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DEVELOPING, IMPLEMENTING, AND TESTING A CONCEPTUAL CHANGE TEXT ABOUT RELATIVITY

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Abstract

The objective of this study is to develop a tested conceptual change text (CCT) which can be useful in guiding the students to reorganize their misconceptions only by reading a text. To this end, a CCT and a traditional text (TT) about relativity were developed. As data collecting tool, simulation aided semi-structured interviews were used. Research sample was composed of the two different ninth grade physics classes. Students of the Class A read the CCT as experimental group and the students of the Class B read the TT as control group. 12 students were chosen as interviewee by comparing the differences between pre- and post- achievement tests. Content analysis of the interviews revealed that all of the students who read CCT gave correct answers to interview questions and the target misconception could not be found in their conceptual schema. On the other hand, 4 of the 6 students reading the TT had the target misconception in their conceptual schema even though they gave the right answers to the questions. As a conclusion, it was determined in this study that the CCT was more effective than the TT in reorganizing the conceptual schema of the students about relativity.

Keywords: Conceptual change text, misconception, velocity, relativity, physics education.

INTRODUCTION

Almost all concepts taught in the high school physics course are related to the daily life as these students do not attend the physics classes as a tabula rasa (Chi & Roscoe, 2002; Beerenwinkel, 2006; Physics Education Program, 2007). Before they started go to school and after the school times while they are going to school, students learn from their environment with individual experiences. These individual experiences procreate different mental structures about the concepts. However, on some occasions, daily life can mislead young minds. Chi and Roscoe (2002, p. 3) defined the previous knowledge of the students about the concepts as naïve knowledge and according to them this knowledge is often wrong. This knowledge which is not based on a scientific ground may cause misconceptions (Yağbasan & Gülçiçek, 2003). Clement (1993) and Tippett (2010) explained the term misconception as the knowledge which conflicts with the scientific knowledge. In physics, there are many common misconceptions and many studies on these misconceptions showed that it is hard to reorganize young minds (Tippett, 2010).

Actually when a group of students gathers in a class and only one teacher tries to find their individual misconceptions, it can be challenging to reorganize the conceptual schemas of the

students. On the other hand, as stated by Akgün (2009), the possibility that a teacher can also have misconceptions should not be forgotten. Thus, there is a need for a material which could reorganize conceptual structures of the students. This material must be easily accessible and easily available and must benefit from previous knowledge of the students. Though the use of this material, students must comprehend both old and new experiences on a scientific basis.

Roth (1985) developed the conceptual change texts (CCT) by adopting the stages of the conceptual change theory proposed by Posner et al. (1982) (Chambers & Andre, 1997; Baser & Geban, 2007a; Taşlıdere & Eryılmaz, 2009; Dilber, Karaman, & Duzgun, 2009). CCT aims at helping readers to replace their misconceptions with scientific concepts. According to Roth (1985), stages of CCT direct questions to the relevant individuals with the aim of uncovering their existing misconceptions (dissatisfaction), challenge to existing misconceptions by using analogies (intelligibility), give the formal definitions of the concepts (plausibility) and provide new conditions for applying the new concept (fruitfulness).

Many other researchers have studied on the CCTs since the study of Roth. Baser & Geban (2007a), Baser & Geban (2007b), Chambers & Andre (1997), İpek & Çalık (2008), Çalik, Okur, & Taylor (2010), Durmuş & Bayraktar (2010), Şahin, İpek, & Çepni (2010) are some of the studies concerning the CCTs and physics concepts. Only Chambers & Andre (1997) and Baser & Geban (2007a) studied on the CCTs by comparing them to the traditional texts (TT) in physics and present the texts in their studies. This indicates that there is not enough evidence showing that CCTs are more successful or TTs are more effective in reorganizing the misconceptions. The purpose of this study is to develop a tested conceptual change text which can help teachers guide their students to reorganize their misconceptions only by reading a text. The subject of the conceptual change text is relativity and the target misconception is "Velocity is intrinsic to particle and does not depend on the observer." (Aguirre, 1988; Güneş, 2009).

METHOD

In accordance with the aim of this study, a draft CCT was developed by the researchers and the draft text was applied on 99 tenth grade students as a pilot study. At time same time, a TT which was similar to the CCT and explained the same topics with the CCT was also written. Opinions of 4 physics education experts and 3 language experts were used in proofreading. Original texts were revised in the light of feedbacks obtained from the pilot study and the experts opinions. Developed CCT was composed of four stages as explained by Roth (1985). TT consisted of three stages which were determined by the researcher following the review of several physics course books. Stages of TT were explanation, giving examples and description of a sample, respectively. Structure of the TT was examined by the experts. Texts were about the movement of earth and the sun in relation to one another. Readability values of two texts showed that they were scientific texts. Ateşman (1997)'s readability test adapted from the "Reading Ease" formula of Flesh into Turkish was used due to the fact that both texts were written in Turkish. According to Ateşman (1997), reading ease scores of CCT and TT were 42,238 and 40,083, respectively.

Pre-post test model and content analysis were used together to find out whether any conceptual

change occurred. Three context-based achievement tests were used as pre- and post- tests in two different classes of one school. Out of the pre- and post- tests, context-based learning plan was applied to both classes. While Class A was determined as the experimental group and students in the Class A read the conceptual change text, students of the Class B read the traditional text as control group. Two weeks after the post test, simulation aided semi-structured interview was used to examine the conceptual structures of the students concerning the target misconception. The simulation used in the interview was developed by researchers with Interactive Physics Simulation Program. Students from Class A and Class B were grouped by using the differences between the results of the pre- and post- tests. Three groups were formed out of one class. From both groups, 2 volunteer participated in the interview. Data of this study were collected from 12 ninth grade students through interviews. Qualitative analysis was also used in making inferences by systematically identifying the interview transcriptions.

FINDINGS

There were 3 questions about the target misconception in the pre- and post- tests. Four (01, 02, 04, 06) of six interviewees who read the CCT gave more correct answers to the questions in the post-tests. One interviewee (05) reduced the number of her correct answers in the post-test and all answers of one interviewee (03) were wrong in both pre- and post- tests. The number of correct answers did not change for the interviewees 07, 08, 09, 10, 11, and 12 who read the TT. Two interviewees (07, 09) answered all questions correctly at pre- and post- tests.

Content analysis of interviews showed that all of the students (01, 02, 03, 04, 05, 06) who read CCT gave correct answers to interview questions and the target misconception could not be found in their conceptual schema. On the other hand, although two interviewees who read the TT answered the interview questions correctly; four (07, 08, 10, 11) of the six students had the target misconception in their conceptual schema about relativity. An analysis of the interviews is given in Table 1 with a sample of the student answers to the interview questions.

Table 1. Analysis of the interviews

Text	Category	Sub-Category	f*	Student's code	Sample description
CCT	Correct answer	Non misconception	6	01, 02, 03, 04, 05, 06	"S**: …. [While the reference point is earth] we assume that the earth is constant. At that time the sun seems like revolving around the earth. … … … … … … … … … … … … … … … S: [While the reference point is the sun] other planets revolve around it [the sun]."
		Target misconception	0	-	-
	Wrong answer	Non misconception	0	-	-
		Target misconception	0	-	-

TT	Correct answer	Non misconception	2	09, 12	"S: In the solar system earth is at the third place. [While the reference point is earth] The sun will be its [earths] third orbit. …. R***: …. Explain the sun motion. …. S: Did not it revolving around like an ellipse? … … … … … … … … … … … … … … S: …. If we consider the sun is constant as a reference point earth revolves around the sun."
		Target misconception	4	07, 08, 10, 11	"S: …. [While the reference point is earth, the sun] it will revolve around 360^{o}, anyhow. R: …. Where is it center? …. S: Earth. … … … … … … … … … … … … … … S: …. But I know that earth revolves around the sun. The sun is constant. …. … … … … … … … … … … … … … … S: [While the reference point is the sun] This time earth revolving around it [the sun]. R: Why? S: Because the sun is motionless. Earth is moving. …."
	Wrong answer	Non misconception	0	-	-
		Target misconception	0	-	-

*Frequency, **Student, ***Researcher

DISCUSSION

In this study, interviews revealed that student misconception was an assumption. Because of this assumption, pre- and post- test results were also examined. The pre- and post- tests results were consistent with results of the content analysis.

As the data of this research were collected from only twelve 16 years old ninth grade students of the Turkish education system, results could not be generalized. Although it can be thought that the difference between the reading skills of the students could affect the result, the content analysis made it clear that the CCT was not completely successful in removing the misconceptions of all students but, on the other hand, it was more effective than the TT.

In this study, CCT and TT were not applied as different activities but students read them at the end of a lesson about relativity. Same examples were used in the developed CCT and TT in order to control the factors which could affect the conceptual change. The results cannot be associated with either scientific or linguistic differences of CCT and TT due to the fact that experts confirmed that the difference between two texts was only structural.

It is acknowledged that misconceptions can continue in different instances and events. Therefore, any other study to be carried out with the same students may uncover that students still have the target misconception in their conceptual schema. In parallel to our study, results of the studies of both Chambers and Andre (1997) and Baser and Geban (2007a) revealed that the CCT is more successful and effective than TT.

CONCLUSION

In this study, a CCT was developed in relation to the misconception of "Velocity is intrinsic to particle and does not depend on the observer." (Aguirre, 1988; Güneş, 2009). Through the use of content analysis, it was determined that CCT was more effective than TT in reorganizing the conceptual schema of the students about the target misconception. Studies conducted so far also presented the same results with this study. The CCT developed in this study may also be used by the students to help themselves overcome their misconception.

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