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Construct learning model in heat transfer subject

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Abstract

The goal of this research was to reveal the effectiveness of the learning model used in Heat-transfer subject. In this research, a quasi-experimental method was applied, by choosing treatment by block design. The population of this research were students of the mechanical engineering department, two classes were randomly selected by using cluster random sampling technique. Data was collected by giving diagnostic tests and formal reasoning tests. The data was analized by using Anova formula and t-tests. The findings of the statistical analysis showed that: the student's misconceptions of heat-transfer subject who took part in constructivism learning were found lower than those who took cooperative learning. Based on the findings of this research, it can be concluded that the construction-related learning methodology is suitable to use.

Keywords: Cooperative learning; construct; heat-transfer; learning model; subject; students; lecturers.

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1. Introduction

Heat transfer, known as an abstract science consits of five major characteristics when it deals with heat transfer learning. They are discipline and a mindset, logical, critical, systematic and consistent, beside demanding creativity and and innovative power. This mindset can be learned and internalized by studying heat transfer in the right way [1-4]. This is done to help students' understanding of the abstract concept of heat transfer in a right way or avoiding a misconceptions [5].

Misconception is an inhibiting factor for students to build their own knowledge correctly [6]. Misconception does not merely mean the students' absence of knowledge [7] . It exists when the students compile knowledges, associate it with incomplete or insufficient experience or caused by an incorrect explanation or an incorrect perceived explanation. Having a misconception, knowledge is actually formed by the students themselves or not given the teachers [8].

The construction-related learning curriculum encourages active students to build cognitive structures in their interactions with their environments. With the aid of its cognitive structure, the subject or student constructs an understanding of reality [9]. Knowledge is located in "student centers"; students are solely contribute to knowledge. As a result, during the learning process, the students are actively involved in developing their knowledge, while the teacher posisition is as facilitator [10] . The most crucial aspect of constructivist theory is that students, not the teachers, are responsible for placing emphasis on and being active in developing their knowledge. It emphasis on active student learning needs to be elevated [11].

Constructivism is a learning theory that explains the nature of knowledge and how people learn [12,13]. It is a branch of epistemology. The prior experiences and background information of the learners are used to develop the true understanding. According to this theory, people build their own new knowledge or understandings by fusing what they already known with the concepts, experiences, and activities that they engage with. The instructor serves as a mentor, facilitator, and co-investigator, are responsible to encourages students to analyze, contest, and come to their own findings [14-16].

"The constructivist method may be used to address situations when people see, interpret, and explain the same item in various ways despite having the same feeling. Constructivism has several connotations, depending on someone viewpoint and position. To begin, constructivism is not a social or educational theory; rather, it is a scientific and metatheory that describes the potential and boundaries of beliefs about daily life in the development of mankind. Constructivists are, in a sense, observers of reality as it is being created in science or in daily life. You may find some of the ways to this specific problem" [17]. "Both in individually and collectively, learners must create their own knowledge. Each learner has a set of concepts and abilities from which they may build knowledge to address issues brought on by the environment. It is the responsibility of the community—other students and the teacher—to create the conditions, present the obstacles, and provide the encouragement needed to promote mathematical creation" [18]. "Constructivism characterizes knowledge as transient, developing, socially and culturally mediated, and hence non-objective. It is not a theory about teaching; rather, it is a theory about knowledge and learning" [19].

Learning that is more directed at experiential learning, is a human adaptation based on concrete experiences in the laboratory, discussions with colleagues, which are then contemplated and used as ideas and the development of new concepts. Therefore the existence of educating and teaching is not focused on the techers but on the learners. Students-centered teaching emphasizes creative problem solving and critical thinking skills. This kind of learning is not only concerned with the outcome, but also pays attention to the process in a particular context [20].

Constructivism learning theory has implications for learning heat transfer, helping the students to build heat transfer concepts by using their own abilities through an internalization process to help building the concept through information transformation that lead to create a new concept. Learning heat transfer is the process of building the understandings. The understandings or knowledges are constructed by students based on prior knowledge. Misconceptions can be defined as a belief that is not in accordance with scientific inquiry or unquestioning acceptance by academics. In a legal context, interference is defined as an unacceptable representation of facts [21, 22]. describes misconceptions as inaccurate elaboration, incorrect assumptions, incorrect categorization of examples, confusion of various assumptions, and incorrect historical relationships between assumptions. From elementary school through university, imitations can occur at all levels of education [23].

1.1. Purpose of study

In learning heat transfer, misconceptions can occur or are found in several sources, including: the meaning of words, practical aspects, simplification, and the singleness of heat transfer structures [24]. If a teacher does not understand the structure of heat transfer subject, it will lead the teacher to the misconceptions (misconcepts) that are taught to students. The goal of this research is to reveal the effectiveness of the learning model used in Heat-transfer subject . This article's main objective is to examine the historical development of the constructivist theory of knowledge and beside to highlight the views of John Dewey, Jean Piaget, and Maria Montessori on constructivist learning, three individuals who are considered among the creators of this particular theory.

2. Materials and method

2.1. Participants

The participants in this study were third-semester students of the Engineering Faculty at the University of Ekasakti Padang. There are 60 students in the third semester and taking the Heat-transfer subject, and they are spread across multiple classes. There Class consist of 30 students. The placement of students in each class is based solely on the number of re-registrations made at Ekasakti University and not on any specific criteria. The research was completed in the first semester of the 2021–2022 academic year.

The this study used cluster sampling, where the population was ranomized by group (class), then the two classes—the experiential class and the control class— were chosen. The classes were chosen as the experimental class and the control class were A and B, respectively (table I).

TABLE I

DESIGN TREATMENT BY BLOCK

Learning model (A) / formal reasoning (B)	Constructivism (A1)	conventional (A2)
High Reasoning (B1)	A1B1	A2B1
Low reasoning (B2)	A1B2	A2B2

Note:
A1B1 = group of students who are given a constructivism learning model for high formal reasoning
A1B2 = group of students who are given a constructivism learning model for low formal reasoning
A2B1 = group of students who are given a conventional learning model for high formal reasoning
A2B2 = group of students who are given conventional learning models for low formal reasoning.

According to Table I, this research offers treatment for learning through to moses, specifically constructivism for the experiential class and conventionalism for the control class, which help students overcome their misconceptions in the subsequent lessons in the heat-transfer subject. This research is classified as an experimental rese. Controlling many situations is imposible as precisely as in actual scientific research. The chosen research design was treated with a block. The most distinguishing factor was the diversity of students' formal justifications. Sorting is divided into two levels, specifically formal reasoning above the group average (27% from the top) and below the group average (27% from the bottom) once the data was sorted from the largest to the smallest. With this approach, we anticipate increasing the accuracy of the study's results. In carrying out this research, the division of students' formal justification levels is the key to understand experiential activities.

2.2. Data collection tool

This experimental research involved several variables that can be grouped as follows : Bound Variable (Y), The amount can vary in these classroom assumptions. Independent Variable (X), the dependent variables in this study were the learning curriculum, which consists of: (1) the constructivism learning model imposed on the experimental group, and (2) the conventional learning model on the control group. The moderator variable in this study is the students' formal reasoning. The use of formal reasoning as a moderator variable was intended to analyze straightforward effects (simple effect) of constructivism learning models for each stratum of formal reasoning and whether there is interaction between formal reasoning and learning models.

To describe more operational variables in this study, the followings are the operational definition of each variables.

a. Conventional Learning Model

The conventional learning model is a learning model that is based on behaviorism, the starting point of learning does not start from the initial knowledge possessed by students (pre-conception). Learning starts from presenting information and providing illustrations, followed by example questions, practice questions until in the end the lecturer feels that what is being taught has been understood by students.

b. Constructivism Learning Model

The constructivism learning model is based on students' conceptions (pre-conceptions). Learning activities are carried out by holding cognitive conflicts and class discussions to reduce the students misconceptions.The success of learning lies in the ability of students to change the misconceptions towards scientific conceptions.

c. Student Misconceptions

Student misconceptions are beliefs held by students that do not in line with scientific beliefs, can only be observed in specific circumstances, and cannot be generalized. These assumptions are typically built intuitively in an effort to provide meaning to their everyday experiences. Misconceptions are expressed by scores obtained by students from their inability to understand scientific concepts and principles of heat transfer as measured by a diagnostic test developed by the researcher himself. The data collected for these changes in ranking intervals.

d. Formal Reasoning

Formal reasoning is the student's capacity to carry out formal operations which include: combinatorial thinking, proportion thinking, coordination thinking, mechanical balance thinking, probability thinking, correlation thinking, compensatory thinking and conservation thinking. Students' formal reasoning is measured by the Formal Reasoning Test which was developed based on the characteristics of someone who is at the formal operational level proposed by Piget and Inhelder. The data are collected for these changes in ranking intervals.

2.3. Procedure

After the instruments were tried out and good diagnostic test items and formal reasoning tests were obtained, the two instruments were used to collect research data, they areheat transfer misconceptions data and students' formal reasoning. To get an overview of students with high and low formal reasoning in the experimental and control classes, the researcher gave formal reasoning tests to students before the treatment was applied.

The time allotted for working on this formal reasoning test was limited to 40 minutes for 21 questions. Based on the scoring results, students are categorized as students with high reasoning, or formal reasoning above the group average (27% from above) and students with low formal reasoning, namely formal reasoning below the group average (27% from below) after the data was sorted from the largest to the smallest.

Diagnostic tests were distributed to students after learning the material PLSV (One Variable Linear Equation) and PtLSV (One Variable Linear Inequality) was applied. For dissemination of diagnostic tests to students, researchers themselves carry them out. The time given to students to complete the test is 2 hours of lessons (100 minutes) with a total of 30 test questions. During the implementation of the test, the researcher controlled all students not to cheat. From the results of the diagnostic test it was known that students understood concepts, students who had misconceptions, students who lacked knowledge and students who only guessed answers. However, the data analyzed in this study was only data on student misconceptions.

2.4. Analysis

The normality test was carried out on students' misconception data who took part in learning with the constructivism learning model and conventional learning models. Data normality test was carried out with SPSS).

There were six groups of data that were tested for normality, namely: (1) misconception data of students who took part in constructivism learning, (2) misconception data of students who had high formal reasoning and took part in constructivism learning, (3) misconception data of students who had low formal reasoning and followed constructivism learning, (4) misconception data of students who take conventional learning, (5) misconception data of students who have high formal reasoning and follow conventional learning, and (6) misconception data of students who have low formal reasoning and follow conventional learning.

2.4.1. Homogeneity Test

The homogeneity test was carried out on three groups of misconception data through the Levene test (using SPSS). The three groups of the data are: the first group, data on student misconceptions that take part in constructivism learning and data of student misconceptions that take part in conventional learning. The second group, the data on the students' misconceptions with high formal reasoning who take part in constructivism learning and data of misconceptions of students with high formal reasoning who take part in conventional learning. The third group, the data on the students' misconceptions with low formal reasoning who take part in constructivism learning and data on misconceptions of students with low formal reasoning who take part in conventional learning.

2.4.2. Hypothesis testing

Hypothesis testing was done by performing a t test. For the purposes of testing the hypothesis, it is necessary to formulate a hypothesis statement and a statistical hypothesis as follows:

First hypothesis

$H0 : \mu A1 = \mu A2$
$H1 : \mu A1 < \mu A2$

Second hypothesis

$H0 : \mu A1B1 = \mu A2B1$
$H1 : \mu A1B1 < \mu A2B1$

Third Hypothesis

$H0 : \mu A1B2 = \mu A2B2$

H1 : μA1B2 < μA2B2

Fourth Hypothesis

H0 : (μA1B1 - μA1B2) = (μA2B1- μA2B2)

H1 : (μA1B1 - μA1B2) (μA2B1- μA2B2)

3. Results

The Differences in misconceptions of heat transfer among students who took the constructivism and conventional learning. The t test with SPSS shows a t value of -2.641 with a probability of 0.012. This probability value is smaller when compared to the degree of confidence = 0.05. Thus Ho is rejected and H1 is accepted. This means that students who take constructivism learning experience lower misconceptions than students who take conventional learning.

Differences in misconceptions of heat transfer students with high formal reasoning and participating in constructivism learning and those participating in conventional learning. The t test with SPSS shows a t value of -2.227 with a probability of 0.038. This probability value is smaller when compared to the degree of confidence = 0.05. Thus Ho is rejected and H1 is accepted. This means that students with high formal reasoning who participate in constructivism learning experience lower misconceptions than those who attend conventional learning.

Differences in misconceptions of heat transfer among students with low formal reasoning who take constructivism learning and those who take conventional learning. The t test with SPSS version 16 shows a t value of -2.689 with a probability of 0.014. This probability value is smaller when compared to the degree of confidence = 0.05. Thus Ho is rejected and H1 is accepted. This means that students with low formal reasoning who participate in constructivism learning experience lower misconceptions than those who attend conventional learning.

Interaction between learning models and formal reasoning in reducing student misconceptions. Interaction is a relationship of dependence between a variable to a certain level of other variables. The findings of the hypothesized testing indicate that there is no interaction between the learning model and students' formal justifications in regards to how it affects student perceptions. The Anava calculations confirm this conclusion because it appears from the calculations that the calibrates. In fact, F value = 1.37 is smaller than F table = 4.08 with a significance level of 0.05. Hence, H0 is accepted whereas H1 is rejected. So, there is no discernible difference between the learning method and formal reasoning in terms of how it affects students' conceptions. Due to the compatibility between the characteristics of the construction industry learning curriculum that support changing conceptualizations, it is only natural that students who adhere to this learning environment have less conceptualizations than those who follow conventional learning environments.

4. Discussion

Costructivism learning is better used to reduce student misconceptions that have high formal reasoning. This is because students are more active in the learning process, moreover supported by experiments and the use of modul which can help students be more active and easier to remember the concepts given. By giving students more opportunities to express their opinions and ideas and supported by experiments and using worksheets that can help students be more active and easier to remember the concepts given, learning constructivism is better used to reduce the misconceptions of students who have low formal reasoning.

Finally, There is no relationship between the learning model and students' formal justifications when changing from academic assumptions to scientific justifications because, according to theory, students with high formal justifications are still superior to students with low formal justifications. The absence of this interaction also indicates that the constructivist learning model has significantly been able to reduce the misconceptions that exist in students' cognitive structures. The constructivism learning model will apply to all levels of formal reasoning, both high formal reasoning and low formal reasoning.

5. Conclusion

In accordance with the issues, research objectives, and research findings presented, the following conclusions may be drawn: 1) Students who participate in construction-related learning have lower heat-transfer subject expectations than students who participate in conventional learning. This indicates that construction-based learning is more effective than conventional learning at correcting students' misconceptions about heat-transfer subject; 2) The heat-transfer students' perceptions of those who participate in construction projects and have strong formal motivations. Learning is less effective than the heat-transfer assumptions of students who participate in conventional learning and have strong formal justifications. This indicates that constructivist learning is more effective than conventional learning to challenge misconceptions about students who have strong formal justifications.

The heat-transfer misconceptions of students who participate in constructivist learning are worse than those of students who participate in conventional learning because they have lack formal justification. This indicates that constructivist learning is more effective than conventional learning in challenging misconceptions about students who lack formal justification. The last, There was no significant difference between the teaching method and the students' formal justifications for their assumptions on heat-transfer subject. In general, it can be concluded from the findings of this study that constructivist learning is more effective than conventional learning at refuting students' misconceptions, both for students with high levels of formal reasoning and for students with low levels of formal reasoning.

In general, from the results of this research it can be concluded that constructivism learning is more effective than conventional learning to reduce students' misconceptions, both for students who have high formal reasoning and for students who have low formal reasoning.

6. Recommendations

Based on the research results, there are several suggestions to put forward, namely suggestions for utilizing research results and suggestions for further research. First, the heat transfer lecturers can apply constructivism learning. The results of this study has a significant impact on reducing student heat transfer misconceptions. Second, It is hoped that future researchers will conduct research on a wider scale so that the results can be generalized to a larger population. In addition, the concepts discussed are also expanded to know the concepts of heat transfer misconceptions can be prevented through constructivism learning.

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