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The Effect of Conceptual Change Text on Improving Student Understanding of Electricity Concepts and Learning Motivation

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Abstract

The purpose of this study was to investigate the effect of conceptual change text on improving students' understanding of electricity concepts and learning motivation. A quasi-experimental with pre-test post-test nonequivalent control group design was used in the study. Participant were 142 of 12th-grade students. The experimental group studied electricity concept with conceptual change text and the control group studied it with expository text. Students' understanding of electricity concepts was measured by a conceptual understanding test and students' learning motivation was measured by a questionnaire. Hypothesis testing is done by the MANOVA. The results showed that: (1) conceptual change text can improve the students' understanding of electricity concepts and learning motivation at the medium level, (2) there was a significant difference in the improvement of students' understanding of electricity concepts and learning motivation between the experimental group and the control group, (3) there was a significant difference in the improvement of students' understanding of electricity concepts between the experimental group and the control group, (4) there was a significant difference in the improvement of students' learning motivation between the experimental group and the control group. The finding indicates that conceptual change text was an effective tool to improve students' understanding of electricity concepts and learning motivation.

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1. Introduction

Traditionally understanding of scientific concepts is the main goal of physics lessons at all levels of education. Based on Farmer and Farrell (1980) concepts is a classification of ideas, objects, or events into a set by mentally abstracting the common essential characteristics/attribute which define that set. Thus, the concept itself exists in the mind which is an abstraction. Furthermore, Farmer and Farrell distinguish the concept into three types namely: concepts by inspection, theoretical concepts (concepts by definition), and relational concepts. Everyone can construct concepts differently. In physics, the concept plays an important role, because the success of understanding the concepts can foster interest, values, and attitudes toward physics as the basis of meaningful learning.

Studies show that before formal lesson the students have brought prior ideas about physics that are often inconsistent to the scientific concept (Gonen and Kocakaya, 2010; Dalaklioglu *et al.,* 2015; Cetin, *et al.,* 2015; Kola, 2017). The ideas that are inconsistent to the scientific concept are called misconceptions (Onder, 2017). Misconceptions contribute negatively to student learning outcomes (Ozkan and Selcuk, 2013; Gürefe *et al.,* 2014). Student misconceptions are highly resistant to change (Çelikten *et al.,* 2012). Misconceptions can come from various sources such as prior knowledge, daily life experiences, language, culture, teachers, textbooks and teaching (Cetin *et al.,* 2015). In the teaching of physics, textbooks are an essential component. Most physics textbooks are designed with the expository text format. Expository text-based textbooks are not deliberately designed to tackle student misconceptions

In an effort to overcome student misconceptions, the researchers proposed a conceptual change strategy. According to Posner *et al.,* (1982) the conceptual change strategy must satisfied four conditions, (1) dissatisfaction, the students must be dissatisfied with the concepts they already have, (2) intelligibility, the new concepts must be understood enough by student, (3) plausibility, the student must find the new concept logical and be able to picture it in students' mind, (4) fruitfulness, the new concept should suggest the possibility of a fruitful research program and have a potential to be extend to open up a new areas of inquiry. Base on Posner's thinking above, the researchers developed a variety of conceptual change strategies one of which is conceptual change text (Ozkan and Selcuk, 2013). There are two types of text formats based on the conceptual change model proposed by Posner *et al.,* (1982) that is the conceptual change text and the refutation text.

The conceptual change text is a written discourse that identifies common misconceptions, explains the reasons for misconceptions, and then provides a scientifically acceptable concept (Sendur and Toprak, 2013). In contrast to traditional texts, conceptual change texts are specifically designed to discover students' misconceptions about topics and attempts to change them into scientific concepts (Cetingul and Geban, 2011). Although the style of conceptual change text may differ among developers, the format remains the same.

Ozkan and Selcuk (2013) developing a conceptual change text consisting of five parts. The first part contains questions to identify misconceptions experienced by students. The second part contains common misconceptions and scientifically incorrect answers. This stage is a stage of causing dissatisfaction in students. The third parts contain a scientific explanation of the concepts asked in the first section. The fourth part, contains statements or opinions of students about the differences between misconceptions experienced, the results of the test of ideas and the scientific explanations obtained from the third part and testing his ideas in the fourth section. The fifth parts is a section to check the acquisition of student knowledge and the depiction of the conclusions by the teacher. A number of studies have been conducted to test the use of texts as conceptual changes in the teaching of science, for example Ozkan and Selcuk (2013); Aydin (2012); Çelikten *et al.,* (2012); Gürefe *et al.,* (2014); McKenna (2014) These studies show that conceptual change texts are very effective in reducing student misconceptions.

In addition to improving students' understanding, conceptual change strategies are also expected to be used to improve student learning motivation. Motivation is a process that encourages, directs, and persistence behavior (Santrock, 2004, as translated by Tri Wibowo). Motivation is the internal feeling that arises from the desires and needs of the individual, the continuing process of need and satisfaction that stimulates the individual to perform, a process that inspires a person to utilize his or her best ability to attain certain goals (Abbas and Khurshid, 2013). Motivation can be explained from three perspectives of behaviorism, humanistic, and cognitive perspective. Behavioral perspectives emphasize external rewards and punishments as key in determining student learning motivation. According to this perspective, incentives are positive or negative events or stimuli that can motivate student behavior. The humanistic perspective emphasizes the capacity of students to embrace personality, freedom to choose their fate, and positive qualities. This perspective relates to Maslow's view that basic needs must be met first before meeting higher needs. The cognitive perspective views that students' motivations are guided by their thinking. The cognitive perspective emphasizes the importance of goal setting, planning, and monitoring progress toward goals. According to Lee (2010) motivation derives from the learner's interpretation of objective facts, and his thoughts, beliefs, and expectations influence motivation. Based on the above three perspectives, it can be concluded that learning motivation is an internal psychology process that guides the students to understand the objectives of the learning activity, spontaneously maintaining and directing the activities to the objectives formulated to achieve the learning objectives.

Traditional teaching refers to a teacher-centered teaching model that views teachers and their students as teachers and listeners. Therefore it fails to motivate students to learn physics better. This teaching model focuses directly on concept acquisition and examples used to teach the various ways physics concepts can be implemented. Neuroscientist and psychological findings show that there is no separation between mind and emotion (Akyurek and Afacan, 2013). Studies such as Akyurek and Afacan (2013); Soltanzadeh *et al.,* (2013); Soltani and Motamedi (2014); Soleymanpour (2014) show that the learning strategy influences student motivation.

The conceptual change text is a conceptual change strategy based on philosophical constructivism. Constructivism emphasizes student-centered learning, where students themselves actively seek meaning from others (Butcher, 2010). In constructivism-based learning, students are motivated and directed to solve problems collaboratively (Ayaz and Şekerci, 2015). Text-based teaching conceptual change is an active learning method. Soltanzadeh *et al.,* (2013) show that active learning positively impacts students' motivation. Previous studies have focused more on examining the effect of conceptual change text on conceptual understanding. Meanwhile, the impact of text-based learning on conceptual change in student learning motivation has not been found.

This study aims to investigate the effectiveness of conceptual change texts compared to conventional texts in enhancing students' understanding of electricity concepts and learning motivation. There were three questions answered in this study, namely: (1) Is there a difference in the improvement of students' understanding of electricity concepts and learning motivation between the experimental group and the control group?; (2) Is there a difference in the improvement of students' understanding of electricity concepts between the experimental group and the control group?; (3) Is there a difference in the improvement of students' learning motivation between the experimental group and the control group?

2. Materials and Methods

2.1 Research design

This research is a quasi-experimental with pre-test post-test non-equivalent control group design as follow

Experiment	O_1	X_1	O_2
Control	O_1	X2	O_2

Figure 1. Pre-test-post-test non-equivalent control group design

Which:
X1 = Conceptual Change Text-based teaching
X2 = Conventional text-based teaching
O1 = Initial observation (pre-test),
O2 = Final observation (post-test)

2.2 Research subject

The subjects of this study were 142 students of 12^{th} –Grade. The subjects were divided into two groups: 70 students as the experimental group and 72 students as the control group.

2.3 Data and Instruments

The data on students' understanding were collected using an extended multiple choice test. The reliability index of the test is r = 0.65. Table 1 is scoring rubric of extended multiple choice test. The data of learning motivation were collected by questionnaire. A score of learning motivation is determined by Likert Scale that is score 5 for the respondents strongly agree, score 4 for the response agree, score 3 for the response quite agree, 2 for response disagree, and score 1 for response strongly disagree. The reliability index of the questioner is r=0.89.

Table 1
The scoring rubric of the electricity concepts test

Score	Criteria
4	Right answer, right reason, accompanied by correct evidence
3	Right answer, right reason without accompanied by correct evidences or accompanied by wrong evidence.
2	Right answer, no reason, or indicating wrong reasons or misconceptions
1	Wrong answer.
0	No answer

2.4 Data Analysis

To describe the improvement in students' understanding of electricity concepts and learning motivation, data are analyzed descriptively. The improvement of students' understanding of electricity and learning motivation is calculated by the normalized gain score formula (Hake, 1998) that is:

$$\hat{g} = \frac{X_{post} - X_{pre}}{X_{\max} - X_{pre}}$$

Where:
$\hat{g}$ = normalized gain score; X_{post} = post-test score; X_{pre} = pre-test score; X_{max} = maximum score. Qualifications of the normalized gain score are determined by criteria as indicated in Table 2.

Table 2
Qulification criteria of normalized gain score

Value g	Qualification
$\hat{g} \geq$ **0,7**	High
0,3 $\leq \hat{g}$ **<0,7**	Medium
$\hat{g}$ **<0,3**	Low

To compare the effectiveness of conceptual change text and expository text in improving students' understanding of electricity concepts and learning motivations, the data were analyzed by MANOVA.

Normality Test

Kolmogorov-Smirnov was carried out to test the normality of normalized gain score of students' understanding of electricity concepts and learning motivation of the experimental group and the control group. Statistic value of normalized gain score of students' understanding of electricity concepts for experimental group is 0.100 (p=0,079) and for the control group is 0.093 (p=0,200). This means that data of normalized gain score of students' understanding of electricity concepts for both the experimental group and the control group were normally distributed. Statistic value of normalized gain score of learning motivation for experimental group is 0,066 (p=0.200) and for the control group is 0.111 (p=0,069). This means that data of normalized gain score of learning motivation for both the experimental group and the control group were normally distributed.

Homogeneity Test

Levene's Test was used to test the homogeneity of variance between the group. The result indicated that of students' electricity concepts understanding is 0.958 (p=0.329>0.05) and learning motivation is 1,019 (p=0.314). These results indicate that there is no difference in the variance of students' electricity concepts understanding electricity and learning motivation between groups.

Colinearity Test between Dependent Variables

Test of colinearity between dependent variables was conducted by using product moment test. The result showed that the correlation index r =0.534 (p=0.000), this value smaller than 0.8. This mean, there is no colinearity between dependent variables.

3. Results and Discussions

3.1. The improvement of Students' Understanding of Electric Concepts and Learning Motivation

Table 3 shows the mean normalized gain score $\bar{\hat{g}}$ students' understanding of electricity concepts and motivation of the experimental group and the control group. According to table 2, the mean normalized gain score $\bar{\hat{g}}$ of students' understanding of electricity concepts and learning motivation of the experimental group is in the medium level. As indicated that the mean normalized gain score $\bar{\hat{g}}$ of students' understanding of electricity concepts and learning motivation of the experimental group higher than the control group.

Table 3
Comparison of Normalized Gain Score of the Experimental Group
and The Control Group

GROUP	N	SUEC		SLM	
		$\bar{\hat{g}}$	SD	$\bar{\hat{g}}$	SD
Experimental Group	70	0.63	0.12	0.58	0.09
Control Group	72	0.32	0.12	0.42	0.10

Note: SUEC =Students' Understanding of Electricity Concepts, SLM= Students' Learning Motivation

3.2 Hypothesis testing

There are three null hypotheses were tested in this study:

$H_0 1$: There is no difference in the improvement of students' electricity concepts understanding and learning motivation between the experimental group and the control group?

$H_0 2$: There is no difference in the improvement of students' electricity concepts understanding between the experimental group and the control group.

$H_0 3$: There is no difference in the improvement of students' learning motivation between the experimental group and the control group.

Table 4 shows the results of Pillai's Trace, Wilks' Lambda, Hotelling's Trace, and Roy's Largest Root analysis in MANOVA.

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Table 4
The results of the multivariate test

Effect		F	Sig.
Intercept	Pillai's Trace	2745.439	0.000
	Wilks' Lambda	2745.439	0.000
	Hotelling's Trace	2745.439	0.000
	Roy's Largest Root	2745.439	0.000
Text	Pillai's Trace	153.823	0.000
	Wilks' Lambda	153.823	0.000
	Hotelling's Trace	153.823	0.000
	Roy's Largest Root	153.823	0.000

All test results were significant at p <0.05, which mean that $H_0 1$ is rejected or $H_a 1$ is accepted. Therefore, there is the difference in the improvement in students' understanding of electricity concepts and learning motivation between the experimental group and the control group.

Table 5 shows the results of the Test of Between-Subjects Effects. It appears that the F value for the corrected model and group source for students understanding of electricity concepts is F = 227.234 (p = 0.00 <0.05) and for learning motivation is F = 98,941 (p=0.00 <0,05). Therefore $H_0 2$ and $H_0 3$ were rejected. It can be concluded that: (1) there is a significant difference of the improvement of students' understanding of electricity concepts between the experimental group and the control group; (2) there is a significant difference of the learning motivation improvement between the experimental group and the control group.

Table 5
Tests of Between-Subjects Effects

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected	SUEC	3.378[a]	1	3.378	227.234	0.000
Model	SLM	0.949[b]	1	0.949	98.941	0.000
Intercept	SUEC	31.633	1	31.633	2127.857	0.000
	SLM	35.587	1	35.587	3709.144	0.000
Group	SUEC	3.378	1	3.378	227.234	0.000
	SLM	0.949	1	0.949	98.941	0.000
Error	SUEC	2.081	140	0.015		
	SLM	1.343	140	0.010		
Total	SUEC	36.808	142			
	SLM	37.723	142			
Corrected Total	SUEC	5.459	141			
	SLM	2.292	141			

Note: SUEC =Students' Understanding of Electricity Concepts, SLM= Students'Learning Motivation

The difference in the mean of normalized gain scores of students' understanding of electricity concepts was $\Delta\mu$ = 0.309, with SD = 0.020, p <0.05. The difference in mean gain score $\Delta\mu$ is greater than the LSD rejection limit. Thus, the mean score of students' understanding of electricity concepts of the experimental group and the control group differed significantly at the significance level of 0.05. The mean normalized gain score of the experimental group is greater than the control group. The difference in estimated mean normalized gain scores of learning motivation is $\Delta\mu$ = 0.164, with a standard error of 0.164, p <0.05. The value of μ is greater than the LSD rejection limit. Thus, the mean normalized score of the learning motivation improvement in the experimental and control groups differed significantly at the 0.05 significance level. The mean normalized score of the experimental group is greater than the control group.

The main purpose of this study is to explore the effectiveness of conceptual change texts in enhancing the students' understanding of electricity concepts and learning motivation. The use of conceptual change texts is based on the notion that the misconceptions students bring negatively affect classroom teaching (Ozkan and Selcuk, 2013; Gürefe *et al.,* 2014), and result in a low understanding of student concepts. In addition, the conceptual change strategy is the embodiment of constructivism in learning. According to constructivism learning is the process of knowledge construction by the learners themselves. Butcher (2010) state that concepts and principles of constructivism have a positive impact on student motivation.

The research findings indicate that there are significant differences in the improvement of students' understanding of electricity concepts and learning motivation between the control group and the experimental group. *Tests of Between-Subjects Effects* shows that: (1) there is a significant difference in the improvement of students' understanding of electricity concepts between the experimental group and the control group; (2) there is a significant difference in the improvement of learning motivation between the experimental group and the control group The mean normalized gain score of students' electricity concepts understanding and learning motivation who received conceptual change text-based teaching strategy is higher than that of students who received conventional text-based teaching strategy. Thus, conceptual change text is an effective conceptual change strategy for improving students' understanding and learning motivation.

The effectiveness of conceptual change texts as learning materials is in line with previous research findings on various fields of science. Aydin (2012) found that conceptual change texts are more effective than traditional teaching in reducing student misconceptions about geometry optics. Ozkan and Selcuk (2015), found that the understanding of the floating force of students who were studied with conceptual change text is higher than who were studied with traditional text. In the field of biology, Cetin *et al.,* (2015) concluded that teaching with conceptual change texts is more effective than traditional teaching for the understanding of ecological concepts. In the field of mathematics, Gürefe *et al.,* (2014) conclude that high-concept teaching in grade 5 students with conceptual change texts is more effective than traditional teaching. In the field of chemistry, Sendur and Toprak (2013) conclude that conceptual change texts are more effective than traditional teaching to reduce students' misconceptions about alkenes.

In addition to consistent with the findings of previous researchers, the effectiveness of conceptual change texts in improving conceptual understanding is conceptually supported. At the beginning of the conceptual change text, students are confronted with questions that explore students' prior knowledge about certain concepts. The main purpose of this section is to awaken students that they need the knowledge to answer that question. It also intends to show them what they do not know. Thus, this section can be viewed as a "dissatisfaction step". In the second part, students are introduced to students' ideas/answers/questions in the first section that is scientifically incorrect. This is intended to cause doubt and uncertainty. If among the ideas that are not true it is in the minds of students, it will arise curiosity. Thus students are encouraged to think deeply about the material being studied. In the third part of the conceptual change text, students presented a scientific explanation of the concepts asked in the first section. Explanations are presented clearly and understandably. Explanations are aided by media, simulation, animation or demonstrations that can help student's understanding. Through this section, students can distinguish between misconceptions and scientific concepts. In the fourth section, students are encouraged to convey their opinions about the concepts being studied. In this section can be observed if the student has received new knowledge.

In addition to improving students' understanding of electricity concepts, conceptual change text-based learning can also increase students' learning motivation. The mean normalized gain score of the experimental group is higher than the control group. Teaching with conceptual change texts is active learning, where students are active both physically and mentally in constructing knowledge. In learning with conceptual change text students actively build knowledge based on the preconceptions they have. Students learn collaboratively and socially construct scientific knowledge. Collaborative work not only leads students to construct knowledge within the framework of constructivism but also encourages student motivation in groups. Active learning has a positive impact on the quality of the process and the achievement motivation of the students (Soltanzadeh *et al.,* 2013).

4. Conclusion

Starting from the fact that misconceptions negatively impacted the teaching of concepts, a quasi-experimental study was conducted to test the effectiveness of conceptual change text-based teaching toward improving students' understanding of electricity concepts and learning motivations. MANOVA analysis results show that the improvement in students' understanding of electricity concepts and learning motivation between students who get conceptual change text-based teaching was better than who get expository text-based teaching. Conceptual change text was an effective tool for improving students' understanding of electricity concepts and learning motivations.

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Statement of authorship
We responsible for the conception and design of the research. We have approved the final article.

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