions
5.	Make forecasts and integrations	Decide on an action Interact with other people

The learning outcomes in this study used critical thinking skills assessment instruments, but data analysis was carried out with different treatments.

- **RESULT AND DISCUSSION**

This study not only measures the critical thinking skills and learning outcomes of students, but also measures the implementation of CTL and conventional learning and the responses of students to CTL-based teaching materials, redox and electrochemical materials developed by Prihastyanti (2018).

Implementation of the Learning Process

The implementation of the learning process in both classes was observed and assessed using the lesson plan implementation observation sheet. Two observers assessed the implementation of the lesson plan, consisting of 2 students of Chemistry Education, State University of Malang. Assessment of the implementation of the learning process by providing a score ranging from 1-5 on the observation sheet. The results of the scores obtained from the observers are averaged and accumulated in the form of a percentage. Data on the percentage of lesson plan implementation in the experimental class and control class can be seen in Table 2

Table 2 Data on Percentage of Learning Process Implementation in Experiment Class and Control Class

RPP	**Percentage of Implementation (%)**	
	Experiment Class	**Control Class**
Meeting 1	79	79
Meeting 2	80	79
Meeting 3	80	79
Meeting 4	80	80
Meeting 5	86	85
Meeting 6	94	92
Meeting 7	92	92
Meeting 8	93	94
Average	**86**	**85**

The results of table 2 are accumulated in graphical form. The graph of the implementation of the classroom learning process taught by the CTL model and the class taught using the conventional model can be seen in Figure 1

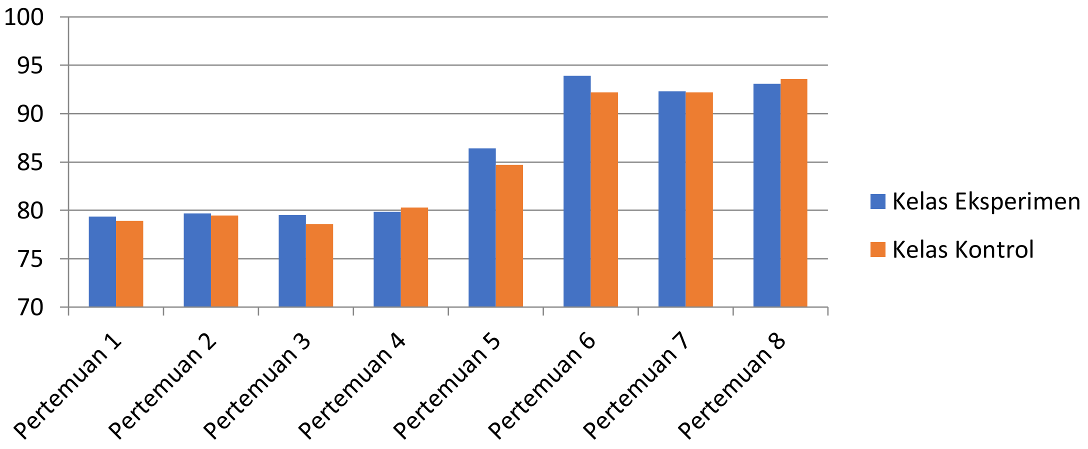

Figure 1 Learning Implementation Graph

Graph 1 shows that the lines in each meeting, from meeting 1 to meeting 8 have increased to be better, at the beginning of the meeting the implementation process was categorized as well done but not maximal because the experimental class students were not familiar with CTL-based learning so that when learning the students still confused and the teacher also still cannot fully master the class because for the first time the teacher enters the two classes. This is possible because learning in the control class is carried out by providing problems, procedures for solving problems, and solutions to problems given and discussed by the teacher. Students in this study are given questions and procedures (methods), and the results are known in advance (Banchi and Bell, 2008: 26). This causes the students' analytical skills in the control class to be less developed. Students are not used to solving problems independently, only depending on orders from the teacher. So that when given the posttest, students' answers are less analytical.

Learning in the experimental class is carried out by students actively and independently in developing thinking skills to solve problems through data search so that a rational and authentic solution is obtained. Rianto (2009: 288).

However, for the next meeting, the learning implementation was getting better because the experimental class students were already familiar with the learning process. Based on Table 2, the average percentage of implementation in the experimental class is 86% while the control class is 85%, this average indicates that the results are almost the same. Through this process the experimental class students can develop their analytical thinking skills. So that when given the posttest, students' answers are analytical.

Critical Thinking Ability

The critical thinking ability of students in the experimental class and control class can be seen from the ability of students to work on instruments of critical thinking with the realm of indicators that refer to critical thinking indicators from Ennis, 1985: 46. The question instrument consists of 25 multiple choice questions and 9 description questions. Data analysis was performed by calculating the percentage of the experimental class or control class who answered correctly, then classified it into the criterion for the level of critical thinking skills. For multiple choice questions, a score of 1 was given for each question so that it was measured by the students who answered correctly, while for the essay questions, a score was given according to the results of students answering the essay questions so that it was measured from the overall score of the students obtained for each question. The percentage of students' answers to multiple choice questions and essay questions for critical thinking skills tests has been classified into 12 indicators of critical thinking according to Ennis, 1985: 46 which are listed in the table 3.

Table 3. Percentage of Students' Answers on the Critical Thinking Ability Test

No	Critical Thinking Indicators	No. Question	% Answer Experiment Class	Control Class
1.	Focusing questions	13, 19, 24, 1	73	62
2.	Analyze arguments	2, 4, 11, 12, 9, 14, (8) descreptiom	70	58
3.	Ask and answer questions that require answers	21, 25, (5b, 1a, 2a, 5c, 7a, 6, 5a) descreptiom	74	52
4.	Assess the credibility of a source	(9a) descreptiom	3	3
5.	Assess the results of observations	17	0	0
6.	Perform deductions	7, 3, 8	79	73
7.	Perform induction	22, 15	100	82
8.	Make and consider the value of decisions	20, 5, 10, (3, 4, 1b, 7b, 2b) descreptiom	69	45
9.	Define terms and consider definitions	16, 18	50	40
10.	Identify assumptions	(9c) descreptiom	0	1
11.	Decide on an action	23, 6	100	75
12.	Interact with other people	(9b) descreptiom	0	2
	Overall average% of answers		66,93	51,32

Table 3 shows that of the 12 indicators of Ennis, 1985: 46 used in the critical thinking instrument, it can be seen that the average percentage of students' answers in the experimental class is higher, namely 66.93 than the control class, namely 51.32, although there are several indicators. or questions where the control class students are superior in percentage than the experimental class, so it can be concluded temporarily that learning by applying the Contextual Teaching and Learning (CTL) learning model can improve critical thinking skills compared to conventional learning. The percentage results in table 2 were then analyzed using SPSS 16.0 for windows. The following hypothesis is proposed:

H_0 : There is no difference in the critical thinking abilities of students who apply the Contextual Teaching and Learning (CTL) learning model with students who apply conventional learning.

H_1 : There are differences in the critical thinking abilities of students who apply the Contextual Teaching and Learning (CTL) learning model with students who apply conventional learning.

The results of hypothesis testing on students' critical thinking skills can be seen in the table 4.

Table 4. Hypothesis Test Results of Students' Critical Thinking Ability

Class	**Average**	**Value of Significance**	**t_{count}**	**Df**	**$\frac{1}{2}\alpha$**	**Conclusion**
Experiment	66,93		1,991	80		H_1 be accepted
Control	51,32	0,050			0,025	H_0 rejected

The results of the complete critical thinking ability hypothesis test of students can be seen in Appendix 18. In Table 4, it shows that the tcount generated from the test is 1.991, then the resulting t-table with df = 62 and a significance level of 0.025 is 1.990. Based on these results, the resulting t count is greater than t table. If tcount> ttable then H0 is rejected and H1 is accepted while tcount <ttable then H0 is accepted and H1 is rejected, so from these results it can be concluded that H0 is rejected and H1 is accepted, which means that there is a difference in the critical thinking skills of students who apply the Contextual Teaching learning model. and Learning (CTL) with students who apply conventional learning to redox and electrochemical materials. Table 4 shows that the average critical thinking ability of the experimental class is 66.93 while the control class average is 51.32. The average critical thinking ability of the experimental class is better than the average critical thinking ability of the control class. Based on these results, the Contextual Teaching and Learning (CTL) learning model in learning can improve students' critical thinking skills than conventional learning.

According to Johnson's (2014: 182) statement in his book that “to help students develop their intellectual potential, CTL teaches steps that can be used in critical and creative thinking and provides opportunities to use these higher-level thinking skills in the real world. " CTL learning is an inquiry-type learning that involves the full activity of students finding concepts, sharing information, and linking them in situations of surrounding phenomena so that they are expected to apply in real life and increase the level of thinking of students (Bahri, 2017: 50). Research was also conducted by Wulandari, et al. (2015) which showed that based on the results of their research, the application of CTL learning to colloid material could increase critical thinking skills as indicated by an increase in critical thinking test results from cycle I (48%) to cycle II (84%)). According to Wulandari (2015: 147) in discussing the results of his research, one of the factors that causes an increase in critical thinking skills is the constructivism

CTL learning process that requires students to be actively involved in group discussions to find their own concepts and exchange ideas or opinions to draw conclusions. of a problem.

Based on the results of research and research references, it can be concluded that learning that applies Contextual Teaching and Learning (CTL) trains students to think more critically and deeply in order to connect concepts with facts or phenomena that are around so that it can provide benefits for students because they can find meaning in the learning process.

Learning outcomes

The learning outcome data used is the overall score obtained by each student in working on the critical thinking ability instrument which is used as a daily test question for students after carrying out the learning process. The learning outcomes data of students in the experimental class and control class can be seen in Table 5.

Table 5. Student Learning Outcomes Data

Class	**Number of Students**	**The highest score**	**Lowest Value**	**Average**
Experiment	29	77	40	64,93
Control	35	60	33	48,69

Table 5 shows that the average learning outcomes of students in the experimental class were 64.93 higher than the control class, namely 48.69. The data were analyzed to determine differences in the learning outcomes of students in the experimental class and the control class. The following is the proposed hypothesis:

H_0 : There is no difference in the learning outcomes of students who apply the Contextual Teaching and Learning (CTL) learning model with students who apply conventional learning.

H_1 : There are differences in the learning outcomes of students who apply the Contextual Teaching and Learning (CTL) learning model with students who apply conventional learning.

The results of hypothesis testing of student learning outcomes can be seen in Table 6.

Table 6. Hypothesis Test Results for Student Learning Outcomes

Class	**Average**	**Value of Significance**	**T_{count}**	**df**	**$\frac{1}{2}\alpha$**	**Conclusion**
Experiment	64,93	0,000	7,640	62	0,025	H_1 be accepted
Control	48,89					$H_{0\ rejected}$

Table 6 shows that the tcount generated from the test is 7.640, then the ttable is generated with df = 62 and the significance level is 0.025 is 1.999. Based on these results, the resulting t count is greater than t table. If tcount> ttable then H0 is rejected and H1 is accepted while tcount <ttable then H0 is accepted and H1 is rejected, so from these results it can be concluded that H0 is rejected and H1 is accepted, which means that there are differences in learning outcomes of students who apply Contextual Teaching and learning models. Learning (CTL) with students who apply conventional learning to redox and electrochemical materials. Table 4.28 shows that the average learning outcomes of the

experimental class were 64.93 while the control class average was 48.89. The average learning outcomes of the experimental class are higher than the average learning outcomes of the control class. Based on these results, the Contextual Teaching and Learning (CTL) learning model can improve learning outcomes than conventional learning

Classroom learning that is taught using Contextual Teaching and Learning (CTL) is categorized as very good but not optimal because learning with this model occurs in two-way learning, namely student interaction and teacher interaction. Students are not familiar with this learning, because students are accustomed to receiving one-way learning so that many students sometimes experience burnout when learning is required to involve students' activeness in learning, even so the learning outcomes of experimental class students can show an average higher than students in the control class. This learning Contextual Teaching and Learning (CTL) in redox and electrochemical materials can make it easier for students to understand the material because students to learn it, are guided to get used to building their knowledge (constructivsm), find concepts from real life examples (inquiry), grow curiosity (questioning), as well as cooperation and mutual learning (learning community) (Trianto, 2007). Likewise with the control class, learning is also carried out in two directions, but variations in learning tend to be teacher-centered so that the understanding of learners' knowledge is only conveyed by the teacher. Although the two classes produce an average that has not reached the KKM, the average of the two classes has a significant difference. Likewise with the results of research from Fadillah, et al. (2016) which showed that the learning outcomes of experimental class students who were taught using the Contextual Teaching and Learning (CTL) learning model were higher (gain value = 0.73) than the control class taught by learning. conventional (gain value = 0.66) in the colloid system material at SMAN 1 Sunggal Class XI.

Student Response to the Use of Contextual Teaching and Learning (CTL) Based Teaching Materials

To find out the response of students while using CTL-based teaching materials, redox and electrochemical materials developed by Prihastyanti (2018) in the learning process, a research questionnaire was used for students. Perception data of experimental class students towards teaching materials were obtained from a research questionnaire given by the researcher after the learning activity was completed. The questionnaire consists of a closed questionnaire and an open questionnaire. Closed questionnaires in the form of students 'assessments of the content of the teaching materials and students' assessments of CTL learning using these teaching materials. Assessment on a closed questionnaire uses a Likert scale. An open questionnaire in the form of exposure to comments, obstacles, and suggestions of students on the use of CTL-based teaching materials after the learning process according to the opinions of students.

Questionnaire for assessing the content of CTL-based teaching materials and learning

Based on the results of the recapitulation of the research questionnaire, the percentage achieved for assessing the content of CTL-based teaching materials by students was 76%, while for the assessment of the learning process using CTL-based teaching materials by students was 72%. The percentage results of both indicate that CTL-based teaching materials are good for use in CTL learning in this study and students respond well to CTL learning that has been applied. This is because the teaching material contains learning activities to observe videos where the available videos include macroscopic and microscopic sources, the material contained coherently provides directions for students to understand, and there are several concepts that relate it to its application in everyday life so that it is effective when used in Learning Activities.

Questionnaire on Comments, Obstacles, and Suggestions in Using CTL-Based Teaching Materials

Comments given by students on CTL-based teaching materials based on the results of the recapitulation showed that 48% of the experimental class students commented that the teaching material was good enough to use and made it easier for students to learn it because the teaching materials had a lot of material that connected it to everyday life days and lots of practice questions that made students trained, there were 28% of students commenting that the teaching material was good if used but there were some materials that tended to make students less understanding and there were 14% of students who thought the teaching materials tended to be boring because students assume that the content of the teaching material is too many questions and is only the beginning of an experiment in observing the video so that students are more likely to be interested in learning activities directly in practice. There are 7% think that the teaching material is difficult to understand and to understand it needs to be explained first by the teacher.

The obstacles experienced by students while using CTL-based teaching materials were 41% of students who found it difficult to understand the teaching materials, but in the questionnaire students did not mention the reason and there were 31% of students having difficulties due to language that was too convoluted or imagination that was too high so that students think that they prefer to be explained directly. Some students stated that the working method or principles were too long and convoluted so that students had difficulty understanding, but when it was explained by means of fast and instant work, students understood more. There are 10% of students who find it difficult to follow learning if the learning is carried out in groups because not all students can understand explanations from their peers. There are only 10% who understand using these teaching materials.

Suggestions given by students for CTL-based teaching materials, there are 21% suggesting to improve the use of clearer language and language that makes it easier for students' level of thinking. There are 28% of students suggesting that the content of the teaching material needs to be improved to add more interesting learning activities or other innovations so that it is not boring if it only contains practice questions. The conclusion that can be drawn from comments, obstacles, and suggestions is that the CTL-based teaching materials for redox and electrochemical materials developed by Prihastyanti (2018) have advantages and disadvantages. The advantages of this teaching material are that it makes it easier for students to understand the material because the material is contained in the form of questions that make students trained in constructing their understanding and there are animated videos where students can learn it not only macroscopically but need to connect it submicroscopically. The weakness of the teaching material is that there are too many video observation activities so that it makes students feel bored and too many questions also make students bored.

▪ CONCLUSION

Based on the results of the research and discussion that has been presented, it can be concluded that: The implementation of the CTL learning model has an average of 86% and conventional learning is 85%, categorized as very good. There is a difference in the average critical thinking ability of experimental class students (66.93) which is higher than the average control class (51.32). There is a difference in the average learning outcomes of experimental class students (64.93) which is higher than the average control class (48.89). Student responses to CTL-based teaching materials based on the results of students' assessments in the questionnaire were 76% which was achieved to assess the content of teaching materials and to assess their use of 72%. The percentage results of both indicate that CTL-based teaching materials are good for use in CTL learning in this study and students respond well to CTL learning that has been applied. Based on the comments, obstacles, and suggestions given by students, teaching materials based on CTL, redox and electrochemical materials developed by Prihastyanti (2018) have advantages and disadvantages, from these shortcomings it can be used as an evaluation material for the improvement of these teaching materials for further use.

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