Effects of computer aided concept cartoons on learning outcomes

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Abstract

In this study, the effects of the computer aided concept cartoons on learning outcomes in science and technology education are explored. For this, computer aided concept cartoons were used in 4th grade science and technology class, in “Classification of Living Things” subject, and effects of concept cartoons on academic achievement, and misconceptions are tried to be understood. The study is held with 4th grade students in an elementary school which is placed in İzmir. Experimental group and the control group were determined randomly. Pre-tests and post-tests were applied for both groups. Interviews about concepts to determine students’ misconceptions are also done by researchers. Data obtained from tests was analyzed by using SPSS 15.0 program. Qualitative data obtained from interviews, and observations are analyzed by context analysis. Results of the study revealed that concept cartoons based learning atmosphere affected students’ achievement positively.

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1. Introduction

In order to raise creative individuals who can think research and obtain knowledge, methods and techniques used in educational process should be in accordance with these qualities. Recent educational researches show that there is an increase in students’ achievements and recalling levels, and also students learn concepts correctly when the modern teaching methods are used. Constructivism offers a new set of assumptions about learning. It presents the argument that a complete explanation of how learning occurs in the classroom must include a consideration of the experience of the learner, the key participant in learning. The application of constructivist approaches to science has been widely documented (Driver et al 1985, Driver and Oldham 1986, Driver 1989, Gilbert and Watts, 1983 cited in Stephenson & Warwick, 2002) and there are many accounts of the sorts of ideas that learners have about the world around them (Osborne et al, 1990 cited in Stephenson & Warwick, 2002). The constructivist teacher accepts that learning is an active and personal process and in doing this is aware that learners bring a diverse range of alternative ideas to the classroom that often conflict with the accepted scientific view. It is crucial that these ideas are taken into account if teaching is to be effective (Stephenson & Warwick, 2002).

Students’ and teachers’ concepts and their roles in learning and teaching processes have become one of the most important areas of science education studies for 30 years. Most of the studies done recently in the field of science education concentrate on students’ misconceptions. The results of these studies indicated that students’ interpretations of some of the scientific concepts did not correspond with the common scientific approaches. It is very important for students to avoid misconceptions, and to form concepts correctly and consistently with the scientific explanations. Thus, we can say that the priority should be given to the determination of misconceptions and concept teaching. The number of the researches on concept teaching strategies increases day by day and various teaching methods and techniques are developed. Moreover, these various methods such as semantic webs, concept maps, conceptual change text, predict-observe-explain technique and analogies can also be used together in concept teaching.

There is also another effective technique in determining and eliminating misconceptions known as “concept cartoons”. Concept cartoons were developed as a result of endeavor to enlighten the relationship between constructivist approach and
epistemology and classroom applications (Keogh and Naylor, 1999). Cartoons combine visual elements with the texts written in the form of dialogues (Keogh and Naylor, 1999). The portrayals of groups which are composed of 3 to 5 students and have different expressions or explanations are embedded. These student statements and dialogues, mostly in the form of dialogue boxes, include misconceptions and/or alternative conceptions. One of the most important characteristics of concept cartoons is the fact that amongst many statements raised by students in the cartoons exists -only- one scientifically acceptable explanation. Other statements -while scientifically incorrect- “are not ridiculously implausible and are often based on students’ experiences and/or intuitions” (Stephenson & Warwick, 2002). Concept cartoons can reveal the students’ misconceptions, make high participation class discussions possible on the causes of them, make students enthusiastic about learning, consequently can eliminate existent misconceptions. The concept cartoons appear to be an effective stimulus for a form of argumentation in primary science (Naylor, Downing & Keogh, 2001). Children respond positively to them, engage in focused discussion and put forward and defend alternative viewpoints. The process of argumentation appears to be purposeful, frequently leading to scientific investigation and enquiry as a way of resolving the argument. By making the learners’ ideas explicit the cartoons support the teacher in the elicitation process. This knowledge can then be used to inform the subsequent teaching, extending the range of restructuring strategies. Practical investigations stemming from the cartoons allow the students to explore their own ideas but within the context of specific curriculum objectives. Keogh and Naylor (1999) found that concept cartoon approach in teaching science enhances motivation, provides a purpose for practical work, minimizes classroom management problems by the focused discussion that keeps the pupils on task, enables finding out students’ ideas prior to teaching, and provides a manageable way to plan and carry out the teaching according to students’ ideas. Thereby researchers think that teaching via concept cartoon is effective in remedying misconceptions. Similar findings were also reported by other researchers (Keogh & Naylor, 1997a; 1997b; Keogh, Naylor, & Wilson, 1998).

Kabapınar (2005) in her study investigated the potential benefits of teaching via concept cartoons. In the study, Firstly, a number of case studies were conducted in different primary science classes (4th and 5th grades) to study concept cartoons’ effectiveness. Students’ ideas were determined both individually via written probes and during classroom interactions. The results of the case studies indicated that the concept cartoons were effective for finding out students’ ideas without being affected by the ideas of others. Secondly, a number of case studies were conducted to determine the effectiveness of concept cartoon teaching. Results showed that concept cartoon teaching was effective in creating focused discussions where reasoning behind students’ misconceptions could be uncovered, especially via teachers’ thought-provoking questions. The results of these experiments indicated that teaching via concept cartoons was effective in remedying the misconceptions. It needs to be emphasized that the success of teaching does not only stem from the concept cartoons itself as a teaching material but it also stems from the quality of classroom interactions during the discussion and investigation phases of the teaching.

Balum, Inel and Evrekli (2008) in their research used concept cartoons for 7th grade science classes and determined that concept cartoons have affected students’ enquiry learning skill perceptions by helping students to enquire new knowledge with their existing experiences. There are also researchers who claim that concept cartoons may be efficient tools in order to identify student misconceptions (İngeç, Yıldız and Ünlü, 2006 cited in Ekici et al, 2007) and remedy them (Saka, et al, 2006 cited in Ekici et al, 2007 ).

2. The Aim of the Research

The aim of the research is to determine the effects of using concept cartoons on students’ science achievements and misconceptions about nutrition and food chains. According to constructivist approach, students are supposed to be active in the construction process of their knowledge. Therefore, the use of concept cartoons which provide students to participate in learning process and to help them learn in a more concrete way to learn meaningful by creating a discussion environment is of great importance. Using new visual and conceptual techniques can affect students’ views by providing them to take an active role in learning process by sharing and discussing ideas, investigating their hypothesis, reasoning about observations.

3. Method

This study is based both exploratory and explanatory design. In this study, the effects of the computer aided concept cartoons on learning outcomes in science and technology education are explored. For this, computer aided concept cartoons were used in 4th grade science and technology class, in “Classification of Living Things” subject, and effects of concept cartoons on academic achievement, and misconceptions are tried to be understood.

The study is held with 4th grade students in an elementary school which is placed in İzmir. Experimental group and the control group were determined randomly. Pre-tests and post-tests were applied for both groups. Interviews about concepts to determine students’ misconceptions are also done by researchers.

In order to investigate the effects of cartoons on students science achievement, science achievement test was prepared by the researchers and pilot study was done for revealing reliability and item quality. Pilot test was applied for 390 elementary students and a KR 20 result is found .87 as it is acceptable for the achievement tests.
Besides, interviews were done in order to determine the differences of ideas held by students between the beginning and the end of the learning process. An interview about an instance is a deep probe of the student’s understanding of a single concept that checks whether the student can not only recognize the concept is present in specific instances but also the student can explain his or her decision. The explanation reveals the quality of the student’s understanding. Interviews about events are similarly deep and sharp probes, though the target now is not ability to recognize presence of a concept but ability to explain a phenomenon (White and Gunstone, 1992).

In this study interviews about instances and events were used to probe students’ conceptions about nutrition and food chains. Pictures of living organisms were showed to the students and asked how they provide their energy, and form a food chain. And their reasons were also asked.

Data obtained from science achievement tests was analyzed by using SPSS 15.0 program. Qualitative data obtained from interviews were analyzed by content analysis.

4. Participants and Process

Study group was consisted with 39 4th grade students. Computer aided concept cartoons were prepared for the unit of Living Things. Review of literature show that children at both ages have naive ideas about ecology, nutrition and food chains. Çetin, Ertepınar and Geban (2004) say ecology is one of the key concepts in most biology syllabuses, there are some studies on students’ misconceptions on ecology (Adeneyi, 1985; Çetin, 1998; Griffiths and Grant 1985; Hellden, 1992a; Hellden, 1992b; Hogan and FisherKeller, 1996; Keng, 1997; Leach, 1995; Özkan, 2001; Web and Bolt, 1990 cited in Çetin et al, 2004). Students had several alternative conceptions about food chain, energy flow, and pyramid of energy, and the carbon cycle. The findings of the study showed that a few of them appeared after instruction, although some of these misconceptions might have existed before instruction and also students’ prior misconceptions tended to block understanding of new concepts and generalizations (Çetin et al, 2004).

By using these alternative conceptions, cartoons were prepared for reflecting students’ misconceptions and also were animated and voiced by using computer animations. Elementary grade class teachers gave lessons for both experiment and control groups. Researchers observed the process, and done interviews before and after the application. In experimental group concept cartoons were used for revealing students ideas before they start learning activities. Cartoons were showed by beamer; teacher invited them to share their ideas. Students wrote their opinions and in class discussion were held.

5. Findings

5.1. Findings about science achievement test

Science achievement test prepared by the researchers was applied both as pre test and also post test in the experimental process. Data obtained from science achievement test is analyzed at the beginning of experiment in order to determine the level of experimental and control groups. Table 1 shows the results of pre-test scores and t-test results for experimental and control groups.

| Group       | N   | Mean   | Std. Deviation | t   | Sig. |
|-------------|-----|--------|----------------|-----|------|
| Pre-test    |     |        |                |     |      |
| Experimental| 19  | 11.7368| 4.23           | .856| 1.29 |
| Control     | 20  | 11.5000| 3.85           |     |      |

It can be seen on Table 1, there is no significant difference between two groups. It is interpreted that two groups are similar at the beginning of unit. In order to find the difference between pre tests and post test scores, and to understand the effect of concept cartoon on students’ achievements, ANOVA for repeated measures is applied to both groups. In table 2, descriptive statistics of pre-test and post-test results are given below.

| Group       | N   | Mean   | Std. Deviation |
|-------------|-----|--------|----------------|
| Pre-test    |     |        |                |
| Experimental| 19  | 11.7368| 4.23           |
| Control     | 20  | 11.5000| 3.85           |
| Post-test   |     |        |                |
| Experimental| 19  | 16.6842| 4.50           |
| Control     | 20  | 14.1000| 4.45           |
It can be seen on Table 2, experimental group gained 11.74 and raised 16.68; control group had 11.50 and raised 14.10 for science achievement test. It can be seen groups increase in science achievement tests. In order to investigate significant difference between two groups’ means, ANOVA for Repeated Measures is done. Results can be seen in Table 3.

Table 3. ANOVA for Repeated Measures Results of Science Achievement Test Scores

| Source                      | Type III | df | Mean Square | F    | Sig.  |
|-----------------------------|----------|----|-------------|------|-------|
| Sum of Squares              |          |    |             |      |       |
| Between subject             |          | 38 | 14217.23    | 429.87 | .000  |
| Grup (Case /Group)          |          | 1  | 14217.23    |      |       |
| Error                       |          | 37 | 33.073      |      |       |
| Within subject              |          | 39 | 277.51      | 86.38 | .000  |
| (Pre test- Post test )      |          | 1  |             |      |       |
| Group*Scale                 |          |    | 26.84       |      | .006  |
| Error                       |          | 37 | 3.21        |      |       |
| Total                       |          | 77 |             |      |       |

According to Table 3, there is significant difference between two groups (F=8.36; p<.05). Therefore it can be said that increase of test grades between two applications of achievement test is significant in favor of experimental group. It is interpreted that concept cartoons based learning atmosphere affected students’ achievement positively.

5.2. Findings about misconceptions of students about nutrition and food chain:

At the beginning and at the end of the unit, 16 students were interviewed about nutrition of living organisms and asked to form food chain about living things. In experimental and control group, 16 students with different achievement level were chosen purposely to provide maximum diversity. Students were presented different pictures of living things and they explained the relationship between each other and formed food chain of the living things presented in picture format.

The students’ level of understanding for open-ended question was assessed using a concept evaluation technique used by Abraham et al. (1994). The open-ended question was analyzed under the following categories:
- **Sound Understanding (SU)**: Responses that included all components of scientific conceptions.
- **Partial understanding (PU)**: Responses that included at least one of the components of validated response, but not all the components.
- **Partial understanding with specific misconception (PUSM)**: Responses that showed understanding of the concept, but also made a statement, which demonstrated a misunderstanding
- **Specific Misconception (SM)**: Responses that included illogical or incorrect information.
- **No Understanding (NU)**: Repeated the question; contained irrelevant information or an unclear response; left the response blank.
- **No Response (NR)**: “No answer; I don’t know; I have no idea”

Table 4. Children’s Responses of Question about Food Chain

| Item: Explain the food chain of living things below | Pre-test | Post-test |
|---------------------------------------------------|----------|-----------|
|                                                   | Control group | Experimental group | Control group | Experimental group |
|                                                   | f | %     | f | %     | f | %     | f | %     |
| SU: Correct representation of food chain, and correct explanation | 2 | 25 | 1 | 12.5 | 4 | 50 | 7 | 87.5 |
| SM: Responses that included illogical or incorrect information about food chain (Giving alternative food chains) | 5 | 62.5 | 6 | 75 | 4 | 50 | 1 | 12.5 |
| No Response (NR): “No answer; I don’t know.” | 1 | 12.5 | 1 | 12.5 | - | - | - | - |

According to Table 4, both experimental and control group students have different views about food chains. At the beginning of the unit, they have similar misconceptions about feeding. Some of the alternative frameworks of students are given below:

5.3. Examples of alternative conceptions from pre-test interviews

“Plants don’t eat anything” (Experimental group; age 10; male)
“Plants drink water, and eat seeds” (Experimental group; age 10; male)
“Plants use water and soil to feed on” (Experimental group; age 10; female)
“Plants feed on water” (Control group; age 10; female)

5.4. Examples of alternative conceptions from post-test interviews

“Lizard eats plants” (Control group; age 10; male)
“Animals are fed on animals that is apparently smaller body” (Control group; age 10; female)
“Plants provide their energy from soil and water” (Control group, age 10; male)
“Plants provide energy from water and seeds” (Experimental group, age 10; female)

It can be seen from the examples of children’s views students have some alternative viewpoints about nutrition of living things different from scientifically accepted views. The misconception research indicates that many students have misconceptions about food chains. Although they may have internalized the idea of a food chain, many students do not understand the idea of a food web or the complexities of interactions that occur within a food web. Also these results were consistent with the previous studies.

Bell (1996) reviewed the work of Simpson and Arnold, Roth, Smith and Anderson and Driver et al, as well as her own work within the Children’s Learning in Science Project. The universal and very persistent intuitive conception, identified in all studies with subjects of all ages is that, plants get their food from their environment, specifically from the soil; and that roots are the organs of feeding (cited in Driver et al, 1994).

Table 4 shows that, number of misconceptions held by both experimental and control group decreased, on the other hand change in control group was not sufficient. Despite the fact that, they exposed a 6 weeks education, students still have alternative conceptions about food chains and nutrition of livings. Because of the fact that misconceptions are stable elements of an individual's conceptual framework and highly resistant to change. Traditional teaching is unlikely to change a student's conceptual understanding (Champagne & Kloper, 1983; Champagne, Kloper, & Gunstone, 1982; Clough & Driver, 1986; Driver & Erickson, 1983; Driver et al., 1985; Hewson & Hewson, 1988; Osborne & Freyberg, 1985; Posner, Strike, Hewson, & Gertzog, 1982 cited in Munson, 1994). As Hewson and Hewson (1988) indicate that educators will not be successful if they simply try to fill the apparent void of knowledge for the individual student. Instead, they will have to present students with experiences that encourage them to abandon their misconceptions in favor of scientifically acceptable conceptions. Since, misconceptions are resistant to change, the reason is that misconceptions are developed by the students as a result of their observations in a long period of time and are invaluable for themselves (Yağbasan & Gülçiçek, 2003). The difference in decreasing of misconceptions between treatment group and control group, it can be said that computer aided concept cartoons served as an effective tools for conceptual change.

6. Conclusion

As a result of the study it is interpreted that concept cartoons based learning atmosphere affected students’ achievement positively.

The findings of our study are quite compatible with the findings of literature and support them. The assertions of many researchers (Keogh, Naylor & Wilson, 1998; Keogh & Naylor, 1999; Stephenson & Warwick, 2002) which have been supported during our study are: concept cartoons (1) help in elicitation of student misconceptions in a short time, (2) provide opportunity for students’ discussion about the causes of these misconceptions, (3) create an environment where all students participate during class discussions, activate them to support their ideas, and consequently (4) remedy their misconceptions. Both the findings of achievement test scores and student-interviews show that this study is compatible with the aims in the literature.

Using concept cartoons is one of the ways that reveal students’ existing knowledge and remedying misconceptions about scientific phenomena. In this study results of using concept cartoons in science teaching is consistent with other researches (Kabapınar, 2005; Saka, 2006; Ekici et al, 2007; Evrekli, İnêl and Çîte, 2006). Results showed that using concept cartoons have positive effects on students’ science achievement and remedying misconceptions by providing social interaction process. In addition, it is accepted that learning should be viewed as a social process with the concept cartoons acting as a tool for both developing and expressing conceptual constructivism in the classroom is possible within the tight constraints of a curriculum. Dabell (2004) states the importance of social interaction and communication when concept cartoons are used cooperatively. Concept cartoons may also be used as a starting point to encourage students during class discussions and identify their prior knowledge (Bing and Tam, 2003).

According to Ballantyne and Packer (1996) group-learning and cognitive-conflict strategies provide a means of developing students’ environmental conceptions using a knowledge-based approach. The educational value of these techniques will be optimized as environmental educators guide their application with an awareness of students’ current and alternative environmental conceptions. Scenarios could be structured and designed to confront them with new knowledge that would highlight the inconsistencies within and the consequences of their own and others’ conceptions. Thus, students would be challenged to reevaluate their understanding of and response to environmental issues. In this study computer aided concept cartoons achieved this goal. And it was found that, cartoons were useful for making class interactions possible and, it is appropriate for revealing children’s ideas about scientific phenomena. In this study, it is clearly observed that students were encouraged to discuss, and in some cases argue about, appropriate responses to the scientific questions and problems presented.
through the computer aided concept cartoons. But it isn’t just accomplished by cartoons, that is also depends on the manner of teachers providing flexible, social and inquiry based class atmosphere.

This study was limited with the nutrition and food chain subject. Further studies can be done for both 4th and 5th grade science subjects. Also this study focused on the achievement and misconceptions of the students, it is recommended to investigate the effects of cartoons on social interactions, students’ motivations, and students’ metacognitive skills.

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