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Research Article

Innovation of the problem based learning model with contextual teaching learning in mathematics learning in the Industrial Revolution 4.0 era: A comparative case studies

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ABSTRACT

This study aims to compare learning outcomes, activeness, and students' responses in learning mathematics in the era of the industrial revolution 4.0. Type of study is a quasi-experimental design with a pretest post-test only comparison design. The study population was the high school students in class XI with the samples consisting of three classes from different schools. The results of the descriptive and inferential analysis show that there were differences from the application of the three learning models which were then being tested by Tukey and they were depicted descriptively and inferentially that the combination model of Problem based learning setting Contextual teaching learning was more effective than the model of Problem based learning and Contextual teaching learning in terms of learning outcomes, activeness and student responses in the industrial revolution 4.0.

Keywords: Problem based learning; Contextual teaching learning; Mathematics Learning; Industrial Revolution Era 4.0

1. INTRODUCTION

Currently, we are facing the fourth industrial revolution known as the 4.0 industrial revolution (Mubarak, 2018). Industry Revolution 4.0 is an era of disruptive innovation, wherein this era, it is developing very rapidly. The digital does not only has an impact on the field of industry but will affect all aspects of human life globally including the world of education. Facing the great challenges of the industrial revolution 4.0 era, education is demanded to change as well because we are only presented with two choices, to change or die. Including education at the level of primary and secondary education. (Mardhiyana & Nasution, 2018). The era of education which is influenced by the industrial revolution 4.0 is called Education 4.0 which is characterized by the use of digital technology in the learning process known as the cyber system and is able to make the learning process take place continuously without space limitation and without time limitation. The challenges of education in the era of the industrial revolution 4.0, especially in Indonesia, are no longer just talking about classic problem of equal distribution and fulfillment of access, educational infrastructure, but also talking about the quality of the alumnus who is able to compete with the demands of development (Kaharuddin, 2019b; Mukhlis & Tohir, 2019; Ramful & Lowrie, 2015). The educators are demanded to be able to adapt to the era, they are demanded to master the technology prior to being able to make the adjustment to the students (Akib, 2016; Cheriani, Mahmud, Tahmir, Manda & Dirawan, 2015; Kaharuddin & Magfirah, 2018). Although the development of education has not been able to optimally cope the speed caused by the industrial revolution, one of the efforts that need to be made to face the challenges of the industrial revolution 4.0 is through improving the quality of learning in order to be able to achieve national curriculum goals (Setyawati, Sukartiningsih, & Subroto, 2018). The information technology in the teaching and learning process must be utilized, otherwise it will be further left behind and this has an effect on the quality of education graduates.

Mathematics is a very important knowledge in human life. Mathematics is one of the fields of study that is taught in schools. This is because mathematics is a universal science that underlies the development of modern technology and has an important role in various disciplines. There is a general perception that has already planted its roots in the world of education, this general perception considers that it is the teacher's job to teach, provide students with information on the development of science and technology (Kaharuddin, 2013; Magfirah, Kaharuddin, & Wangse, 2019). Thus, students need to have the ability to obtain, choose, and manage information. This ability requires critical thinking, logical, creative, and an effective willingness to work together. This way of thinking can be developed through learning mathematics because mathematics has a strong linkage structure so students are skilled at rational thinking.

For the importance of the role of mathematics, the teaching of mathematics at various levels of formal education needs serious attention and treatment. Moreover, students are expected to have high mathematics learning outcomes. Roger M Nisbet (2018) stated that there is no single right way to learn and there is no best way to teach. However, a teacher can apply a suitable model by considering the condition of students. Sulo, (2018) said that teachers as educators must be able to apply the models that can integrate students' curiosity, creativity, critical, honest, responsible, collaboration, and discipline. In accordance with these opinions, students are expected to be able to construct their own understanding.

One way to be successful is by applying a student-centered model including a cooperative model, a cooperative model which is learning that emphasizes student activities in searching, collaborating and reporting information from various sources. (Kaharuddin, 2019a; Magfirah et al., 2019; Sadikin & Kaharuddin, 2019) cooperative models are cooperative learning emphasizing specific structures that are designed to influence student interaction patterns. Several variations of cooperative learning experiments will be used; Problem based learning and Two Stay Two Stray are used because the learning model involves cooperation between groups and provide input to one another to achieve learning objectives. (Avisca, 2017) said that Problem based learning and Two Stay Two Stray are cooperative models that provide opportunities for students to share ideas, encourage students to increase the active role of cooperation, in addition to the students are being trained to process information from other sources to be used as learning materials together, it is supported based on some literature including (Kaharuddin, 2018; Newton & Miah, 2017; Putri, Muslimah, Ratman, Mustapa, & Gani, 2018; Rahayu & Cahyadi, 2019; Rahayu & Suningsih, 2018; Rahman, 2016; Wang, 2012) said that the model Problem based learning and Contextual teaching learning are able to accommodate students in increasing activity, speaking ability and student learning outcomes. In addition, the researcher wanted to test the combination of models of Problem based learning setting Contextual teaching learning because the models' innovation had never been done and also it had been proven that the two models have their own advantages in the learning process. From the three results of the application of the model, comparison was carried out according to the testing that had been done (Thompson & McDowell, 2019), therefore a comparison was made between the models of Problem based learning, Contextual teaching learning and the model combinations of Problem based learning setting Contextual teaching learning.

2. RESEARCH METHOD

This study was conducted at the High Schools in Kendari, Southeast Sulawesi Province, in the Academic Year of 2019/2020. The type of study is Quasi-Experimental research with pretest post-test only comparison design. The population in this study was the State High School Students in Kendari in the Academic Year of 2019/2020 consisting of 13 State High Schools. To determine the study sample, Cluster Stratified Random Sampling technique was used i.e. sampling based on the stratum/level. This study purely compares the three treatments in terms of effectiveness indicator criteria. According to (Kaharuddin & Liasambu, 2019) effectiveness criteria in learning are; (a) learning outcomes (post-test, gain), (b) activeness, (c) responses descriptively and inferentially.

Table 1. Research Design

Methods	Models	Pretest	Treatment	Post-test
R	PBL	O_1	X_1	O_4
	CTL	O_2	X_2	O_5
	PBL-CTL	O_3	X_3	O_6

Source: (Kaharuddin, 2019b).

The Data collection techniques in this study were conducted by (1) learning outcomes data were collected by using student learning outcomes tests. (2) student activeness data were collected by using student observation sheets on learning. (3) student response to learning data was collected by using student response questionnaires. The major hypothesis is (1) the application of the Problem based learning model was effective in learning mathematics in high school students in Kendari. (2) the application of the Two Stay Two Stray model was effective in learning mathematics in high school students in Kendari. (3) the application of the Problem based learning-Two Stay Two Stray model is effective in learning mathematics in high school students in Kendari. (4) there are differences in the effectiveness of the Problem based learning, Two Stay Two Stray, and Problem based learning-Two Stay Two Stray models in mathematics learning for high school students in Kendari.

The statistical hypothesis is (1) The application of the Problem based learning model is effective in learning mathematics in high school students in Kendari. $H0$: $\mu 1 \leq 0$ against $H1$: $\mu 1 > 0$. (2) The application of the Two Stay Two Stray model is effective in learning mathematics in high school students in Kendari. $H0$: $\mu 2 \leq 0$ against $H1$: $\mu 2 > 0$. (3) The application of the Problem based learning-Two Stay Two Stray model is effective in learning mathematics in high school students in Kendari. $H0$: $\mu 3 \leq 0$ against $H1$: $\mu 3 > 0$. (4) There are differences in the effectiveness of the Problem based learning, Two Stay Two Stray, and Problem based learning-Two Stay Two Stray models in mathematics learning for high school students in Kendari. $H0$: $\mu 1 = \mu 2 = \mu 3$ versus $H1$: at least one sign is not valid.

3. RESULTS AND DISCUSSION

3.1 Results

The application of the model in learning is a measurable learning process with several stages and considering the effectiveness indicators. The descriptive analysis results for learning outcomes, activeness, and student responses, both before and after the Problem based learning model was applied concluded that an increase in value of pretest to post-test for 0.3 or there was an increase in the category of medium with 52% completeness classically. The activeness of students from the 4 learning meetings. Student responses of 3.1 or in the category of positive inclination which described the level of student preference towards the application of the student learning model of 3.1 or being in the category of active, this proves that the acquisition of a score of 3.1 indicates the level. Based on these descriptions, it can be concluded that descriptively mathematical learning outcomes, activeness and student's response in the experimental class I meet the effectiveness criteria. The inferential analysis results for learning outcomes, activeness and student responses, both before and after the Problem based learning model was applied with still paying attention to the results of the normality test as a prerequisite test, it can be concluded that for learning outcomes (pretest, post-test, gain), activeness, and student responses, the significant value is greater than $\alpha = 0.05$ which means that the data is normally distributed and has fulfilled the requirements to conduct hypothesis 1 test which can be seen in Table 3.3 below. From the results of hypothesis 1 analysis, it can be seen that for learning outcomes, activeness and student responses with a significant value of $0.00 < \alpha = 0.05$, which means rejecting H0 or in this case the application of the Problem based learning model in learning process of Kendari Senior High School 5 students effectively.

The descriptive analysis results for the learning outcomes, activeness, and student responses, both before and after the Problem based learning model was applied concluded that an increase in value of pretest to post-test for 0.4 or there was an increase in the category of medium with 68% completeness classically. The student activeness of 2.9 or being in the active category, this proves that the acquisition of the score of 2.9 shows the level of student activity from the 4 learning meetings. The student responses of 3.4 or in the category rather positive which indicates the level of the student preference for the application of learning models. Based on these descriptions, it can be concluded that descriptively mathematical learning outcomes, activeness and student's response in the experimental class I meet the effectiveness criteria. Inferential analysis results for learning outcomes, activeness and student responses, both before and after the Contextual teaching learning model was applied with paying attention to the results of the normality test as a prerequisite test, it is concluded that for the learning outcomes *(pretest, post-test, gain)*, activeness, and student responses, the significant value is greater than $\alpha = 0.05$ which means that the data is normally distributed and has fulfilled the requirements to conduct hypothesis 2 test, which shows that for learning outcomes, activeness and student responses with a significant value of $0.00 < \alpha = 0.05$ which means rejecting H0 or in this case the application of the Contextual teaching learning model in learning in Kendari Senior High School 9 students effectively.

The descriptive analysis results for the learning outcomes, activeness, and student responses, both before and after the Problem based learning model was applied concludes that there was an increase in value of pretest to post-test for 0.4 or there was an increase in the category of medium with 83% completeness classically. The student activeness of 3.3 or being in the active category or approaching the very active category proves that the acquisition of a score of 3.3 shows the level of student activity from the 4 learning meetings. The student responses of 3 or in the category of rather positive which indicates the level of the student preference for the application of learning models. Based on these descriptions, it can be concluded descriptively that mathematical learning outcomes, activeness and student's response in the experimental class III meet the effectiveness criteria. Inferential analysis results for learning outcomes, activeness and student responses, both before and after the Contextual teaching learning model was applied with paying attention to the results of the normality test as a prerequisite test, from there it is concluded that for the learning outcomes *(pretest, post-test, gain)*, activeness, and student responses, the significant value is greater than $\alpha = 0.05$ which means that the data is normally distributed and has fulfilled the requirements to conduct hypothesis 3 test, which shows that the learning outcomes, activeness and student responses with a significant value of $0.00 < \alpha = 0.05$ which means rejecting H0 or in this case the application of the Problem based learning model Contextual teaching learning in learning in Kendari Senior High School 4 students effectively.

Descriptive analysis of differences in results for learning outcomes, activeness, and student responses, from the Problem based learning, Contextual teaching learning model and Problem based learning Combination Contextual teaching learning Settings can be seen in the **Table 2**.

Table 2. Results of Descriptive Effectiveness Analysis

Statistics	Models		
	PBL	CTL	PBL-CTL
Pretest	62.5 (2.5)	67.4 (2.6)	68.9 (2.7)
Post-test	76.7 (3.1)	82.3 (3.2)	83.7 (3.3
Gain	0.3 (1.7)	0.4 (2.3)	0.4 (2.3)
Activeness	3.1	2.9	3.3
Response	3.1	3.4	3.2
Effectiveness	2.7	2.9	3.0

Based on the **Table 2**, it can be concluded descriptively that the effectiveness score has a sequence of 3.0 from the application of the PBL-CTL model, 2.9 from the application of the CTL model, and 2.7 from the application of the PBL model, in other words descriptively the CTL model is more effective than the PBL and PBL-CTL models are more effective than the PBL and CTL models.

Descriptive analysis of differences results for the learning outcomes, activeness, and student responses, from the Problem based learning, Contextual teaching learning model and Problem based learning Combination Contextual teaching learning Settings can be seen in the **Table 3**.

Table 3. Inferential Effectiveness Difference Analysis Results

ANOVA	Pretest	Post-test	Gain	Activeness	Response
Sum of Square	859.3	1075.4	0.1	3.2	3.4
df	2	2	2	2	2
Mean Square	429.6	537.7	0.7	1.6	1.7
F	9.970	5.813	1.037	7.737	4.005
Sig.	0.000	0.004	0.358	0.001	0.021

Based on the **Table 3**, above it appears that for the values of pretest after one way ANOVA testing was carried out, it is obtained that a significant value of 0.000 < of α = 0.05 which means that there are differences in values of pretest from the application of the learning model, hence, further testing is conducted. The score of post-test after one way ANOVA testing is carried out is a significant value of 0.004 < of α = 0.05 which means that there are differences in values of post-test from the application of the learning model, hence, further testing is carried out. The gain score after one way ANOVA testing is a significant value of 0.358 > of α = 0.05 which means there is no difference in gain value from the application of the learning model, hence, further testing is not necessary. The activity score after one way ANOVA testing is a significant value of 0.0001 < of α = 0.05 which means that there are differences in the score of activeness of the application of the learning model, hence, further tests are conducted. The response score after one way ANOVA testing is a significant value of 0.021 < of α = 0.05 which means that there are differences in response values from the application of the learning model, hence, further tests are conducted tukey and the results in a descriptive and inferential way show that the Problem based learning combination model Contextual teaching learning setting are more effective than the Problem based learning model and Contextual teaching learning in terms of learning outcomes, activeness and student responses in the industrial revolution 4.0

3.2 Discussion

Based on the results of descriptive analysis and it can be seen that there are differences in descriptive and inferential from the effectiveness indicators, namely, learning outcomes (pretest, post-test, gain), activeness and response give an indication that from the application of the PBL, CTL, and PBL-CTL models, there are steps from an ineffective learning model. Reviewed during the process of applying the PBL model, it could be seen on the syntax stages of the model, especially for the students in Kendari Senior High School 5 which is located on the coast or near the port of Kendari, they seemed to be less interested due to several factors including; students tend to go out of the class during the learning process even though they had received direction from the guardian teacher to not to go in and out, which made it difficult for researchers to carry out the research process to the fullest, even though the application of the PBL model remained effective.

The process of applying the CTL model to students in Kendari 9 Senior High School were greeted with joy because the students were happy with the learning process of this model because two came two left, exchanging information without regarding the gender and the intelligence of the students, random division of groups made a sense of justice to be formed. This was also supported because students in this school were geographically located in the border area of BTN PNS Kendari, where most of these students were the children of a civil-servant and police and had received strict and good education from their parents, so the treatment of the CTL model was effective. While the implementation of the PBL-CTL combination model was carried out very well and every step of the combination of the models was welcomed with delight, the results of the combination of these models made students in Kendari Senior High School 4 got the opportunity to learn, pair up, share and play. This school is located in the heart of Kendari and of course, this school is a favorite school, by this treatment the PBL-CTL model, it was effective and welcomed with a good response.

The occurrence of differences in the results of the application of this learning model is also supported by research (Bütüner, Baki, & The, 2020; Greiff, Holt, & Funke, 2013; Nur Fidiyanti, 2017; Olivares, Ceglie, The, Olivares, & Ceglie, 2020) that the results of the combination of the PBL-CTL cooperative model have drastically improved student learning outcomes. This is because the syntax of the learning model from the results of the combination produces the following experiments: forming paired groups, calling numbers in pairs, discussion in pairs and appreciation of the results of discussions/presentations, the syntax is able to increase self-esteem to be higher because working in pairs, speech ability, learning determination, deeper understanding, kindness, sensitivity, student learning tendencies to become more meaningful, class \mastery in learning and positive behavior of students. So in general, it can be concluded that the Problem based learning model and Contextual teaching learning is a cooperative learning model in a group that is able to improve student learning outcomes and activeness but has a weakness of the lack of student participation in the learning process, which from that, based on the experimental process that had been carried out in the field, it is the evident that the innovation of the combination of Problem based learning models Contextual teaching learning setting are very effective in improving student learning outcomes and activeness in the industrial revolution era 4.0, this is supported by the opinions (Ariani, 2017; Putri et al., 2018) that the combination of cooperative models is a new innovation in learning.

4. CONCLUSION

Based on the result of study and discuccion, it can be concluded that show that there were differences from the application of the three learning models which were then being tested tukey and they were depicted descriptively and inferentially that the combination model of Problem based learning setting Contextual teaching learning was more effective than the model of Problem based learning and Contextual teaching learning in terms of learning outcomes, activeness and student responses in the industrial revolution 4.0.

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AUTHOR'S CONTRIBUTIONS

The authors discussed the results and contributed to from the start to final manuscript.

CONFLICT OF INTEREST

There are no conflicts of interest declared by the authors.

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