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Effectiveness of Teachers' Creative Skills Using Analogy in Learning of the Concept of Basic Electric Circuits

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***ABSTRACT**--Basic electric circuits (BEC) are major subject matter in the Electricity Skills Engineering competency study program at the Vocational Technical School (VTS) in Indonesia. Because electricity is an abstract phenomenon, resulting in students often have difficulty learning BEC which results in a misunderstanding of concepts or known as misconceptions. One factor occurs misconceptions because teachers use conventional teaching. Creative teaching skills using analogy are methods of teaching to change students' misconceptions on BEC subject matter. The research objective is to compare the creative skills of teaching using analogies with conventional teaching. This study uses a quasi-experimental method. The research subjects were 67 students who attended the VTS Electricity Engineering competence consisting of 34 students as an experimental group, and 33 students as a control group. Research findings indicate the experimental group is more effective than the conventional group.*

***Keywords**--Creative teaching skills, analogy, concept understanding, basic electric circuits.*

I. INTRODUCTION

Electricity is an energy that gets an essential role and an important contribution to developing 21st-century technology. Technology constitutes an equipment usufruct to engineer that beneficent to prop human activity at various area starts from simple work until on complex level. Since the importance of electricity, therefore in a general way of education at the world designs curriculum to be studied for the student from elementary school until college. Curriculum 13 is performed in Indonesia, notably study area of tech skill interest to electric energy at VTS, BEC'S material mandatory taught by a teacher and studied by the student.

Electric series gets an abstraction and complex character causes students frequenting to snag of studying BEC. A lot of students misunderstands concept or often be called misconception to BEC [1–3]. This handicap happening because students are difficult to concern current phenomenon content, tension and resistance in a series. According to [4, 5], students struck a snag to study and correlated material already be studied by a tutorial material context that will be studied. By reference that gets as follows been given a lead, the student that experiences misconception to current, potential difference and resistance they will be struck, a snag to study quits subjective electricity series, parallel, and parallel draw combine. Another example which is a student which misconception to direct current electricity they will strike, a snag to study further about electricity shuffle through.

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Based on a survey at umpteen province in Indonesian, in a general way, students struck a snag to study BEC because they misunderstand studied or frequent concepts called misconception. The survey that points out that teacher constitutes one of factor cause of handicap student studies and misconception since teacher applies conventional or traditional teaching method. Conventional teaching is a learning type that gets the character to gaze face among teacher and student, this learning gets center on a teacher, where does material pass on in discourse form which is one-way communication of teacher goes to student utilize textbook with the terminology or difficult word to be understood by the student. One way communication, making weary students and boring [6] conventional teaching a method that doesn't effectively be utilized the deep current concept of electricity learning [7]. In conventional learning, a student in a passive state and memorizes study material [8].

Several observational finds that one of the factor causes of student misconception toward the concept of BEC learns [2, 3]. Misconception toward a student on BEC because of teacher limited creativity to informs and communicating material study to students. That chastened concept gets to be understood required by method teaches an effective one. But is not all learners will successful, as said by reference [9] teach don't task easy for the teacher. There is no perfect teaching method [10]. But the teacher that has an interest pedagogic able to create environment academics that lead student behavior to active in learning activity so they can find an alone study of BEC concept. There are many teaching methods already been found researchers already been applied in various science study content, amongst those creative skills to teach [11, 12]. Teacher that have creative skill gets to apply particular strategy, amongst those have analogy ability to student to understand tutorial material concept.

Statement of Problem

BEC'S teaching concept in Indonesian still a lot of teachers teaches to apply conventional method which is a teaching process that gets center on learns, they presenting material verbalizes study by use of terminology still intern that was understood relating student with tutorial material about content, electric current, potential difference, resistance, energy, and electric power. In a general way, a student has understood symbols and a big set of utilized in cognitive tutorial material electric, like conductivity, Joule conversion/second goes to Ampere, voltage or potential difference among terminal second linked series with battery or source. One that constitutes a potential difference among terminal second at one particular series. It begets material study that at presentation, student experiences misapprehension (misunderstanding) or misconception, begetting it difficult to study succeeding study material. Creative teacher pedagogics' interest with its creativity as to establish studying which was support espoused by reasoning analogy for contracting study material corresponds to the real world that experienced by student most dodge from misconception.

Research questions

Questions in this research, how creative teaching skills to be utilized in BEC'S cognitive learning?

1) How is students' understanding of BEC'S concept?

2) What is creative skill approaching teaches to utilize analogy more effective than conventional teaching approach in understand BEC'S concept?

3) How effective creative teaching skill to utilize analogy than conventional teaching in BEC'S concept learning?

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Objective of research

The aim of this research as follows

1) To know teaching skill effectiveness to utilize analogy in BEC'S concept learning.

2) To compare teaching skill creativity to utilize analogy with conventional method teaching in BEC'S concept learning.

II. LITERATURE REVIEW

2.1 Learning Concepts Understanding of BEC

Implemented teachers' learning, teaches concepts to get bearings with gnostic are taught to students. Concept is a forming about object, instance or scene, and also relationship, that has particular attributes [13] Reference of [4] stated concept is declared for about situation objects, instance, situation, marking that has typical alone represent to culturize particular that espoused by symbols or sign. Meanwhile in literature [14] worded that concept is a relevant statement with scientist concept. The content, current, potential difference, resistance, energy, and electric power is base concept already be studied at junior high school. The base concept most conceive of student startup science to study BEC on ladder study programs tech skill interest electricity engineer at VTS. Studying BEC, a student shall understand symbols, physic, and mathematics to solve BEC'S abstraction and complex phenomenon. In the tutorial content written textbook of factual viewpoint with analyzing mathematical approaching and calculus.

In the teaching process, teacher presenting definition, fact and law series is espoused with an equation, e.g. to solve the simple electric series problem by use of ohm's law which is [15–17]. In a general way, the textbook presents procedural skill and most structure to solve problem series. Studying BEC, a student shall understand the series law concept, e.g. ohm's law which declares for electric current strength that is adrift pass-through connector should be proportionate straight with tension that applied to her. To know potential difference on the two series terminal is where = potential difference in unit Volt that given by symbol V , = electric current that is adrift at one particular series with unit Joule / second or Ampere that given by A's symbol, and = resistance with unit Ohm that given by symbol W [18, 19].

2.2 Students' Misconception Toward BEC

Students' problems in studying BEC which is a misunderstood concept or misconception studies about connection battery and bulb, current, potential difference, resistance, subjective electric series quits, parallel and parallel draw combine. A problem learning BEC was analyzed at state sort at the world with ethnical background, culture, socio-culture, and language that variably. Generally way misconception student toward BEC covers (i) textbook deep language difficult comprehended student; (ii.) student don't see symbol and unit in BEC'S tutorial material; (iii.) student has startup and experience science every day at its environment that gets touch with formative technological product that progressive massively in concept about BEC in contrast to concept scientist; (iv.) teacher utilizes difficult terminology to be understood, student; and (v) teacher experiences misconception impacted to tutorial material representations, begetting teacher gives incorrect concept contribution to student [3, 20–30]

The student who has experienced misconception, they will be struck a snag to study new study material [4, 5] e.g. student experiences misconception to their direct current concept handicap will study alternating current concept and vector diagram. The teacher who has the misconception, therefore in their teaching activity will develop the misconception that to a student. It happens since teachers do not master control science concepts that necessarily they understand [31]. It is supported by research results by previews researchers [5] [17] [24]. Purpose says in a pass on study material is adjusted with student condition comprises age or reasoning student. Related to the thing reference [32] stated important of pre-condition is important to help student understands and re-build own and corrects conception that already they believe before study tutorial material concepts.

2.3 Conventional Teachings

Conventional teaching or traditional utilize discourse method constitutes is a teaching method that gets center on learns [33–35]. Material representation with this teaching method done by one way, which is from teacher to student [36]. This teaching student just imitates information that is given by teachers, memorize, read and not develop students critical thinking [37] teaching is brazed that gets the character to gaze face at brazes, a teacher gives science to the student with oral language [38]. Conventional teaching, teacher utilizes to methodic discourse to presenting word-of-mouth information, and the student accepts passively [39] and memorizes study material [40].

In this teaching, the teacher lacks control over students' problems and forces them to master the knowledge presented, and students are forced to be able to answer exam questions [41]. The use of conventional teaching methods is less interesting and boring for students and does not try to do the assignments and get poor test scores [42–44]. Conventional or traditional teaching uses lecture methods used by teachers to convey information knowledge verbally and passive students [45]. This method makes students less initiative [46]. In general, instructors use lecture methods to present constructs and concepts about definitions [47]. The lecture method is not practical if used in a large enough class[48, 49].

2.4 Creative Teaching Skills

Someone before the profession of teachers, they have followed along the educational process to obtain knowledge and pedagogical competence in higher education, especially education. In the process of education, in addition to being given theoretical knowledge, they are also equipped with structured teaching exercises ranging from teaching small classes (micro-teaching) to going to school to learn the characteristics of students and practice teaching in real classrooms. Through this education, they gain meaningful experience, and when carrying out formal teaching assignments they are expected to be able to educate and direct student behavior in learning activities given theoretical and laboratory subject matter.

The implementation of learning is a collaborative activity between teachers and students [50]. To create effective collaboration the teacher must be creative. Creative teachers are needed in education to help students in learning activities. Creativity is a critical thinking skill that is crucial for creating new, useful and valuable teaching innovations. Creativity influences the way of teaching to deliver subject content [50]. Creative teaching is an important component in creating creative learning [48] [51].

Creativity is a psychological process consisting of 1) a creative process, which is a way to build creative products that lead from unusual ideas. In this case old ideas are promoted to new ideas according to the existing conditions; 2) creative products, namely creating a useful new product; 3) Someone creative, has features that include curiosity, diligent work, rich imagination, confidence, not afraid to fail, ambitious, and have a sense of humor; and 4) creative environment, which uses the existing social environment to create creative [10]. Creative teachers are very important to be a modern school [10] [52]. The teacher needs creative skills in conducting student learning activities, including learning BEC.

In the context of learning, creative teaching is defined as behavior that can make a unique and meaningful transformation for all learners [9, 10]. Creative teachers are people who dare to take rational risks in situations that were not predicted before [48]. This statement stated by [9] teachers who apply the concept of creative teaching dare to take risks to experiment with new ideas using different teaching approaches to create learning conditions and students get the best results in learning the concept of the lesson. The foundation of creative teaching is how to teach to apply the creative skills it possesses to improvise so that sustainable change occurs [9].

Teachers who have creative skills can design teaching activities to realize students' weaknesses, they will self-correct [53]. Teachers who have teaching creativity skills will motivate students in learning activities [53, 54] and interest in learning [10] [53] students will be creative [51]. Creative teaching is a complex activity, perspective and involves a variety of skills and teaching experience [12], "improvised discipline," which is closely related to the experience of the teacher [11] the unique and meaningful teaching process that teachers do and is adapted to the conditions learning [10], creating a pleasant and interesting environment for students [55].

The creative personality of the teacher has four characteristics, as follows : (i) the ability to innovate to gain insight into making changes; (ii) have ideas to be adapted in teaching activities; (iii) ability to control oneself to gain autonomy and speed in carrying out tasks; and (iv) having the relevance of teaching interest in implementing meaningful learning to communicate and influence students [56]. Professional teachers will do creative teaching, which is conscious, they act using tactics that are comfortable facing ambiguity that is challenging for teachers and students to do creative ways. There are three important elements for implementing creative teaching, as follows: (i) teaching tactics, conducting tactics or strategies to inspire students to be motivated in creative and meaningful learning activities; (ii) using the ability and skills of teacher creativity to present and communicate lesson content effectively; and (iii) teachers who have motivation and attitudes play an important role in the provision of subject matter [57].

Research conducted [12] found that the success of creative teaching involves three components, namely belief in education, dedication, and intrinsic motivation. This is to form an attitude of creativity, use of tactics, friendly learning ethics, instill creative thinking for students and support the development of creativity. Further explained [12] there are three main strategies for creative learning challenges namely student-centered learning activities, using multi-teaching, and effective learning management.

2.5 Analogy

An analogy is important for scientists to explain their findings [58]. Whereas for analogy science teachers are used in teaching activities to explain the subject matter to students to understand the science concepts taught [59, 60]. Using analogies in teaching methods aims to build than by the subject matter presented in the class [61].

Various teaching models have used analogies to make it easier for students to understand the concepts of science subject matter [1] [62, 63].

An analogy has a role to understand or form a concept [62]. Analog to compare about the unknown with the unknown [64]. Simply stated, an analogy can describe the process of identifying the similarity of two scientific concepts compared to a concept known as an unknown concept as a target [1] [65] [66, 67]. The role of analogy is to change existing concepts and knowledge to build new knowledge [68].

One of the advantages of analogy is that the teacher promotes students 'prior knowledge to express students' misconceptions about previously learned content [69]. An analogy is often used as a tool to explain so students understand abstract scientific concepts [70] the use of analogies is instructive to connect everyday experiences with abstract and complex concepts [1] [71]. To understand the concept of electricity, an analogy of gravity is used [72, 73] while to understand the concept of electric current circuits an analogy of water flows in a pipe [74, 75].

If in the teaching process the teacher uses an incorrect analogy there will be a misconception for students [75]. This happens because students are not familiar with the analogy features used so that students have difficulty connecting the analogy explanation with the target knowledge taught [66]. For the teaching process to be effective, the teacher must be creative in using analogies in teaching activities. Creative teachers can use the right analogy, so the learning process is more meaningful and interesting for students.

III. METHODOLOGY/MATERIALS

3.1 Participant

Participants in this study were 10th-grade students aged between 14-15 years totaling 67 students consisting of 34 students in the experimental class and 33 control classes. In this study involving two teachers. Each was assigned to treat the experimental class and the control class. The treatment was adjusted to the BEC content implementation schedule. This treatment was carried out as many as 8 treatments. At the end of the treatment, interviews were conducted with students and teachers. At the 9th meeting, an evaluation was held.

3.2 Research design

The study design was a quasi-experimental study to determine the effectiveness of the teaching creative skills of teachers compared to conventional teaching in learning BEC concepts. The research design is presented in Fig 1.

Experiment	O	X_1	O_1
Control	O	X_2	O_2

Figure 1: Research Design

Information: O: pretest; O1: posttest; X1: treatments of teaching strategy methods; X2: conventional treatment methods.

Experimental variable in this research is the creative teaching skills of teachers while conventional teaching is the control variable.

3.3 Instrument

Test instruments for BEC are presented in Table 1.

Table 1: BEC instrument

Content BEC	Item	value weights
The concepts of charge	1	1
The concept of electric current	2	1
The concept of potential difference	2	1
The concept of resistance	1	1
The concept of electric energy	2	2
The concept of battery	1	2
The relationship between battery and bulb	2	2
Circuit with one resistor component	1	2
The circuit consists of a series resistor	2	2
The circuit consists of a series resistor	2	3
Series-parallel combination	2	4
Total	18	

Each item uses a scale of 0-10. The range of the pretest and posttest values is converted to a scale of 0-100. In order to obtain accurate data, the research instrument was validated by two experts and one practitioner, namely experts in the BEC content, linguists, and VTS teachers as education practitioners. The result of instrument validation is 0.76 and reliability is 0.84. These quantities in the instrument category meet valid and reliable requirements.

3.4 Data Analysis

Analysis of research data using independent statistics "t" test and normal Gain (N-Gain) test using SPSS. The N-Gain value is calculated by the formula [83]:

$$N - Gain = \frac{Posttest\ score - Pretest\ score}{Maximum\ score - Pretest\ score}$$

N-Gain Test (Normalized Gain) to decrypt the difference between the abilities obtained by students before and after applying a teaching method in research [Hake, 1999]. In this study, the pretest was carried out before the treatment was carried out and the posttest was carried out after the treatment.

3.5 Procedure

To implement the treatment is implemented by two teachers, one for the treatment of creative teaching and the other teacher applies conventional teaching that they carry out every day. Teacher recruitment for treatment in the experimental class can apply teaching skills based on information from the teacher and students then conducted observations to prove the information. During the implementation of the treatment in the experimental class and

control were observed by researchers. Before the treatment is implemented, the researcher discusses with the teacher about the experimental treatment that will be applied.

The stages of implementation are (1) preparation phase. First the teacher explores the subject matter, plans / designs pedagogical strategies, and prepares tools including teaching media needed in accordance with the content of BEC material; (2) the implementation stage, namely the teacher implements the planned teaching strategy, including forming cognitive aspects about students' mindset and affective aspects concerning attitudes, motivations, and stimulating interests regarding feelings and emotions of student learning teaching activities. At this stage, the teacher applies creative teaching using language according to the age of the student and the analogy, interesting illustrations are accompanied by examples in the learning environment, real-life of students so they can find their knowledge learned; and (3) Closing, which is the stage to evaluate the students' absorption of the subject matter and proceed with the assignment of homework.

IV. RESULTS AND FINDINGS

Research data is described in Table 2

Table 2: Description of Research Data

Group	N	Pretest		Posttest	
		Minimum	Maximum	Minimum	Maximum
Experiment	34	19	37	66	83
Control	33	21	38	44	62
Total	67				

Based on the pretest and posttest data in Table 2 shows that the experimental and control groups experienced an increase in BEC learning outcomes.

Table 3: Tests of Normality

Group	Kolmogorov-Smirnov			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Experiment	.074	34	.200*	.978	34	.714
Control	.077	33	.200*	.978	33	.710

Normality test results in Table 3 for experimental data obtained sig 0.714 > 0.05 and control data is sig. 0.710 > 0.05 the experimental and control data are non-distributed.

Table 4: Group Statistics

Group	N	N-Gain Percent	SD
Experiment	34	56.96	4.26
Control	33	35.33	4.92

Table 5: Interpretation of the Effectiveness Category of N-Gain Score [Hake, 1999]

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

From Table 4, the mean percentage of the experimental group was 56.96%. While the mean percentage of conventional teaching methods was 35.33%. Based on Table 5 shows that creative teaching skills using analogs in the category are quite effective, whereas conventional teaching in the category is not effective.

Table 6: Independent Samples Test

	Levene's test for equality of variances		t	df	Sig (2-Tailled	Mean difference
	F	Sig				
Equal variances assumed	.746	.391	26.65	65	.000	29.95
Equal variances not assumed			26.59	63.12	.000	29.95

Table 6 shows that sig .39 <.05 shows the variance of experimental and control data in the homogeneous category. Based on the analysis of the data in Table 6, it was obtained sig .000 <.05 thus statistically showing a significant difference in effectiveness between teaching creative teaching skills using analogue with conventional teaching.

V. FINDING AND DISCUSSION

Based on the results of the study it was found that (i) teaching using conventional methods was not effectively applied in BEC learning; (ii) creative teaching skills using effective analogs in BEC learning; and (iii) there is a significant difference between teaching using conventional methods and creative teaching using analog in learning BEC concepts, in this case creative skills using analog are more effective than conventional teaching methods in learning BEC concepts. Ineffective teaching of conventional methods because teaching activities are teacher-centered.

In this teaching activity, the teacher presents the BEC content using lectures that are one-way [35] while student activities only listen and write [76] resulting in them getting bored quickly not trying to do the assignment and poor learning outcomes [41] [43]. Teaching like this, students do not focus on following the presentation of the subject matter presented by the teacher.

Based on observations during conventional teaching treatments, students often ask permission to go in and out of the classroom with a variety of unclear reasons and there are also just playing or disturbing friends beside and

not doing the assignment. The questions raised by the teacher were not responded to, and students rarely asked even though they had been given the opportunity by the teacher. But some teachers who teach using conventional methods do not like student questions [77, 78]. The following sample is the result of the interviewer's (R) interviews with some students (S) in the conventional teaching treatment group. This interview was carried out after the treatment was completed, as follows:

R: Is the presentation of the subject matter interesting?

S6: Not interesting

S19: not interesting

R: Do you understand the subject matter that the teacher presented?

S23: just a little

S14: only certain content

R: What do you think is the BEC content that is difficult to learn?

S31: memorize the formula for calculating the current in a series-parallel combination circuit

S24: I am confused to see the circuit diagram.

This interview shows that using conventional teaching methods students experience difficulty in understanding the concept of BEC.

Following are the results of the interviewer's (R) interviews with several students (S) in the experimental group, namely:

R: Is the presentation of the subject matter interesting?

S2: Interesting

S26: I'm interested

R: Do you understand the subject matter that the teacher presented?

S19: A lot of my BEC content is understood

S7: Pretty good

R: What do you think is the BEC content that is difficult to learn?

S12: series of parallel-series combinations

R: Is the series-parallel combination circuit difficult to understand?

S29: can be understood.

Based on interviews it was shown that the experimental group was more interested in participating in learning activities and better understood the BEC concept. In this case, the results of the interview are relevant to the results of the study. The results of this study prove that teachers have creative teaching skills using analogies quite effectively for students in learning activities and the students' pretest scores have increased significantly in the posttest. This shows that an increase in student learning outcomes from before and after the experimental treatment. The content of BEC lessons includes science and empirically the results of this study are relevant to several studies that have successfully used analogs in science teaching [72] [79, 80]. Students can understand BEC content because the analogs explained explain real events, they experience every day. The effectiveness of the teacher's creative skills using analogs stimulates interest and positive attitudes are formed so that students are motivated to learn BEC and do assignments. Interest, attitude is part of the affective domain very important in studying electrical content [81].

Relevant as said retention [82] learning that creates interest and motivation, students more easily understand the concepts being learned compared to conventional teaching.

This is relevant to the results of observations during the treatment in the experimental group, where students pay attention to the presentation of BEC content, the teacher's questions are answered by the majority of students, actively asking questions, and are diligent in making assignments.

VI. CONCLUSION

In the learning activities of the BEC concept, a suitable and appropriate teaching method is needed so that the BEC abstract phenomenon can be understood by students according to the experts' concepts. To learn BEC, the teacher is not only mastering content, but creative skills are needed using an analog that can be understood so that subject matter that is targeted in learning activities can be understood. In learning analog BEC water and pipe can build students' thinking construction about currents, potential differences, resistance and conductor are the factors present in BEC. The current is identified with water flowing in a pipe analogous to a conducting wire. While the potential difference is the difference in pressure between the two ends of the pipe. Water will get a bottleneck if between the pipes installed a tool that can work if it is pushed by water. This analogous feeling is to illustrate the movement of current in a series going through a filament constructed in a bulb so that it emits light. These teachers who have creative skills using analogs, the abstract content of BEC will be as concrete as the real life of students who are in daily contact with electrical and electronic equipment in their environment.

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