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by Hantje Ponto

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Methods of Learning the Concept of Basic Electric Circuits: A Comparative Study between Lecture, Discussion and Collaboration

Hantje Ponto^a, ^aDepartment of Electrical Engineering Education, Universitas Negeri Manado, Minahasa, PO Box. 95618 North Sulawesi, Indonesia, Email: hantjeponto@unima.ac.id

Electricity contributes to technological development so that there is an industrial revolution 4.0 in the 21st century. Basic electric circuits (BEC) is a subject matter that must be mastered by students who pursue Electrical engineering technical competence in the Vocational Technical School (VTS). Teaching method plays an important role in the learning activities of BEC in the classroom. The use of appropriate teaching methods can help students understand the concepts of BEC subject matter. In Indonesia, there are still many teachers using the lecture method in learning activities, so students often have difficulty learning the BEC concept. This study aims to compare lecture, discussion and collaboration methods in BEC learning activities. Participants in this study consisted of 79 students and 3 teachers. The research method is an experiment to compare the effectiveness of lecture, discussion, and collaboration methods. Data analysis uses Covariance Analysis (Ancova) to compare teaching methods and N-Gain Score testing to study the effectiveness of teaching methods in learning BEC concept.

Key words: *Lecture method, discussion, collaboration, concept understanding, basic electric circuit.*

Introduction

Vocational Technical School VTS students were required to study the basic subject matter and to apply themselves in a workplace or industry in order to face the challenges of the industrial revolution 4.0 in the 21st century. Electrical engineering students were obliged to study and to comprehend the BEC concept. Electricity is basic concept of science subject: physics



(Baybars, 2019). Many student had difficulties learning the BEC concept for electricity. This was considered an abstract phenomenon (Korganci et al., 2015) that created misconceptions among students (Ate and Polat, 2005; Küçüközer and Kocakulah, 2007; McDermott and Shaffer, 1992; Maloney et al., 2001; Turgut et al., 2011). What is meant by misconception is that students had different knowledge and conceptual understanding of the natural phenomenon from that of scientists (Magnusson et al., 1994). Misconceptions took place because in the material there were so many formulas that linked one another (Hung, 2006). Therefore, students misunderstood the Ohm concept, as there were many formulas to comprehend, which were related to each other. Reference [9] stated that student perception caused the misconception, for they were used to integration with the physical environment. For instance, students were able to directly interact with the electrical devices (electric installation, cooking equipment, washing machine, etc.) and electronic devices (computer, cellphone, and others) in their surroundings.

Numerous academics from countries all over the globe had undertaken research on the misunderstandings and misconceptions regarding the electric subject matter (De Jong et al., 2013; Duit and von Rhöneck, 1998; Engelhardt and Beichner, 2004; Kapartzianis and Kriek, 2014; Lee and Law, 2001; Psillos et al., 1988; Shipstone et al. 1988; Taber et al., 2006). Researchers in Indonesia recently reported the finding that students' misconception with regard to electrical series was up to 83%, while 17% did understand the concept (Widodo et al., 2019). Based on observation in some provinces in Indonesia, one of the factors that contributed to this misconception was that teachers still used the lecture method. This was relevant to what stated by the reference (Kock et al., 2013) that the teacher was one of the casual factors to students' misconception for they did not use the appropriate teaching method. Teaching method must be in accordance with the material and student need (Sanda and Mazila, 2017). The lecture method was used in conventional teaching, and so there was only one-direction communication taking place for it put teacher as the centre of attention, while students who did not actively interact only took down notes, listened to the material presented by teachers, which was passively receive (Michel et al., 2009; Stewart-Wingfield and Black, 2005). In the discussion method, communication was built in a group that consisted of several students who put forward their ideas (Abdulbaki et al., 2018). The disadvantage of discussion method was that the teacher only supervised and did not actively took part in the discussion.

Teacher who has pedagogical competency possesses the ability to apply the appropriate teaching method in line with the material, such as the collaboration method. Ones who possessed the collaboration teaching skill were able to communicate the concept of the material as well as to connect current, different potential and resistance put forward by Ohm so that it would positively impact a student's learning achievement in the electrical direct current subject.



Statement of the Problem

VTS students were experienced in applying Ohm law in an electoral series because they poorly understood the basic concept of electricity such as capacity, current, different potential and resistance. This difficulty was caused by the teacher not having the skill to rectify the misconceptions students had in the learning process. Students stood with their own concepts, which were not in line with the scientists'. In teaching activities, teachers used inappropriate methods such as the lecture and discussion method. Teachers who had pedagogical competence would be able to use the appropriate method for EDC learning, such as the collaboration method. In this method, the teacher would be able to communicate the material to students to establish an effective knowledge transformation.

Student difficulties in implying the concept of Ohm law in BEC series were caused by the fact that they did not totally understanding it.

Research Question

The following questions were addressed in this research:

- a) How was the process of teaching while teacher used the lecture method, discussion method and collaboration method to comprehend the concept of BEC?
- b) Was there any difference in terms of student achievement when either the lecture method, discussion method and collaboration method were used?

Purpose of the Study

This study aimed to know:

- a) The difference found in EDC concept learning with regard to the lecture method, discussion method and collaboration method.
- b) The effectiveness of lecture method, discussion method and collaboration method toward student learning achievement of the EDC learning concept.

Research Hypothesis

Research hypothesis was to compare the average score of students' achievements by using the lecture method, discussion method and collaboration method in learning the BEC concept.

Literature Review

Before teachers were assigned to teach, they had already undergone the education process and been trained for pedagogical and didactical competence. The purpose of this was establish a



guide line of teaching activity, which would inform and construct concept definition, observe phenomenon and fact, value the differences each student had, and to direct the learning process to a situation that developed student knowledge (Veselinovska et al., 2011). Although teachers had stepped into the education process and pedagogical training, many still use their own self-method without paying attention to the content that would be presented to the students such as BEC. The following were methods used in teaching activity.

Lecture Method

The lecture method has been known for a long time and has been used by teachers to transmit cognitive comprehension to groups of students (Ganyaupfu, 2013). Generally, the lecture method is conducted by a teacher who speaks from the front of the classroom to students, who are occupied in writing down the material (Hackathorn et al., 2011). In this method, the teacher was seen as an expert (McKeachie and Svinicki, 2006), and uses the lecture method to present the material (Mokhtar, 2016; Oxford, 1990; Smith and Renzulli, 1984). Learning by using lecture method was less interesting to students. Indeed, it was boredom that caused students to not work the assignment out (Godleski, 1984; Felder and Silverman, 1988) and achieve only a poor result (Mokhtar, 2016; Oxford, 1990; Smith and Renzulli, 1984; Godleski, 1984). Lectures are monotonous (Stewart-Wingfield and Black, 2005) (Dorestani, 2005), and so students sometimes played around, became sleepy and fell asleep in classroom (Van Eynde and Spencer, 1988). Research showed that teaching by using lecture method turned students down and decreased mastery over the material (Michel et al., 2009). Empirical studies conveyed that active learning was more effective than the lecture method (Serva and Fuller, 2004). Although the lecture method had sometimes been criticized over, the fact showed that it could still stand in this technological development era (Kaur, 2011). According to Capon and KD (2004), the lecture method transmitted only a small amount of knowledge for it was able to discuss, indicating its failure to catch student attention. According to Rahman et al. (2011), only students who were well prepared could go through the learning process delivered in lecture method. This perception revealed that the lecture method has many disadvantages that impact student achievement.

Discussion Method

Discussion was not a new term in learning. Group discussion consisted of some forms namely small group, sitting in circle, panel discussion and debate (Yusuf et al., 2016). Discussion method is a kind of group learning, which is led by one of students in the same group (Perkins and Saris, 2001). Discussion could raise self-confidence (Brookfield and Perskill, 2005). On the principle discussion method, knowledge and ideas from number of students might lead to an answer for a particular issue (Oyedeji, 1996). The discussion method was a forum where students' ideas were exchanged (Yusuf et al., 2016). Discussion was a type of activity that



turned a class into small groups to effectively speak about certain topics or to address issues. This was a process of thinking together where students had the access to freely speak or interact with the teacher. This process put students in the centre because students needed to actively participate (Yusuf et al., 2016). The teacher played the role as moderator. There was a stream from teacher to students as well as from students to one another. Teachers should not let an individual student dominate the discussion (Yusuf, 2012).

The discussion learning method was beneficial to students. It brought out advantageous results for the students (Yusuf et al., 2016; Perkins and Saris, 2001). In certain situation, the discussion method would involve the students' spoken or written expression (Abdulbaki et al., 2018). In group discussion, there would be provocative questions that trigger critical thinking. According to Ross (2008), the quality of the group discussion sometimes developed elementary and junior high school students.

This method could lead to students' active participation (Rotenberg, 2010), self-confidence and leadership skills (Yoder and Hochevar, 2005). A researcher (Yusuf et al., 2016) concluded that the discussion method could increase students' potential.

The perception above showed that the discussion method was applicable to certain learning activities and had a positive impact on students

Collaboration Method

In the 21st century, the collaboration method has become a trend in thinking, and in resolving global issues that have been noticed internationally (Austin, 2000). Collaboration was a teaching model that had been applied in varied field of science (Jenni and Mauriel, 2004). The collaboration method is an intellectual approach involving the collaboration of the teacher and the students, as well as the collaboration of students with their classmates to solve problems, finish tasks, and to have a ready product (Laal and Laal, 2012; Le et al., 2018).

Collaborative teaching is the most effective method of teaching (Pugach and Johnson, 1995). Collaborative teaching would increase students' interest and promote critical thinking (Gokhale, 1995). Researchers found that students face some issues in collaboration learning. These issues occurred because students did not listen or interrupted others' opinion (Laal and Laal, 2012). The lack of the collaboration skill would also slow students down in learning the material (Popov et al., 2012).

Researchers reported issues in collaboration teaching such as the organizing of the learning activity, teacher supervision of student behaviour, managing the learning time distribution, preparing relevant material, and developing student behaviour (Gillies and Boyle, 2010). This issue was caused by teachers who did not prepare themselves for collaborative work and were



less productive (Blatchford et al., 2003) in organizing collaborative work and facilitating the activity process (Ruys et al., 2012). Based on that point of view, teachers might be able to comprehend and apply the collaborative teaching method so that students would comprehend the concept of BEC.

Methodology/Materials

Participant

79 students and 3 teachers of Electrical Engineering subject participated in this research. This research was undertaken in Vocational Technical School in Manado, North Sulawesi, Indonesia.

Design

This research was comprised of experimental research to compare the effectiveness of the lecture method, discussion method and collaboration method. This research was to study the pros and cons as well as the effectiveness of those three methods in learning the concept of BEC.

Instrument

Data Analysis

To analyse the data, Analysis of Covariance Statistics was used to study the effectiveness of teaching with the lecture method, discussion method and collaboration method. The analysis result would be the reference relating this discussion with the writing of this article.

Procedure

Teaching was applied by three teachers who had relevant backgrounds in VTS. They had all taught BEC for over 10 years. Each of them was assigned to undertake the teaching by using a method that was different from what the others would apply. Before the experiment took place, they were directed by the researcher regarding their own tasks. 27 students attended the class where lecture method was used, 27 students attended the discussion method class, and 28 students went to the collaboration method class. The undertaking of the experiment took place over 8 meetings. Each meeting took 90 minutes. A test was held in their last meeting and was 90 minutes long. During the test, the researcher was involved in observation and interviews were taken to end the treatment.



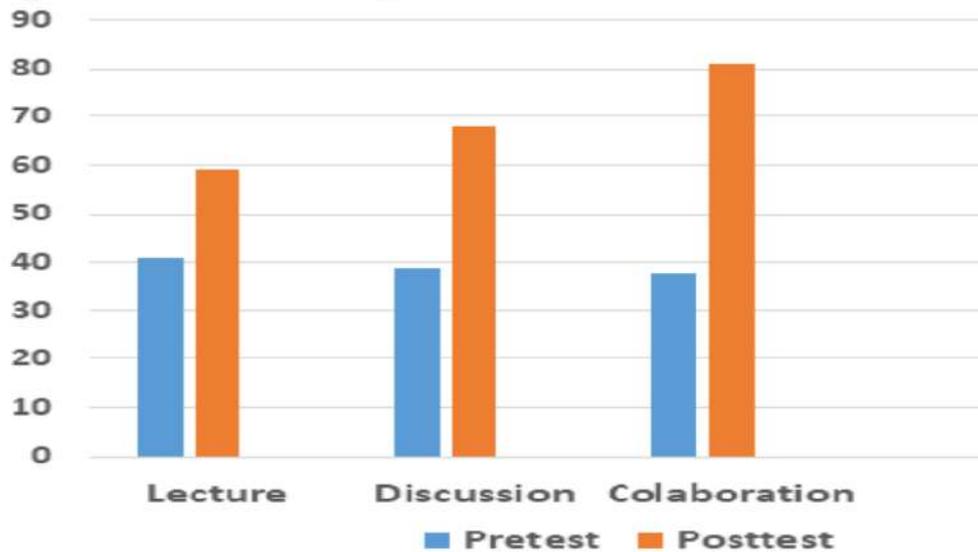
Results and Findings

The result of treatment was described in Table 2.

Table 2: Pre-test data and Post-test Data

Method	N	Pre-test		Post-test	
		Minimum	Maximum	Minimum	Maximum
Lecture	27	22	41	43	59
Discussion	27	22	39	54	68
Collaboration	27	19	38	65	81
Total	81				

Figure 1. Pre-test and Post-Test Diagram



The requirements of Anova Statistics examination were the research data needed to be normally distributed and the variance of research data group were homogenous.

Table 3: Tests of Normality

Method	Kolmogorov-Smirnov			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Lecture	0.134	27	0.200	0.961	27	0.386
Discussion	0.158	27	0.083	0.960	27	0.373
Collaboration	0.095	27	0.200	0.970	27	0.648



The criteria of data normality test were if sig. Score was above $\alpha = 0.05$, it can be concluded that the research data distribution was normal. Table 3 showed Sig. > 0.05 . It explained that the research data of those 3-teaching method was normally distributed.

Table 4: Test of homogeneity of variances

Levene Statistic	df1	df2	Sig.
0.889	2	78	0.416

Sig. Score showed in table 4 was $0.416 > 0.05$. The result showed that all these teaching methods were categorized homogenous and had same variances.

Table 5: Students' average achievement

	Sum of Squares	df	Mean Squares	F	Sig.
Between Groups	7656.469	2	3828.235	229.354	0.000
Within Groups	1301.926	78	16.691		
Total	8958.395	80			

The result of analysis in table 5 showed sig. score as $= 0.000 > 0.05$. This result proved that students' average achievement on these three teaching methods were significantly different. Later on, effectiveness analysis was taken from three teaching methods in learning the BEC concept.

Table 6: The categorization of effectiveness N-Gain Score (Abdu-Raheem, 2011)

Percentage (%)	Interpretation
< 40	Not effective
40 – 55	Less effective
56 – 75	Effective enough
> 76	Effective

Table 7. N-Gain score

Method	N	Mean N-Gain Percent	SD
Lecture	27	28.30	3.53
Discussion	27	40.26	2.77
Collaboration	27	63.63	3.56

Good teaching depends on an appropriate method. Students' who were taught by using lecture method (Hackathorn et al., 2011) had low learning achievement because the learning process was a teacher-oriented one. Students became passive and only memorized the material (Pedersen and Liu, 2003). This type of teaching made students tired and bored easily, because they only listened to what the teacher had to say (Othman, 2013).



This research finding was relevant to the study by Abdu-Raheem (2011), which showed the effect of the discussion method was greater than that of the conventional method. The reason for this is that the use of lecturing method caused less critical and creative thinking as well as collaboration in problem solving (Olutola, 2017).

The learning result of group discussion was better than the lecture method because the discussion session was more effective than the lecture method. Capon and KD (2004) opine that the discussion session was more effective than lecture session in stimulating students' interest and in viewing their understanding about the material. As stated by Bloom in Hussain (1994), use of the lecture method was determined by certain objectives of the teacher, which was to communicate the information in an efficient way. The discussion method, however, better develops students' critical thinking skills, problem solving, and behaviour. Teachers who applied the discussion method would motivate students (Brookfield and Perskill, 2005) (Hussain, 1994) and improve behaviour (Gage and Berliner, 1988). Therefore, the overviews on some references addressed the teaching of the discussion method, which could stimulate interest, behaviour and motivation. This was an aspect in a field that actively support students' cognitive skills (Ponto et al., 2018).

There was also an increase in the academic community to investigate vocational students' conceptual comprehension about electricity and to find ways to develop the conceptual comprehension between students (De Jong et al., 2013) (Kollöffel and Jong, 2013). A solution was offered to overcome the conceptual issues regarding electricity, but with limited success (Mullhall et al., 2001). These topics still drew attention (Engelhardt and Beichner, 2004) (Taber et al., 2006) (Hart, 2008; Duit and Schechker, 2007) and less of communication occurred between teacher and students. In Indonesia, there were still many teachers using the conventional method in delivering the material of BEC subject. Teachers who already had pedagogical competency through education training were expected to have varied skills and strategies to apply in the classroom and thus create effective communication between teachers and students. Teachers who had the collaboration skill in teaching activities communicate the concept of BEC material so that students could be motivated to think along with their classmates and eventually find the concept in their surroundings.

Apart from the advantages in discussion method, McCarthy and Anderson (2000) suggested that there were limitations in this method such as dominant students in a session, that other students might not participate at all in the discussion, and that the discussion could be taken out of its context. Brookfield and Perskill (2005) wrote that sometimes discussion flowed well but there were times it got slower and lost its effectiveness (Abdulbaki et al., 2018).



The problem found in teaching by using discussion and collaboration method was that some students were shy and were less able to participate in discussion and collaboration with the teacher and other students.

Some students were shy but did not find difficulties in following the learning process, but their ideas and opinions were not delivered in class. Rather they received information from the teacher and other students, which only benefited themselves. In collaboration learning, there would be analogical thinking to provide clarity about the BEC material with its abstraction so that students would be able to comprehend the concept that was being taught (Chiu and Lin, 2005).

Conclusion

According to the result and research finding about BEC learning achievement in using these three teaching methods, it could be concluded that: (i) there was a significant difference in the achievement brought about by these three methods; (ii) the achievement of students who were taught using the collaboration method were higher than those taught with either discussion or lecture methods; (iii) the result obtained by discussion method was higher than the lecture method, which was un-effective; (iv) the use of discussion method was less effective; and (v) collaboration method was sufficiently effective.

This research finding could be taken as reference for teachers to apply the collaboration method when compared to either the discussion or lecture method in BEC learning.



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