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Students' scientific representation enhancement through "ECRA" techniques in formative examination design

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Abstract. The recent studies in science learning has a specific interest with 4C's which are communication, collaboration, critical thinking and creativity. This study explored the students' 4C's as they engage with physics concepts relating to alternating currents. This engagement entails students' interpretation for descriptive questions. Following action research cycle, the study begin with planning the intervention using "ECRA" technique and conducted the activities with 38 Matriculation College students. The analysis attempt to make a connection between students' ability to construct representational aspects of scientific description with formative achievement. This study systematically describes students' understanding on the representations signify in the descriptive questions. Data collected from this study were Work Report, review of answers tutor questions, and interviews during observation stage. The finding suggests that, the ECRA technique is enabling students to obtain higher percentage in formative assessment by allowing them to developed richer conceptual understanding. Hence this study suggest that the representational issues in physics questions constructed in essay can be moderated with ECRA technique.

1. Introduction

Physics is a lesson about facts, concepts, theories, principles and natural laws [1]. When learning Physics, students' should not only memorize what they had learnt in the class, instead learning must revolves around doing experiment and Physics concepts comprehension. Nowadays, emphasis on 21th century invite more attention to four main competency skills required as learning outcomes. In the end of the lesson, students must acquire critical thinking skills, creative thinking skills, communication skills and collaborative skills [2]. These skills also known as 4C competency.

Critical thinking is a fundamental skill in problem solving. Critical thinking should be not only an educational option but an integral part of education practices[3]. Critical thinking skills is needed to foster students' thinking skills since it requires examining assumptions, discerning hidden values, evaluating evidence, and assessing conclusions[4]. Students' ability to interpret the descriptive questions are important to ensure that students are able to translate the different representatives used in the exam questions. Therefore problem solving although its integral to knowledge development, students must be guided to ensure the process meet the answers scheme demand. Guiding students for this standard require an introduction to a proper answering technique to accompany the problem-solving process. One of the thinking skills that is expected to be emerge in physics learning is critical thinking skills.



Critical thinking can stimulate students to solve the problems that are related to the learning materials [5]. The better development of these abilities will make students' able to overcome the problems with satisfying results. Critical thinking can stimulate students to solve the problems that are related to the learning materials [5].

Similarly, creative thinking skill has its significant role when solving difficult physics concept. Therefore, learning requires a strategy or to ensure the creativity is visible to learners. Creativity is known for allowing higher reasoning abilities, stronger thinking abilities, increased level of trust, motivation and learning involvement, critical thinking and problem-solving abilities [6]. These outcomes can be obtained since creativity encourage students to propose various ideas, various solution approaches, offering new alternatives, and being able to explain easily [7]. This study aimed at improving student's attainment in examination by introducing specific answering technique that benefit students' creativity and critical thinking known as "ECRA" technique.

Muhammad Noor Kholid [8] finds that a non-routine question can cause the students have reflective thinking about the question given and lead to their confusion. The unfamiliar question for students will encourage them to apply their knowledge and experience to solve the problem. A non-routine question to explore the students' critical thinking and creativity in solving descriptive question. Accordingly, this study proposes a method for answering descriptive question in the Physics assessment.

2. Context of study

This study is an extension work from analyzing students' performance in final exam. One of the most concerning part is related to student's performance involving descriptive questions. From the Candidate Work Report (LKC) students did not get full marks for descriptive questions. In fact, students are able to get full marks in this descriptive question if they know the technique appropriate in answering the questions. A series of interviews were conducted to identify the possible reasons behind this outcomes. Students also complained of always not successful to get full marks for descriptive questions. The results of interviews with students showed that:

1. They are not interested to try and they try to avoid from answering descriptive questions.
2. They do not have the confidence and insist for right answering technique for descriptive question
3. Their physics concepts is weak.
4. They do not know the intent of this question and what needs to be stated in the answer.
5. The narrative of questions is not easy to be understood thus limit their chances to get full marks.

Apart from the interview sessions, a review of the tutoring and students' test answers showed students are

1. Not proficient in answering descriptive questions.
2. Students also tend to answer descriptive questions as a final choice of their trial to get the best results.
3. The test results also found that it was difficult for students to get marks full of descriptive questions. Usually full marks for such questions is 3 or 4 marks, but most students get only 1 and 2 marks.

3. Methods

This type of research was conducted using Descriptive Research Design (DRD). The results of this study were to obtain from the implementation of ECRA techniques in the pre-test and post-test. This research was conducted in February 2019 in Malacca Matriculation College, specifically in Module I students. The subjects of this study were 38 students of SDS Matriculation Programme Session 2019/2020. Data collection methods by using SPSS and questionnaire given to the students. The research instrument has been validated by two experts and has been declared valid and reliable.

Following the prior analysis, this study attempts to introduce students with a technique for answering descriptive questions to overcome the problems faced by students. The technique employed as an intervention is the "ECRA" technique. ECRA is an acronym represented by Equation, Constant variable,

Relationship and Answer. The abbreviation describes the steps needed to be taken when answering descriptive question. Therefore, a quasi-experimental study without controlling group is used as the methodology for this study. The students' improvement by applying this skill in answering descriptive questions were measured through the percentage of achievement students' pass, increasing grade A and full marks in the descriptive questions.

The study conducted is focused on improving students' problem-solving skills for Matriculation Physics subjects in alternating current chapter. There were 4 activities were carried out in this research. Here are the steps of the activities that have been implemented.

3.1. Activity 1: Pretest

For Activity 1, students are required to answer a pretest question which contains 1 descriptive question. The question and the sample of student' answer are presented in Figure 1 and 2, respectively. Pre-tests were conducted for 10 minutes.

LAMPIRAN A

NAME: _____ PRACTICUM: _____

UJIAN PRA

An ac generator with a frequency equal to the resonance frequency of the circuit is connected in series with an inductor of inductance 75 mH, a capacitor of capacitance 1 mF and a resistor of resistance 100 Ω . If both inductance and capacitance are doubled, does the frequency increase, decrease or remain constant? Explain.

Figure 1. Pretest descriptive question

UJIAN PRA

Name: _____ Practicum: _____

1. An ac generator with frequency equal to the resonance frequency of the circuit is connected in series with an inductor of inductance 75mH, a capacitor of capacitance 1mF and a resistor of resistance 100 Ω . If both inductance and capacitance are doubled, does the frequency increase, decrease or remain constant? Explain.

$L = 75\text{mH}$
 $C = 1\text{mF}$
 $R = 100\ \Omega$

$L \ \& \ C$ doubled, f ?

$f = f_r = \frac{1}{2\pi\sqrt{LC}}$ \uparrow

When L and C doubled, frequency increase \times

($\frac{1}{4}$) f_{awal}

Figure 2. Sample of student answers

Figure 2 shows an example of students' answers in a given pre -test. Next, the lecturer will check the students' answers and the marks are recorded.

3.2. Activity 2: Implementation of "ECRA" technique

After carrying out Activity 1, Activity 2 was implemented to all students. In this activity the "ECRA" technique is introduced. Students are given an explanation about steps need to be taken into account when answering the descriptive questions using the guidance words E: Equation, C: constant variable, R: relationship and A: Answer.

3.3. Activity 3: Posttest

For activity 3, students were given a posttest which contains 2 descriptive questions that need to be answered within 7 minutes. Question given is similar to the question in the pretest. Next, the lecturer will check post-test students' answers of scores were recorded for both groups.

3.4. Activity 4: Questionnaire

The lecturer distributed the questionnaire to all students. The goal is to obtain student feedback on the use of the "ECRA" technique. There are 7 items that should be answered in this questionnaire (see Table 1). The questionnaire survey was designed to meet the goal of this study based on items concerning the self-efficacy, critical thinking intrinsic value, creative thinking and collaborative skills.

Table 1. Items in Questionnaire survey

Name	Description	Answer form
Self-efficacy: within the scope of the course	The use of 'ECRA' techniques is very easy to understand.	5-point scale assessment
Self-efficacy: save time	The use of the "ECRA" techniques save my time in answering formative questions.	1:Strongly disagree, 2: Disagree,
Critical thinking: understand	The use of the "ECRA" techniques helped me answering the formative question correctly.	3: Undecided, 4: Agree
Intrinsic value: interesting	I am more enthusiastic about answering descriptive questions using the "ECRA" techniques.	5: Strongly agree
Creative thinking: answering method	The use of "ECRA" techniques helped me from making mistakes while answering test questions.	
Intrinsic value: improvement	The use of ECRA techniques improved my performance in answering test questions.	
Collaborative skills : introduced to other students.	"ECRA" techniques should be introduced to all students.	

4. Results and Discussion

Figure 6 shows the comparison of scores between pre-test and post-test. There are as many 38 students participated in this study. For both pre-test and post-test, 5 marks and below consider as fail. In the Pre-Test a total of 8 student failed in this test while in the post-test no student failed. While the number of students who passed the pre –test was 28 people and 38 students passed in post-test. The number of students who got grade A, a total of 8 people got grade A's in pre-test and it has increased to 31 people in post-test. For the number of students who got full marks, only 6 people got full marks in the pretest and has increased to 25 people in the post-test. In addition, a total of 32 students managed to improve the score in the posttest. The detailed comparison of scores between pretest and posttest is presented in Figure 3.

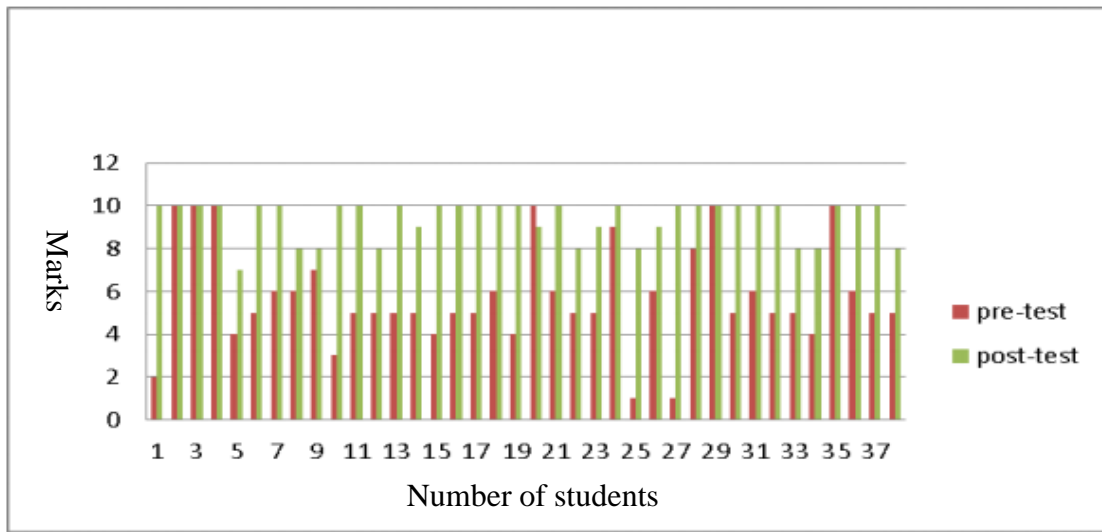


Figure 3. Comparison of scores between pre-test and post-test

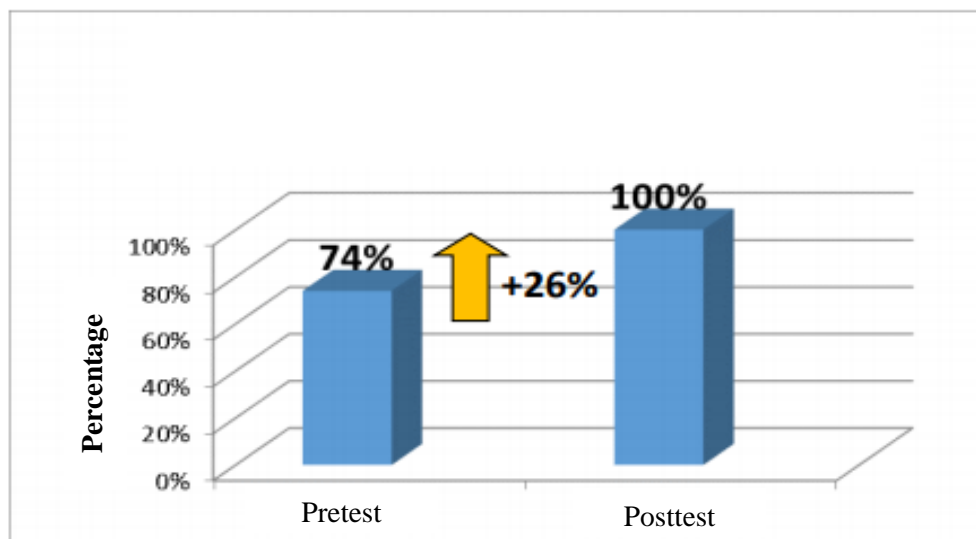


Figure 4. Comparison of percentage of students get pass between pre-test and post-test

Figure 4 shows a comparison of the percentage of students get pass for both the pre-test and post-test. For the pre-test, 74% of students passed in this test. While for the post-test has increased to 100% of graduating students. Therefore this study found that there have increase in the percentage of students passed the test by 26%.

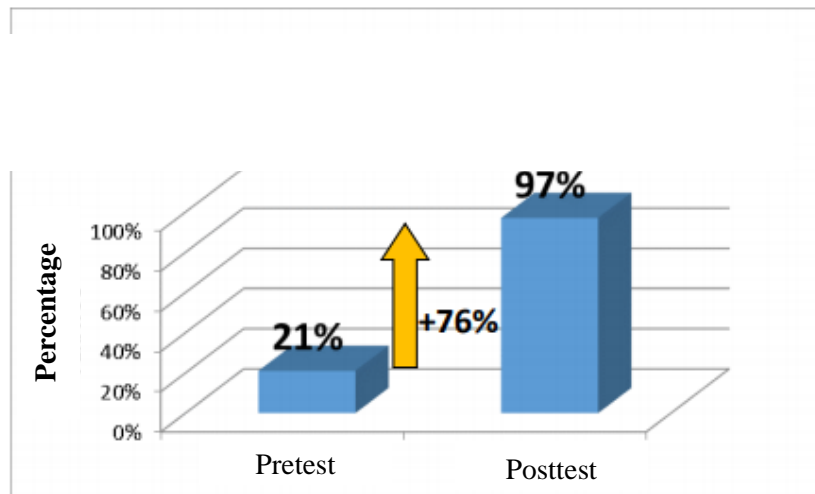


Figure 5. Comparison of the percentage of students getting A's between pre-test and post-test

Figure 5 shows a comparison of the percentage of students getting grade A's for the both tests. For the pre-test, 21% of the students got an A grade in this test. Meanwhile, for the post-test, it has increased to 97 % of students getting an A grade. This study found that there was an increase in the percentage of students getting an A grade by 76%.

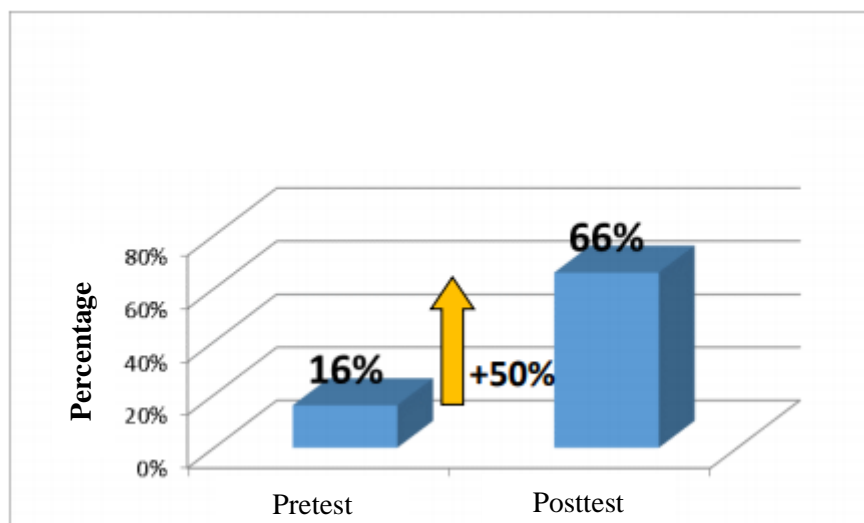


Figure 6. Comparison of the percentage of students getting full marks.

Figure 6 shows the comparison of the percentage of students getting full marks for both pre-test and post-test. For the pre-test, 16% of the students got full marks in this test. Meanwhile, for the post-test, it has increased to 66 % of students got full mark. This study found that there was an increase in the percentage of students getting marks full by 50%. Number of students who passed, got full marks and got A's grade for pre-test and post-test as well as the number of students who have an increase in marks in the posttest.

Following are the findings from the questionnaire that has been implemented to a total of 38 respondents. All questionnaire findings were analyzed and each item have be calculated the average scores are shown in Table 2.

Table 2. Mean score values for questionnaire items

No	Item	Average Score
1.	The use of 'ECRA' techniques is very easy to understand.	4.59
2.	The use of the "ECRA" techniques save my time in answering formative questions.	4.47
3.	The use of the "ECRA" techniques helped me answering the formative question correctly.	4.59
4.	I am more enthusiastic about answering descriptive questions using the "ECRA" techniques.	4.56
5.	The use of "ECRA" techniques helped me from making mistakes while answering test questions.	4.68
6.	The use of ECRA techniques improved my performance in answering test questions.	4.68
7.	"ECRA" techniques should be introduced to all students.	4.68
AVERAGE		4.61

Based on Table 2, it was found that all the questionnaire items obtained a mean score above 4.00 and an average mean score is 4.61 which describes the use of the technique "ECRA" is at a level of very satisfying. The highest mean score value was 4.68 which was recorded on the 3 items. Based on the highest score values of these three items prove that the "ECRA" technique helps improve students' skills of answering descriptive question.

The instrument of the study comprised: 1) a test with a questions related to alternating current, 2) a note of introduction of ECRA technique for understanding the students' descriptive question problem solving, and 3) a questionnaire for confirming the students' ability to solve the descriptive type of question. Referring the results of the data analysis above, it can be stated that the students of Malacca Matriculation, Malaysia tend to use the ECRA technique in solving descriptive question for alternating current. Most of the students play their role in creative thinking and they understand the purposes to answer the questions correctly. It is agreed by the Handayani et.al that the students understand the purpose of the problem solving[9]. In the monitoring component, researchers found that they have improvement in term of getting grade A's, pass and full marks in the assessment.

Based on the results of the test and questionnaire by the students, introducing the ECRA techniques improves the students' problem solving skills. This problem solving skills helps teachers to increases students motivation, students learn how to organize themselves to learn physics, and increase the ability to think in creative way to answers the questions given in the assessment.

5. Conclusion

Following are the marks obtained for the pre-test and post-test. The results show that all students that involved in the study have passed 100% after being introduced to the "ECRA" technique. It is found that the percentage of students who get grade A's has also increased by 76% from 21% in the pre-test and to 97% in the post-test. The increase in the percentage of grade A's has exceeded the objective target of the study which is to increase the percentage students who get an A grade of 50%. Percentage of students who get full marks has increased by 50% from 26% to 66% after "ECRA" was introduced and this achievement meets the target of the study which is to increase the percentage of students who get full as much as 50%.

Findings from the student responses in the questionnaire have also shown that this techniques helps to improve students' skills in answering descriptive questions. This study was conducted after students learned the topic of "Alternating Current". There are many descriptive questions in this topic. After the

introduction of the "ECRA" technique to this group of students, researcher found that this technique can improved students' skills in answering descriptive questions.

Acknowledgement

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