Students' mathematics learning achievement in junior high school using 7E learning cycle

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Abstract. The aims of this research are to determine the effect of applying the 7E learning cycle model and direct learning of students' mathematics learning achievement. This research was conducted in several State Junior High School of Nganjuk Regency for academic year 2018/2019. The research method used the experimental method. The sample consisted of 184 students. The experimental class was given a 7E learning cycle model. The control class is given a direct learning model. This research used the documentation method and test method in data collection. Data analysis using a t-test, with a significance level of 5%. Data were obtained from the experimental class and the control class. The results of this research concluded that there were differences in the effect of 7E learning cycle implementation and direct learning on students' mathematics achievement, and students' mathematics learning achievement using the 7E learning cycle model was better than students using direct learning. The steps of the 7E learning cycle model such as for elicit, engage, explore, explain, elaborate, evaluate and extend can make students active in learning. To improve student's mathematics learning achievement in junior high school can use the 7E learning cycle model.

1. Introduction
Learning is a fundamental activity in people’s educational process in schools, where either success or failure in achieving learning goals depends on how the learning process is experienced by students in the class. Learning activities in schools require students to learn optimally, thus learning objectives can be fulfilled. Mathematics is a lesson that plays an important role in the development of science and technology [1]. Mathematics is also an abstract and deductive science whose existence is significant in everyday human life. Sometimes people think that mathematics is abstract in science and learn a lot of formulas that lead to difficulties students understand the concepts of math. So that students are less excited when learning time takes place [2]. Furthermore, the student has to learn many formulas that make them difficult to understand the mathematical concept. Implementing inappropriate learning and lack of learning resources contribute to leading students less interested in learning, as a result, students’ mathematics learning achievements are declining.

The decline in mathematics learning achievements can be found at various levels of education in Indonesia, one of which is at the junior high school level, especially state junior high school in Nganjuk Regency. Nganjuk Regency was chosen because based on the 2017 PAMER UN data the learning achievement of junior high school / MTs students in the regency was ranked 35th out of 38 Regencies and Cities in East Java Province. This shows that the learning achievements in Nganjuk Regency are still relatively low from other regency or cities. Based on the 2017 PAMER UN data, it also shows that...
the average score of mathematics national exam of the state junior high school in Nganjuk Regency is 43.39. The achievement shows that 57% of students have not mastered the subject, meaning that students are still having difficulty in learning mathematics especially in the subject of straight-line equations.

The difficulty in learning mathematics in the subject of straight line equations is supported by the results of interview researcher with one of the mathematics teachers from several schools in Nganjuk Regency, among others SMPN 1 Berbek, SMPN 1 Pace, and SMPN 1 Sukomoro. The teacher stated that one of the difficulties of students in understanding the concept of straight line equations. Such difficulties such as students still have difficulty in determining gradients in everyday life and determine the equation of the line through a certain point and gradient. Based on the results of the survey of the researcher on the three schools, it shows that teachers still dominate the teaching and learning process where the teacher still uses the direct learning model. The direct learning model was chosen because it was easy in practice, so it seemed monotonous. This learning process is still centered on the teacher while students only work based on the instructions given by the teacher without creativity and activities that stimulate students to explore their potential.

The steps of direct learning include; first, the teacher prepares students to be able to learn and deliver the learning objectives, students prepare to do the learning. Second, the teacher explains to students about the subject being studied, students pay good attention and listen to the teacher's explanation of the subject being studied. Third, the teacher provides examples and guidance to students to work on the subject being studied, students follow the teacher’s examples. At the final step, the teacher instructs assignments to students, which is done in order that students can evaluate the subject being studied, additionally, they do the tasks as instructed by the teacher. The steps were taken in direct learning usually tend to lead the students to get bored, precisely this often causes students to be passive in learning, consequently, the student's learning achievements decline. Alternative solutions are needed to solve problems so that an effective learning atmosphere is created. Many research studies argue that applying interesting learning approach gave positive effects in learning mathematics [3]. According to [4] the teacher should be able to develop teaching techniques to encourage students to actively participate in the learning process.

Bearing the importance of improving students' learning achievement, it needs to compile a learning model which can accommodate students' learning developments and achievements. This can be realized by using a constructivism learning model. One model of constructivism learning is the 7E learning cycle. A number of relevant studies show that the results of the 7E learning cycle were claimed much better than other typical learning approaches. The research was conducted on the comparison between 7E learning cycles and traditional learning models [7].

The results of Siribunnam's research showed learning achievement and attitudes in chemistry in students taught by the 7E learning cycle was higher than the KWL method and conventional approaches [8]. [9] which reveals that students' mathematical communication skills using 7E learning cycle were much better than students' mathematical communication skills with direct learning. There were significant differences in students in increasing self-esteem of students using the 7E learning cycle model compared to conventional learning [10]. Despite the fact it has a lot of positive impacts on learners, there was also found research which reveals that the 7E learning cycle was proved no better than other learning. Polyiem's results show learning achievement, science process skills, and moral reasoning in socioscientific-based learning which is better than the 7E learning cycle [11]. There is also research that uses the 7E learning cycle model, which is about evaluating multimedia assistance applications designed according to the 7E learning model regarding the students’ opinions [12].

The 7E learning cycle model is a student-centered learning model consisting of seven phases. They are elicit, engage, explore, explain, elaborate, evaluate, and extend [9-20]. In the initial phase of 7E learning cycle learning, elicit. In the elicit phase aims to bring up students' initial knowledge where the teacher gives a statement that stimulates students' initial knowledge, then students answer the teacher's statement according to their understanding. The second phase, namely engage, aims to arouse interest and motivate students by telling stories, giving demonstrations, or showing a short object, picture, or video. From these two phases, students' initial knowledge begins to form. Students' initial knowledge
makes it easier for students to receive information about the subject being taught and can solve problems based on their knowledge.

The third phase, namely exploration aims so that students gain knowledge with direct experience related to the concepts learned. The fourth phase is to explained where students are introduced to new learning concepts and theories. From the exploration steps, students can draw conclusions about the findings. The fifth phase is elaborate where students are given the opportunity to apply their knowledge to new situations. The sixth phase is evaluating where students' understanding is measured using a test in the form of a quiz as a form of practice questions and assessment. The last phase is to extend where students apply knowledge that has been obtained in a new context or material that will be learned by being guided by the teacher.

Some of these phases make students more active and motivated in learning, and students better understand the subject being studied. This is because by raising the initial knowledge the student can train students to learn to find concepts through experimental activities. Students are trained to think, search, find, and explain the application of concepts that have been learned so that students' mathematic learning achievements increase. The Jati research which states that the 7E Learning cycle can be used to improve the math skills of junior high school students [10]. Therefore, to improve the students' mathematics learning achievement of junior high school, in this research was used 7E learning cycle model.

In this research 7E learning cycle learning and direct learning were used in mathematics learning achievement at the SMPN related to straight line equation subject. The students learning achievement referred to in this research is the learning outcome indicated by either evaluation or test process, then the test results are assessed by the teacher. [21] notes that there are three aspects of learning assessment among others: a) cognitive domain, including thinking skills, the ability in memorizing, understanding, applying, analyzing, synthesizing, and evaluating; b) affective domain, including behavioral characters such as feelings, interests, attitudes, emotions, and values; c) psychomotor domains, including imitation, manipulation, accuracy, articulation, and naturalization. The students' mathematics learning achievement in this research concerns mathematics learning outcomes in the cognitive domain obtained after having the test.

Based on the description above, the researcher intends to try to apply the 7E learning cycle model to the results of mathematics teaching in the 8th grade at Nganjuk Regency in the 2018/2019 academic year. The aims of this research are to determine the differences in the effect of the application of 7E learning cycle and direct learning on students' mathematics learning achievement in the subject of straight-line equations. In applying the 7E learning cycle model and direct learning model, which mathematics learning achievement is better.

2. Experimental Method
The method in this research is the experimental method. This research population is All eighth-grade students of the SMPN in Nganjuk Regency in 2018. In the population three school samples were taken with stratified cluster random sampling technique, so selected school included SMPN 1 Sukomoro, SMPN 1 Pace, and SMPN 1 Berbek as research sites. Grouping of schools uses national exam results data for the 2016/2017 school year with 3 categories, namely high, medium, and low category. Each school is divided into two categories, namely the experimental and control classes as the research sample. The research sample consisted of 184 students. The class that is treated using the 7E learning cycle model called the experimental class. The class that is treated using the direct learning model are called the control class. The following are presented in the results of the class taking as research samples in each school.
Table 1. The class taking results as the research sample

| Names of the School | Experimental Class | Control Class |
|---------------------|--------------------|---------------|
| SMPN 1 Sukomoro     | 8E                 | 8G            |
| SMPN 1 Pace         | 8B                 | 8D            |
| SMPN 1 Berbek       | 8C                 | 8A            |

In this research, the documentation method and test method are used as methods of data collection. The first students' mathematics learning achievement as the initial data is obtained from the documentation method. The second students' mathematics learning achievement as the final data is obtained from the test method. The preliminary data in this research is the grade 7-grade increase exam for the 2017/2018 school year, while the final data in this research is the result of the mathematics learning achievement test written in the form multiple choice of straight line equation subject. The instrument was validated by the mathematics education lecturer at Universitas Sebelas Maret. After the instrument is validated and tested on a trial class, the instrument is analyzed.

Reliability test with the Kuder-Richardson or KR-20 technique used to analyze the instrument. Reliability values are used to describe the use of an item in a measurement. The results of the instrument analysis were $r_{11} = 0.879$. This means that the measurement results have a reliability index of 0.70 or more so the instrument can be used for measurement [14]. The initial analysis was conducted to determine whether the two sample classes came from the same initial conditions. In the initial analysis and final analysis used the normality test, homogeneity test, and t-test [10].

3. Result and Discussion
This research is about the application of the 7E learning cycle model in the mathematics learning of straight-line equality 8th-grade subject. This research was conducted for 8 meetings in each class. Before conducting the research, the researcher first took the initial data on mathematics learning achievement from the 7th-grade rise test grades for the 2017/2018 school year using the documentation method. After the 7E learning cycle model was given to the experimental class and direct learning model in the control class, the second student's mathematics learning achievement was obtained as the final data. The analysis of the initial and final data is explained as follows:

3.1. Early Mathematics Learning Achievement Data Analysis
In this research, the analysis of the initial data was taken from the previous semester final exam. The results of the normality test in the experimental class and control class are in Table 2 using SPSS 21.0.

Table 2. Test the normality of the initial data in each class

| Class                      | Statistic | df  | Sig.  |
|----------------------------|-----------|-----|-------|
| Experimental (7E learning cycle) | 1.139     | 96  | 0.149 |
| Control (direct learning)   | 1.105     | 88  | 0.174 |

Based on the normality test in Table 2, the significance value of the experimental class is 0.149 and the control class significance value is 0.105. Because the significance values of the two classes show more than 0.05, the initial data on mathematics learning achievement from the experimental class and control class can be said to be a normal distribution. Levene's test with SPSS 21.0 was used to determine the variance homogeneity of the two classes. The homogeneity variant test results are sig = 0.973 more than 0.05, then the data from the experimental class and control class have a homogeneous variance.

To find out whether there were differences in the two classes before being given treatment, the t-test with SPSS 21.0 was used. The results of the t-test can be seen in Table 3.
Table 3. T-test premiliarly data for students' learning achievement

| Class                               | N  | Mean   | SD   | t-value | df | Sig |
|-------------------------------------|----|--------|------|---------|----|-----|
| Experimental (7E learning cycle)    | 96 | 61,420 | 14,109 | 0,130 | 182 | 0,896 |
| Control (direct learning)           | 88 | 61,170 | 11,212 |        |     |     |

In Table 3 shows the results of the significance value of the t-test in both classes of 0.896. The significance value shows more than 0.05, so it can be said there is no difference in the experimental class and the control class. Both classes have the same mathematics learning achievement. Because both classes have the same ability in mathematics learning achievement, the two classes are treated with different learning models. 7e learning cycle learning model in the experimental class and direct learning model in the control class.

3.2. Final Mathematics Learning Achievement Data Analysis

In this research, data analysis of final mathematics learning achievement was taken from the test after the two classes were treated with different learning models. The results of the normality test in both classes are in Table 4 using SPSS 21.0.

Table 4. Normality test mathematics learning achievement of final data

| Class                               | Statistic | df  | Sig.  |
|-------------------------------------|-----------|-----|-------|
| Experimental (7E learning cycle)    | 1,194     | 96  | 0,116 |
| Control (direct learning)           | 1,263     | 88  | 0,082 |

Table 4 shows the significance value of the experimental class and the control class which is more than 0.05 so that the final test data on students' mathematics learning achievement after being treated is normally distributed. Levene's test with SPSS 21.0 was used to find out whether the variants of the two classes were homogeneous. Levene's test results obtained a significance value greater than 0.05, then the data on students' mathematics learning achievement after being treated using different learning models had a homogeneous variant.

After the two classes were treated using different learning models that had the same variant, then the final test of mathematics learning achievement of students in the experimental and control classes was tested using the t-test with SPSS 21.0. The results of the t-test with SPSS 21.0 can be seen in Table 5.

Table 5. T-test on mathematics learning achievement of final data

| Class                               | N   | Mean   | SD     | t-value | df  | Sig  |
|-------------------------------------|-----|--------|--------|---------|-----|------|
| Experimental (7E learning cycle)    | 96  | 78,080 | 10,904 | 2,664   | 182 | 0,008|
| Control (direct learning)           | 88  | 74,090 | 9,272  |         |     |      |

In Table 5, the significance value of the t-test is 0.008, which is less than 0.05, it can be said that there are differences in the results of the final test of student's mathematics learning achievement of the experimental and control after being treated differently. Based on the average value of students' mathematics learning achievement in Table 5, it can be said that the students' mathematics learning achievement in the experimental class is better than the control class. The results showed that students' mathematics learning achievement in the subject of straight line equations using the 7E learning cycle model was more effective than the direct learning model. The steps of the 7E learning cycle model such as for elicit, engage, explore, explain, elaborate, evaluate and extend can make students active in learning.

By using the 7E learning cycle model in the experimental class, students become more active in learning, students can explore learning subject, and students become the center of learning. The first phase of 7E learning cycle learning is elicit. The purpose of this phase is to bring up students 'initial knowledge where the teacher gives a statement that stimulates students' initial knowledge of the previous
subject, namely relations and functions, then students answer the teacher's statement according to their understanding. The second phase in the 7E learning cycle is to engage. In this phase the teacher explains the benefits of learning straight line equation subject in everyday life, then students enthusiastically observe and listen to the teacher's explanation. From these two phases, students' initial knowledge begins to form. The next phase of students is easier to investigate the concept of straight line equations. Students with 7E learning cycle get initial knowledge that will help them build further knowledge [5].

The initial knowledge formed in students will make it easier for students to receive information about the subject being taught. Students can solve problems based on their knowledge. The third phase in the 7E learning cycle model is to explore. In the phase of exploration, the teacher asks students to observe and analyze the position of the two lines in the subject of straight-line equations. The process of observing the position of the two lines, students independently observe two lines given by the teacher to find out their position. The fourth phase in 7E learning cycle learning is explain. In the phase of explain, the teacher gives the task to students to convey the results of their discussion from the exploration step, then some students actively convey their ideas about their findings regarding the position of two lines to teachers and all students in the class, after that some students are welcome to give opinions on the ideas of their friends. Furthermore, students and teachers make a summary of the results delivered by students about the position of two lines.

The fifth phase in 7E learning cycle learning is elaborate. In this phase, the teacher provides new situations and students have the opportunity to apply their knowledge. In the implementation phase students have the opportunity to apply the concepts of existing straight-line equations to solve some of the story questions the teacher gives. The sixth phase in 7E learning cycle learning is evaluate. In the evaluate phase, the students' understanding is examined by the teacher by giving quizzes to the students as a form of practice on the questions and assessment of learning. Each student works on a quiz form the teacher about the subject of straight-line equations. The seventh phase in 7E learning cycle learning is extend. In the last phase, the teacher provides several examples of applications for applying straight line equations to more complex problems. Students try to understand and pay attention to the teacher about the application of straight line equations. Next, students try to solve subject problems with straight line equations.

Some of these phases make students more active in learning and students better understand the subject being studied, so that students' mathematics learning achievements become better. This is in line with Polyeim's opinion which states that the 7E learning cycle is beneficial for students [11]. Student learning abilities can increase. Through various learning resources new knowledge students begin to form, students become able to apply learning models in real life [8].

Direct learning is given to the control class. The steps in direct learning are, first, the students are prepared by the teacher to learn by conveying the objectives of the learning subject in a straight line equation. The second step is for the teacher to convey subject on a straight line equation. Students understand the teacher's explanation of the matter of straight-line equations. The third step, the teacher discusses sample questions and asks students to do the exercises about the subject of straight-line equations. Students follow the solve completion steps in the sample questions explained by the teacher. In the final step, students are given assignments by the teacher about the learning questions in the straight line agreement subject and students do the assignments given by the teacher. Learning like this makes students less active in learning, makes students only learn, study, rarely ask the teacher, lack of discussion with friends, teachers are very dominant in learning, and students are not drilled to be active in learning. This learning makes some students successful and not eager to learn.

Below is a description of several steps in implementing the 7E learning cycle model and the direct learning model. Figure 1 is the learning ambiance using the learning cycle 7E model at the elicit stage, where the teacher gives a statement that stimulates students' initial knowledge of the previous subject and aims to elicit initial knowledge. Figure 2 is an ambiance of learning using the direct learning model where the teacher explains the subject and examples of material questions in a straight line equation.
In the control class students' learning achievement in mathematics is not as good as in the experimental class. Table 5 shows that the average mathematics learning achievement of students using the 7E learning cycle model is better than the class that uses the direct learning model. This research is consistent with several other studies. Mulyono's research is the use of 7E learning cycles, effective models of self-regulation and problem-solving abilities in mathematics learning [15]. Khaskan's research shows that 7E learning cycles are more effective than traditional methods in mathematics learning [5]. Shaheen's research results show that biology learning achievement using 7E learning cycles is better than traditional learning [7]. The results of Siribunnam's research showed learning achievement and attitudes in chemistry in students taught by the 7E learning cycle was higher than the KWL method and conventional approaches [8]. There were significant differences in students in increasing self-esteem of students using the 7E learning cycle model compared to conventional learning [10].

4. Conclusion
The results of this research indicate that learning using 7E learning cycle is more effective than direct learning in the matter of straight line equations. The steps in the 7E learning cycle model are effective for increasing student learning achievement in the matter of straight line equations. In learning using the 7E learning cycle model students' initial knowledge will be raised. Students' creativity in finding the concept of the material being studied will increase based on students' initial knowledge. In describing and evaluating the steps used by students to practice that is by applying learning material that has been obtained to solve the problems given by the teacher. In the next step, students can learn more broadly. Based on the results of this research, the researcher suggests that to improve student learning achievement straight line equation material can use the 7E learning cycle model. Suggestions for further research are researchers conducting research using 7E learning cycle learning on other subject, applying at higher education levels such as high school, and comparing the results of the implementation of the 7E learning cycle model with other learning models.

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