The role of cognitive conflict in constructivist theory: An implementation aimed at science teachers

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Received October 25, 2008; revised December 11, 2008; accepted January 2, 2009

Abstract

In this study, cognitive conflict activities were prepared aimed at science teachers and these activities were then applied to science teachers. The study was conducted with the participation of 10 volunteer teachers who were teaching in primary schools in the province of Izmir, Turkey in 2007. A worksheet for each cognitive conflict activity was distributed to the teachers at the beginning of the implementation. The worksheets contain the sections of prediction, various questions and making explanations. At the end of each cognitive conflict activity, the worksheets relating to the completed activity were collected to be analyzed by the researcher. Furthermore, the teachers were asked for their views on the implementation in writing. On examining the worksheets and the teachers’ views on the implementation, it was observed that most of the teachers experienced cognitive conflict (that their previous knowledge was wrong or insufficient) regarding the implementation activities provided; and stated views that these types of activities in science lessons would capture the students’ attention in the lesson, get them to take ownership the problem and be more eager to solve it, and contribute to learning of the topic to be more lasting.

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Keywords: Cognitive conflict; constructivist theory; science teachers

1. Introduction

In the last three decades, science educators and researcher have strongly advocated the perspectives of constructivism on learning and teaching (Wu & Tsai, 2005). There are a lot of studies based upon the assertions of constructivism to promote students’ learning science (Marss, Blake & Garvin, 2003; Alparslan, Tekkaya, & Geban,
The constructivist view of learning pays special attention to students’ prior knowledge (Akpınar & Ergin, 2005). Because, one of the core statements of this view is the necessity of connecting students’ prior knowledge with the new contents to be taught (Bodner, 1986). When students are learning a new topic, previous concept confusions they may have relating to that topic negatively affects the correct and meaningful learning of the topic to be learnt. These confusions are significant learning issues which prevent the students from learning the new concepts they encounter during the learning process, lead them to misinterpret the events they encounter in daily life, cause them to generate invalid solutions or no solution at all when they encounter problem situations (Akgün & Deryakulu, 2007). The important issue at this point is to bring about a conceptual change in the students (Posner, Strike, Hewson, & Gertzog, 1982). One of the most common conceptual change instructional strategies implemented in the classroom was to induce cognitive conflict through presenting anomalous data or contradictory information (Limon, 2001). Most of the models proposed to explain conceptual change have emphasised the role of cognitive conflict as a central condition for conceptual change (Kang, Scharmann and Noh, 2004). Many educators have applied the idea of cognitive conflict in the classroom (Zohar &Aharon-Kravetsky, 2005). Cognitive conflict constitutes a crucial stage in the influential conceptual change model proposed by Posner and colleagues (Posner, Strike, Hewson, & Gertzog, 1982). Studies conducted on students have shown controversial results regarding the effectiveness of cognitive conflict in learning (Limon, 2001; Zohar &Aharon-Kravetsky, 2005). Whilst positive results were obtained in some studies, in others positive results were not obtained. It was observed that especially due to students’ previous knowledge differing, some students experienced cognitive conflict whilst others did not (Limon, 2001). In order to eliminate this negative situation, the present study was conducted with the participation of science teachers. On reviewing the literature relating to cognitive conflict, it was observed that almost all of the studies were conducted with students (Baddock & Bucat, 2008; Palmer, 2003; Akgün & Deryakulu, 2007; Kang, Scharmann, Noh & Koh, 2005). Whereas in this study cognitive conflict activities were prepared aimed at science teachers and it was investigated whether the teachers had concept confusions regarding the topics discussed and whether these concept confusions were removed with the cognitive conflict situations created. Furthermore, in this study, teachers’ views on cognitive conflict were sought.

In recent years, it is observed that science programs are influenced by the constructivist theory. Whereas the people who will implement this viewpoint in science classes are science teachers. Therefore, it is considered important to establish the views of the teachers, who will implement the constructivist approach in science classes, regarding how effective the cognitive conflict activities based on constructivist approach are. In this study, cognitive conflict activities were composed at teacher level and applied to 10 science teachers.

2. Methodology

This study was conducted with the voluntary participation of 10 science teachers with permission obtained from their institutions. The teachers participating in the study had at least ten years of experience. All of the teachers were working as science teachers and had experience and knowledge of cognitive conflict situations. Because, the teachers are teaching their students in science lessons the concepts contained in the cognitive conflict activities composed for this study. In this study, four cognitive conflict activities were prepared. Worksheets were distributed to the teachers relating to all activities and each worksheet contained spaces where the teachers could write down their predictions regarding the activities and explain the reasons for their predictions. Teachers wrote their explanations in pen. All activities were conducted in the science laboratory of a primary school in Turkey. In the implementation, first, the teachers were shown the activity where they were expected to experience cognitive conflict and asked to answer some questions regarding this activity. After the teachers wrote down their answers regarding the activities, the same activity is demonstrated with an experiment. At this stage, the teachers were asked to compare the result of the experiment they saw and their own explanations and to re-write the conclusion they reached. At the last stage, the teachers discussed among themselves and those with different conclusions tried to convince each other. The teachers’ end of activity discussions were not included in this study. End of activity discussions will be analysed in another study. At end of the implementation, all worksheets distributed to the teachers were collected and analysed by the two researchers. In the analysis of the worksheets, primarily, it was determined whether the teachers experienced cognitive conflict. Then, the explanations of the teachers who experienced cognitive conflict were analysed. Finally, the teachers’ views on the cognitive conflict activities were taken in writing.
3. Results

In this section, the cognitive conflict activities applied to science teachers in the approximately 8 hour long seminar and the analysis results of the answers given to these activities by the teachers have been provided. Furthermore, the teachers’ written views on the cognitive conflict have been included at the end of the section.

3.1. First cognitive conflict activity

![Blowing to the ping pong ball in the funnel. What happens to the ping pong ball?](image)

The teachers were shown the above picture on the worksheet, asked to predict what would happen to the ping pong ball when the student in the figure blew into the funnel from below, and to write down the reasons for their predictions. Then, 5 ping pong balls were put in a larger funnel and it was asked what would happen when blown into the funnel. Once the teachers wrote down their predictions in the space provided on the worksheets, a random teacher was given the ping pong balls and funnels, and asked to perform this experiment with one ball as the above student and with 5 balls in front of all the teachers. The teacher first put one ball in the funnel and blew, and then increased the number of balls to 5 and blew again. During this process, all the teachers observed carefully the result they were curious to find out. As a result, it was observed that the balls did not fall out of the funnel. At this stage, the teachers were asked to compare their previous predictions with the experiment result and explain the reason for this situation. The teachers were not allowed to exchange information among themselves until this stage. After the teachers made the explanations requested of them, the worksheets relating to this activity were collected from the teachers in order to be analysed. The teachers then exchanged views among themselves. During the discussion, one teacher who experienced cognitive conflict stated that the ping pong balls should have definitely bounced out of the funnel and that the person blowing into the funnel did so slowly and that they wanted to do the experiment themselves. This teacher was allowed to perform the activity, who expressed their astonishment after having done the activity. At the end of the discussion process, all the teachers dispelled their concept confusions regarding why the ping pong balls did not fall, with the help and explanations of the implementation teacher (one of the authors of this study).

On examining the written answers of the teachers on the worksheets, it was observed that 8 out of 10 teachers stated that the ball would fall out of the funnel when blown relating to the experiment with one ping pong ball. Regarding the experiment where five ping pong ball were used, again 8 teachers stated that all of the balls would fall. On examining the explanations given by the teachers for this situation, it was seen that they gave answers such as “when the funnel is blown into from below, a force is applied to the balls, and with the thrust of this force, the balls fall out of the funnel”, “with the blow, the air in the funnel hits the balls and makes them fall out of the funnel”, “when we blow into the funnel, a pressure is formed in the funnel and this pressure pushes the balls
upwards and the balls fall out”, and “as the ping pong ball is light, it will fall out with a light blow of air”. These results indicate that except for two teachers, the teachers had a concept confusion regarding this topic and that they could not scientifically explain this situation they encountered. It was seen that the teachers had the scientifically acceptable knowledge that the moving air would be lighter and therefore the balls would not fall. The teachers’ answers, after the experiment was conducted, to the question whether their previous predictions were consistent with the experiment result, indicate that nearly all of the teachers were unable to explain this phenomenon in a scientifically accurate way. However, most of the teachers stated that they were curious to find out why the result came out differently. These results indicate that this activity made most of the teachers experience cognitive conflict.

3.2. Second cognitive conflict activity

The teachers were given the worksheet (cognitive conflict activity) containing the picture and explanations in Figure 2 and asked to make predictions regarding this situation and the reasons for their prediction. Then, when this experiment was implemented in the laboratory, the teacher saw the results of the experiment. At this stage, the teachers were asked to write the reason if there was any discrepancy between their pre-experiment predictions and the experiment result. After the worksheets were collected, the teachers were asked to discuss this experiment. The discussions among teachers have not been included in this study. By the end of the discussion, all teachers came to a level where they were able to scientifically explain how water could be boiled with ice. On examining the teachers’ answers on the worksheets, at the prediction stage, two teachers stated that the ice would cause the erlenmeyer to explode, five that the water would cool and it was impossible for the water to boil, three that the water may boil. However, one of these three teachers was not able to explain what would cause this, to a scientifically acceptable level. This situation indicates that although most of the teachers know the relationship between pressure and water boiling, they were not able to scientifically explain this situation. It was observed that after the experiment was conducted in the laboratory, the number teachers who were able to scientifically accurately explain that water can be boiled with ice rose to eight. Whereas two teachers were not able to explain exactly the reason for this situation. The fact that eight teachers experienced cognitive conflict indicates that this activity was effective.

3.1. Third cognitive conflict activity

In Figure 3, the activity of glazier’s putty being dropped from a certain height is demonstrated. The experiment was conducted before making an explanation to the teachers and it was observed that the glazier’s putty stuck to the floor and stayed that way. The teachers were asked to explain the energies and the energy transformations of the
glazier’s putty dropped from a certain height. After the worksheets were collected from the teachers, except for one teacher (who categorically refused to accept that there could be a transformation into heat energy and asked it to be proved with an experiment) the other teachers reached the correct answer by discussing with the guidance of the implementation teacher. On examining the teachers’ answers to the questions in this activity, five of the teachers explained the energy possessed by the glazier’s putty and the energy transformation when it fell on the floor to a scientifically acceptable level; whilst the other teachers had concept confusion. Two of these teachers stated that the potential energy the glazier’s putty had when it was dropped turned into shape energy when it touched the floor. The remaining three teachers stated that it turned into kinetic energy.

3.1. Fourth cognitive conflict activity

The teachers were given the electric circuit in Figure 4 on a worksheet and asked how this circuit was connected (series or parallel). After the teachers gave written answers to this question, this experiment set up was created in laboratory environment. Opportunity was given to any teacher who wanted to experiment on the electric circuit created. Then, the teachers were asked to compare their pre-experiment predictions to the experiment result and make an explanation. After the teachers’ answers were collected, the teachers concluded through discussion that this circuit was parallel. Whereas when the teachers’ written answers were examined, at the pre-experiment stage, give teachers stated this circuit was series connected, and the remainder that it was parallel connected. After the experiment was conducted (the teachers generally decided whether the circuit was connected series or parallel by removing one of the bulbs in the experiment and seeing whether the other bulb lighted), it was observed that all of the teachers possessed the knowledge that the circuit was parallel connected.

At the end of the study, the views of all teachers on these activities were taken in writing. The teachers were asked whether these types of activities would help students’ learning and whether they would use such activities in science lessons.

On examining the teachers’ written views, all teachers stated views that such activities would help students review their knowledge on the topic, and could be used to establish whether the topic was understood completely and correctly. More than half the teachers stated that they were curious about the result in the activities performed and that a similar situation could be experienced by the students. It was stated that especially the end of activity discussions were important and the students could realise the mistakes in their own knowledge through such discussions. Furthermore, they stated that students would learn scientific knowledge more accurately through discussion. All of the teachers stated they could use these types of activities in their classes. In addition, five teachers stated that the activities conducted were well suited to their level but it could be difficult to prepare such activities at the student level.

4. Conclusions and Discussion

The most important point of cognitive conflict is the formation and resolution of the cognitive conflict (Akgün & Deryakulu, 2007). In this applied study aimed towards teachers, it was established that cognitive conflict activities could be created in different ways. In this study, predominantly, cognitive conflict situations which could be tested in science laboratory environment were created. In all the activities except for the electric circuit activity, more than half of the teachers experienced cognitive conflict. Furthermore, in all activities, it was also established that some teachers had concept confusions and incorrect knowledge relating to the activity topic. However, these concept
confusions could not be investigated in detail in this study. Based on the classroom observations in the activities with the teachers and conversations with them, it can be stated that the cognitive conflict based activities attracted the teachers’ attention and helped them get motivated towards the lesson. Furthermore, it was stated that the teachers would like to use these types of activities in the classroom and that it would contribute to the students’ learning. Limon (2001), based on the related research findings, stated that the students were not able to achieve a significant and required level of cognitive conflict to bring about conceptual change, and that those who did achieve that level were not able to dispel this conflict unless they had the required cognitive and affective qualities. The students’ level of prior knowledge on the topic, achievement levels, interest and motivation towards the topic affect their getting into cognitive conflict (Akgün & Deryakulu, 2007; Zohar & Aharon-Kravetsky, 2005; Tyson, Venville & Harrison, 1997; Mischel, 1971). The most important different of the present study to other studies conducted based on cognitive conflict, is that it was performed with teachers. With the present study, it was demonstrated that implementations based on cognitive conflict can be effective when conducted with people who have knowledge of a certain topic. Therefore, in future studies, when selecting the topic to conduct the cognitive conflict based activities, it should be taken into consideration that the students have a certain level of knowledge on the topic to be studied. Otherwise, it may be difficult for students to experience cognitive conflict. However, teachers should, providing guidance, give students the opportunity to explain a concept, help them think in order to establish a relationship between this concept and previous concepts, and test their ideas regarding this concept. Furthermore, science teachers and researchers should prepare cognitive conflict activities utilizing their own knowledge and experiences, using a variety of materials; and conduct studies on the effectiveness of these implementations in the classroom environment. In addition, there are not sufficient research findings on whether cognitive conflict arises in a way to increase conceptual change when working on an individual or group basis (Akgün & Deryakulu, 2007). This situation could not be established in the present study. This situation can also be investigated in future studies. Furthermore, in future studies, computer animations, concept maps and conceptual change texts can be utilized in creating cognitive conflict activities.

References


