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A NEW APPROACH FOR TEACHING 'ENERGY' CONCEPT: THE COMMON KNOWLEDGE CONSTRUCTION MODEL

[a]Ümmügülsüm İYİBİL

[a]Research Assistant, Faculty of Education, Giresun University, u.g.iyibil@gmail.com

Abstract

Energy concept in science curriculum is one of important interdisciplinary topics so it is hard to learn, much research has been conducted to define students' understanding. Therefore, a model like The Common Knowledge Construction Model (CKCM) enhancing the environment with alternative assessment and socio-scientific situations should be used to facilitate students' understanding. The aim of the study is to determine the effectiveness of the teaching sequence based on CKCM on the students' conceptual change process. The research was conducted as an experimental study and carried out with the 42 students at 7th grade in Trabzon. For collecting data, in the study many data collection tools were used: The achievement test, The word association test and The concept map. The result of this study shows that the students in experiment group seem to be more successful than the students in control group. Although CKCM is useful way to teach a concept or a subject, the lessons' time in the science curriculum isn't enough to use this model, especially, if students have learning difficulties. And also, students must be willing to learn and explore the knowledge if teacher want to use this model in her/his lessons.

Keywords: .The Common Knowledge Construction Model, Energy, Conceptual Change.

INTRODUCTION

Students' pre-existing knowledge acts very important role for further learning (Şahin et at, 2009), therefore, much research has been carried out in this area. As results of these researches, researchers discovered that students learn the concepts in different ways (İpek and Çalık, 2008). In the related literature, these ways called misconception, misunderstanding, preconception, alternative framework, children science, spontaneous knowledge and naïve theory were defined and these terms have same meaning (Köse et al, 2003; Çalık and Ayas, 2005). Why students hold alternative conceptions can be explained by several reasons: teaching method, learning environment and its designer and so forth (İpek and Çalık, 2008). When teachers know what their students think, they can implement instructional activities to address their students' ideas (Biernacka, 2006).

In physics studies, the studies were described students' alternative conceptions in many physics branches such as mechanic, electricity and so on (İpek and Çalık, 2008; Şahin et al, 2009). Because energy is one of important interdisciplinary topics in science curriculum, much research has been conducted to define students' understanding. Especially physics contents in the science curriculum contains many abstract concepts, students may learn them in these ways as mentioned above (İpek and Çalık, 2008). This situation becomes a big problem for students, teachers and researchers in science education. To handle that, the effectiveness of the teaching method gain the important part of the concept learning in science lessons. In this study, the effectiveness of the new teaching strategy, CKCM, is to investigate.

Theoretical Background - The Common Knowledge Construction Model

As a model for teaching and learning, The Common Knowledge Construction Model (CKCM) is developed by Ebenezer and Connor (1998, cited from, Biernacka, 2006). The model is essentially based on Marton's "Variation Theory of Learning" in respect of theoretical roots and Piaget's works of conceptual change in terms of tasks (Ebenezer et al., 2010). Besides these, it is premised on Bruner's view of language as culture's symbolic system, Vygotsky's zone of proximal development mediated within a social environment and Doll's post modern thinking on scientific discourse and curriculum development (Biernacka, 2006). As a philosophically sound teaching model, the CKCM informs students to construct beliefs about the world through personal interaction with the natural phenomena and through social interaction with others (Biernacka, 2006). This model has four interactive phases, namely: Exploring and Categorizing; Constructing and Negotiating; Translating and Extending; and Reflecting and Assessing.
The first phase of the model is exploring and categorizing. Students become aware of their own ideas, beliefs and attitudes by using some simple tasks which is related to everyday "systems", tasks, or phenomena (Ebenezer and Puvirajah, 2005; Ebenezer et al, 2010). In the constructing and negotiating, the second phase, students learn new content for a particular unit which in consistent with the first notion of science, the 'what' of science (Biernacka, 2006). According to the second notion of scientific literacy, the how of science, in this phase students have many opportunities to see that science is socially constructed (Biernacka, 2006). The third phase, translating and extending, acts upon third notion of scientific literacy, the 'why' of science (Biernacka, 2006). In the third phase, students try to find solutions a societal and environmental problem at the local or national level (Biernacka, 2006; Ebenezer et al, 2010) so that they have a chance to translate their understanding of scientific ideas to personal and societal context (Ebenezer and Puvirajah, 2005). Last phase of the model is reflecting and assessing. This phase reflects upon students' understanding through the process of CKCM lessons (Ebenezer and Puvirajah, 2005). The CKCM allows the teacher to easily answer following questions: 'What do my students know?', 'What do I want my students to learn?' and 'What have they learned?' (Biernacka, 2006). To achieve this evaluation, the teacher calls for alternative assessment which effectively measured conceptual change (Ebenezer et al., 2010).

Participants learn to construct their knowledge in the light of scientific literacy's fundamentals (what, how and why of science). We can also say that CKCM reflects the nature of scientific inquiry and develops scientific literacy (Biernacka, 2006; Ebenezer et al, 2010). In the literature the CKCM model has been subject a small number of researches on its practical effectiveness (Ebenezer et al, 2010). The first two phases are done in Ebenezer et al. (2010)'s research and there is no research on all phases of CKCM. As a result of these reasons, our study was designed to show influence of the Common Knowledge Construction Model on student achievement. The research question is:

'Do the CKCM lessons on energy significantly improve 7th grade students' achievement compared to traditional teaching?'

METHOD

The research was conducted as an experimental study. The sample of the study comprised forty-two, (21 students in the experiment and 21 students in the control group), ages 12-14, from two 7th grade classes from two different elementary schools in the center of the district named Akçaabat. Both classes may be considered having same features because; they have same grade and similar cultural background.

The research procedure is that, in the second unit of 7th grade science curriculum, the second sub-topic, 'work and energy', is the subject of our study. This study took place a week period and according to school timetable classes were held two times in the week. Groups had different teachers, the experimental group's teacher is the researcher and the control group's teacher is the teacher having teaching experience.

The same pre-test were used to both classes by researcher. Then, the control group was taught standard lessons in consistent with curriculum while the experimental group was taught CKCM lessons. The same post-test were used to both classes after the topic.

Data Collection Tools and Data Analysis

For collecting data, in the study many data collection tools were used. Hereinafter, each data collection tool is shortly introduced.

Achievement test

The achievement test is two-tier test including 6 open-ended questions. At the meantime, it is used instead of pre and post test. The test is used both exploring and categorizing students' ideas about the subject and determining students' understanding's development. To evaluate the achievement test, we use two ways. The first way's purpose is to explore the students' understanding according to phenomenographic categories. The phenomenographic categories are answers related to subject, answers not related to subject and alternative answers. In the other way, we tried to identify their development about the subject with 1st, 4th and 6th questions in the pre and post test. The understanding levels are adopted several studies (e.g. Abraham et al, 1994 and Karataş et al, 2003) by the researcher because of being two-tier test and used in the analysis. The understanding levels are shown in the Table 1. Owing to these criteria, students' answers can classify and compare their level of understanding (Çalık and Ayas, 2005). Besides that, we can use the statistical analysis for the understanding levels via SPSS.

Table 1. The understanding levels.

The understanding levels		The evaluation criteria
[4]	Sound understanding	Correct answer - Correct reason
[3]	Partial understanding	Correct answer - Partially correct reason
[2]	Partial understanding with specific alternative conception	Correct answer - Incorrect reason / No reason
[1]	Specific alternative conceptions	Incorrect answer - Correct reason
[0]	No understanding	Incorrect answer - Incorrect reason

Word association test

In order to create the test, six key-concepts were chosen in the relevant sub-topic of unit, work and energy in the 7th grade science curriculum. In the test, every key-concept was placed to a page. On the application process, students were informed about the test and given a minute for each key-concept to students to answer them.

In the evaluation process of the test, every answer is counted. Frequencies and cut points in the frequency values are determined and then students' concept map about the subject was drawn (Ercan et al, 2010). The cut points were determined as follows because of the lack of answers and each color represents their own cut point. The first cut point is between 4 and 8 and represents green; the second cut point is between 9 and 13 and represents purple and the last cut point is between 14 and 18 and represents blue.

Concept maps

Concept maps are interconnected schemas that defining concepts and distinct relations between them, two-dimensional and organized with hierarchical levels (Şahin, 2002). In the study, concepts maps were used as an alternative assessment to evaluate the students' knowledge after the instruction. By using teachers' handbook, the concept map was built. The concept map has ten gaps and each gap is scored just one point. In total, a student will take maximum ten points from the map (See Figure 1).

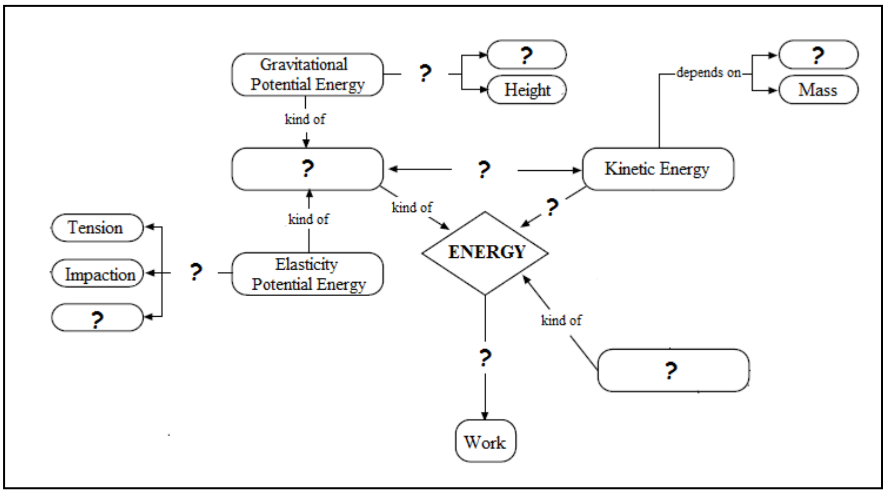


Figure 1. The concept map using for evaluation

FINDINGS

Findings from achievement test

From the phenomenographic categories, both group's students generally have alternative conceptions about the energy. But, after the teaching of the subject, we can see that these conceptions' numbers decrease. Nevertheless, after the teaching sequence we haven't got the findings like we expected. Students still can not define the energy concept related to the work concept. For the answering question, they counted the types of energy such as electricity, light. They generally resemble the energy to the electricity, light, sun etc. types of the energy, too. Besides, the students in the both groups counted renewable energy sources and kinetic and potential energy as energy types. After the teaching sequence, the experiment group's students add them the gravitational potential, elasticity potential, mechanic and nuclear energy types. The number of thinking 'energy converts' increased. Before the teaching sequence, students couldn't give any examples about the energy conservation. After the teaching sequence, the experiment group gave more examples about the energy conservation than the control group. To identify students' development about the subject via pre and post test, we used the way of statistical analysis. The results of the Mann Whitney U test were represented in the following table.

Table 2. The results of Mann Whitney U-test

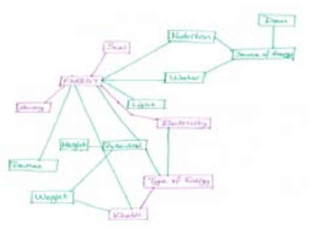
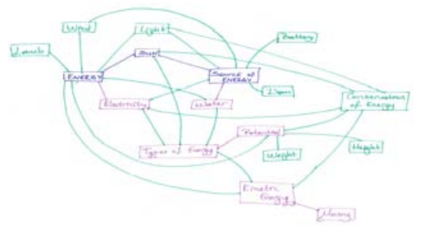
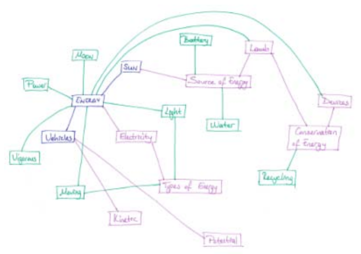
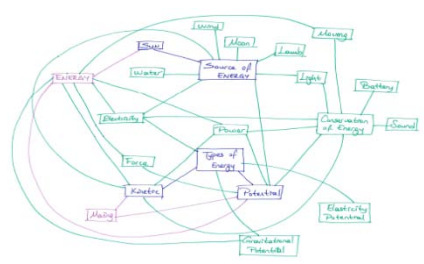
	Group	N	Mean rank	Sum of ranks	U	p
Pre-test	Experiment	21	23,71	498,00	174,000	0,234
	Control	21	19,29	405,00		
Post-test	Experiment	21	24,31	510,50	161,500	0,135
	Control	21	18,69	392,50		

According to Table 2, there isn't meaningful difference between experiment and control groups at the pretest (U=174,000, p>0,05). However, between experiment and control groups at the posttest, the meaningful difference wasn't found (U=161,500, p>0,05). Taking into account the mean ranks, we express that in the both tests experiment group's means are greater than control group's means. From this finding, we can claim that the teaching sequence with CKCM are more efficient than the traditional lessons.

Findings from word association test

The figures were drawn after their answers' frequencies had been determined as follows. The control group's concept map from the pre-test is simple and not complex. It is based on the definition, types and source of energy. After the teaching sequence, their concept map's from the post-test have more complex structure. We see main and some auxiliary concepts about defination, source, types and conversion of energy. But, this finding shows us that students' development hadn't complete in the light of the science curriculum's aims.

Table 3. Students' concept maps derived from the word-association test.

	Pre-test	Post-test
Control group		
Experimental group		

The experiment groups showed a development in their concept building as seen from the concept maps. In the first map, they said definition, source, types and conversion of energy like in control group's second concept map. The complex map is emerged from their post test answers. They said some different concepts besides, the expected concepts they stated. When we look at the experiment concept maps at the pre and post-test, we say that they are more complex than the control groups' (See Table 3). The differences between two groups at the post test can be explained the effectiveness of the teaching sequences, yet, at the pre-test's difference can't be explained with this reason.

Findings from concept map

Students can get maximum 10 points from the concept map, but no students can take it. As seeing following table, a few students take the point bigger than 6 points. In the concept map, students mostly didn't fill the blanks about nuclear energy as a kind of energy and the relationship between the work and energy. Although they couldn't explain what the energy types depend on (e.g. what gravitational potential energy depends on), they could say that potential and kinetic energies and what they are. It shows that the students know the subject on the basic level. It also shows that the students couldn't build the relationships between concepts because of having the pre-existing knowledge about the subject.

Table 4. Students' marks for the concept map

	8 points	7 points	6 points	5 points	4 points	3 points	2 points	1 points	0 point
Frequencies	4	1	1	3	4	1	3	3	1

CONCLUSION

The results of this study show that students built their energy concept incompletely or built an alternative concept. With using the teaching sequence based on CKCM, the students in experiment group seems to be more successful about explaining types of energy, energy conversion and its examples than the students in control group. The concept maps derived from the word association test show the same result. From this perspective, we can say that the teaching sequence based on CKCM is useful concept building and changing process. Although it is useful way to teach a concept or a subject, the lessons' time in the science curriculum isn't enough to use this model. Especially, if students have learning difficulties or alternative conception, guiding them to the right and complete concept is pretty difficult. And also, students must be willing to learn and explore the knowledge if teacher want to use this model in her/his lessons. On the other hand, it is emerged in this study that students have difficulties to learn the subject of energy as supported by the researches' results in the literature (e.g., Ünal et al, 2007; Hırça et al, 2008; Yürümezoğlu et al, 2009).

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