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Concept Cartoons Supported Problem Based Learning Method in Middle School Science Classrooms

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Abstract

Problem based learning, in which events from daily life are presented as interesting scenarios, is one of the active learning approaches that encourages students to self-direct learning. Problem based learning, generally used in higher education, requires students to use high end thinking skills in learning environments. In order to use effectively for secondary students, concept cartoons can be integrated to problem based learning environment. Concept cartoons provide alternative views and help students at problem solving stage. So, in this study the effects of concept cartoons and problem based learning on students' inquiry learning skill perceptions and levels of relating knowledge with daily life were examined. Two experiment groups and one control group were formed and pre test-post test control group quasi experimental design was used in this research. During four weeks experimental practice, courses were continued with concept cartoon integrated problem based learning in experiment group 1 while only problem based learning was used in experiment group 2 and science program activities was used in control group. 553 sixth grade students (13-14 age group) from 9 different middle schools in Turkey participated in this study. Inquiry learning skills perception scale and knowledge-daily life relating open ended questions were used as data collection tools. In the result of the data anaylsis, it was found that students' inquiry learning skill perceptions scores differ significantly in favor of experiment groups. However, no significant difference found between groups in terms of knowledge-daily life relation scores.

Keywords: problem based learning, concept cartoons, inquiry based learning

1. Introduction

1.1 Introduce the Problem

Scientific concepts and principles provide an explanation to individuals about the fundamental scientific phenomena they encounter in daily life. Individuals who learn science can use their knowledge in daily life, thus their knowledge is permanent and they are motivated about learning new scientific concepts. Today, various studies are being done about different teaching methods to improve the effectiveness of learning science and students' different learning abilities. Learning is a lifelong activity and the lifelong learning of students is important. A problem based learning method helps students to develop lifelong learning and their abilities to discuss, inquire and think critically (Schmidt et al., 2009). Similarly, concept cartoons encourage students to ask questions, express their thoughts and develop thoughts (Keogh & Naylor, 2000; Long & Marson, 2003). Therefore, it is thought that concept cartoons support problem based learning and contributes to students' inquiry learning skills, and their ability to relate knowledge with daily life.

1.2 Problem Based Learning

Problem based learning is defined as one of the methods that helps students to be active in the learning process and emphasizes learning in the problem solving process. Students have to use different cognitive abilities such as inquiry, research and problem solving in the learning process (Severiens & Schmidt, 2009). Problem based learning, which has come to prominence in recent years was first used at McMasters University faculty of medicine in 1969 (Woltering et al., 2009). After positive results were found in medical faculties, problem based learning has been used in the fields of nursing, pharmacy and dentistry (Wilkinson, 2009). Problem based learning, which is a student centred learning method, and uses daily life problems in a semi-structured form

during the learning process (Lin et al., 2010), encourages students to learn (Lee & Bae, 2008). In a problem based learning process, students work together and structure their own knowledge by inquiring, searching and problem solving. Thus, it is possible to say that the foundations of problem based learning depend upon cooperative learning principles (Wang et al., 2008). Problem based learning emphasizes self learning, because it requires students to direct their own learning (Finch, 1999). Self directed learning requires high end thinking skills such as research, critical thinking, problem solving, inquiry, analysis and logical thinking, from the definition of a problem to find the solution of a problem (Chaves et al., 2006). It is possible to say that problem based learning may improve students' lifelong learning skills, such as critical thinking, because students use these skills in the learning process (Chou & Chin, 2009). Also, it helps the process of knowledge construction by helping current knowledge to reveal and relate with prior knowledge (Williams & Pace, 2009).

In problem based learning the learning process begins after students need to solve a problem taken from daily life (Shamir, Zion, & Levi, 2008; Şahin, 2010). Thus, problems that encourage students to learn are of great importance. The choice and design of problems provides a preparation phase for the application of problem based learning in the learning process (Hung, 2009). Problems used in problem based learning practices are semi-structured problems from daily life. Problems are prepared with interesting scenarios and shaped in a semi-structured form. Semi-structured problems are similar to problems encountered in daily life (Şendağ & Odabaşı, 2009). Thus, a problem based learning process helps students to solve problems encountered in daily life. In problem based learning, which starts after the presentation of a problem (Yew & Schmidt, 2009), students try to solve problems from their prior knowledge and the knowledge obtained after research (Sockalingam, Rotgans, & Schmidt, 2011). Problem based learning practice is conducted with small groups consisting of 6-8 students (Abou-Elhamd, Rashad, & Al-Sultan, 2011). Therefore, students' cooperative working skills are an important aspect in the effectiveness of the problem based learning method (Tarmizi et al., 2010). Students who work in groups try to define the problem's situation, understand the problem, communicate each other, and define the knowledge needed to solve the problem (Yuan, Williams, & Fan, 2008). After students define their issues, they focus on solving the problem (Wang et al., 2008). In problem based learning students direct their own learning by exchanging views, instead of teacher centred learning (Delisle, 1997). Teachers who act as a leader encourage students to analyse and produce solutions for problems (Annerstedt et al., 2010; Searight & Searight, 2009; Yew & Schmidt, 2009). Leaders are an important part of problem based learning and supervise the whole learning process (Turan et al., 2009; Schmidt et al., 2009). Both help student discussions and rarely explain complex concepts (Charlin, Mann, & Hansen, 1998). In addition, leaders quide student groups by supporting interactions between students and help them to determine the knowledge required for solving the problem (Gijselaers, 1996). Problem based learning, which requires more tasks and responsibilities than other learning methods, encourages students to use high end thinking skills during the learning process. Thus, this learning method is generally used in high schools and universities. Various teaching methods and visual tools may be used in order to make problem based learning more appropriate to lower secondary education level. One of these visual tools might be the concept cartoon.

1.3 Concept Cartoons

Concept cartoons are visual tools in which cartoon characters declare views about an event from daily life (Keogh, Naylor, & Wilson, 1998; Sexton, Gervasoni, & Brandenburg, 2009). In concept cartoons, which were developed by Keogh and Naylor (1999b), cartoon characters are used to encourage students to discuss (Morris et al., 2007) and short texts are used as dialogues to help students solve issues (Chin & Teou, 2010; Naylor, Downing, & Keogh, 2002). Ideas of cartoon characters include logical thoughts about daily life from different points of view (Uğurel & Moralı, 2006). Concept cartoons might be declared a good starting point for class discussions because they present similar views of students (Kinchin, 2004). In the discussion process, which starts via cartoon characters, students are quided to reach scientifically correct ideas (Kabapınar, 2005). Thus, the most important aspect of concept cartoons is routing them to discussion, and encouraging them to reveal their individual views via presenting different scientific views from cartoon characters (Naylor, Keogh, & Downing, 2007; Sexton, 2010). Concept cartoons quide learners to inquire about reasons for their answers, compare their views to cartoon characters, and search for evidence for their answers (Dabell, 2008). Therefore, students are encouraged to verify scientific thoughts and complete conceptual change by removing misconceptions (Chin & Teou, 2009). According to Akamca, Ellez and Hamurcu (2009), concept cartoon is one of the techniques that can be used to reveal prior knowledge and remove misconceptions. Concept cartoons that are used as a tool for conceptual change may provide a social environment for the learning process (Stephenson & Warwick, 2002). Students can explain their own views and share them in social environments via concept cartoons. In addition, the use of concept cartoons is easy because they are easy to prepare. Concept cartoons encourage younger

students to be curious and improve their inquiry skills (Long & Marson, 2003).

1.4 Literature Review about Problem Based Learning and Concept Cartoons

The problem based learning method was first used in medical faculties, thus most of the studies about problem based learning have been conducted in medical faculties (Drake & Long, 2009; Likic et al., 2009). Raupach et al. (2010) indicated that using web supported, problem based learning, increases the academic achievements of medical students. Similarly, Distlehors, Dawson and Klamen (2009) used problem based learning on medical students and determined that problem based learning improves students' communication skills. The successful results of studies in the medical field encouraged educators to use and conduct studies about problem based learning in law, business and education faculties (Chen, 2008; Demirel & Turan, 2010; McCall, 2010). Studies showed that problem based learning improved several abilities in higher education students (Amador, Miles, & Peters, 2006), and directed the focus of studies on high school and middle school students. In the literature studies have examined the effects of problem based learning on student views and perceptions (Hatısaru & Küçükduran, 2009; Sockalingam, Rotgans, & Schmidt, 2011), build students' arguments, and develop creative thinking and problem solving skills (Belland, 2010; Belland, Glazewski, & Richardson; 2011; Drake & Long, 2009; Lim, 2011). In order to use problem based learning effectively in lower age classes (Ertmer et al., 2009), studies in this field continue. Thus, different techniques might be used to increase the effectiveness of problem based learning in lower age groups.

Concept cartoon, which is one effective technique, was first used as a teaching strategy in London subway stations by Keogh and Naylor (1999b). After proven to be effective, concept cartoons were used in learning environment studies. Various studies examined the effects of concept cartoons on students' argumentation skills (Cavagnetto, 2010; Naylor, Keogh, & Downing, 2007), academic achievements and science learning (Akamca, Ellez, & Hamurcu, 2009; Dalacosta et al., 2009; Doğru, Keles, & Arslan, 2010), and logical thinking skills (Şengül & Üner, 2010). There are also studies that use concept cartoons in problems in daily life scenarios. For example, Cengizhan (2011) determined that presenting concept cartoons with daily life scenarios provides students with different ideas and points of views. Similarly, Oluk and Özalp (2007) indicated that using concept cartoons with problem based learning, improves students' knowledge and consciousness about the global environment. Problem based learning and concept cartoons quide students to inquire about events they encounter in daily life. Thus, this study examines the effects of concept cartoons and problem based learning on students' inquiry learning skill perceptions and levels, or relating knowledge with daily life. The research problems are as follows.

1) Is there any significant difference between the concept cartoon integrated problem based learning experiment group 1, the only problem based learning experiment group 2, and the science and technology programme content control group, on students' post-test inquiry learning skill perceptions?

2) Is there any significant difference between the concept cartoon integrated problem based learning experiment group 1, the only problem based learning experiment group 2, and the science and technology programme content control group, on students' post test levels of relating knowledge with daily life?

2. Method

In this study, the non-equivalent pre-test/post-test control group with quasi-experimental design was used to determine the effectiveness of the concept cartoon in integrated, problem based learning (Bulduk, 2003; Christensen, 2004; Marczyk, DeMatteo, & Festinger, 2005; Cohen, Manion, & Morrison, 2005; Balcı, 2005; Karasar, 2006). A symbolic view of this research was given in Table 1.

Table 1. Symbolic view of research

Groups	Pre-Test	Process	Post-Test
Experiment Group-1	*T1-T2*	*Problem Based Learning- Concept Cartoon*	*T1-T2*
Experiment Group-2	*T1-T2*	*Problem Based Learning*	*T1-T2*
Control Group	*T1-T2*	*Science and Technology Teaching Program*	*T1-T2*

T1=Inquiry learning skills perception scale, T2=Knowledge-daily life relating open ended questions

In this study, two experimental groups and one control group were formed. In experimental group 1, courses continued with concept cartoon integrated problem based learning, while only problem based learning was used in experimental group 2. Science and technology programme activities were used in the control group. The experimental process took 16 hours in each group. An inquiry learning skills perception scale and knowledge-daily life relating open ended questions were used pre-test and post-test in terms of this study.

2.1 Participants

Because of the quasi-experimental design, a workgroup was formed instead of sampling. The workgroup consisted of sixth grade students (13-14 age group) studying in 27 classes of 9 different schools located in the central districts of İzmir. The students who participated in this study (n=553) consisted of 47.6% (n=263) male students, and 52.4% (n=290) female students. Thirty-two per cent (n=177) of participants continued in courses with concept cartoon integrated problem based learning, while 33.8% (n=187) continued with problem based learning, and 34.2% (n=189) continued with a science and technology teaching programme. When the students' mothers educational level was examined, it was found that 5.2% (n=29) could not read-write, 38.9% (n=215) were primary education graduates, 20.4% (n=113) were lower secondary education graduates, 23.7% (n=131) were secondary education graduates, and 10.1% (n=56) were licensed graduates. When the students' fathers educational level was examined, it was found that 2% (n=11) could not read-write, 29.8% (n=165) were primary education graduates, 26.9% (n=149) were lower secondary education graduates, 26.8% (n=148) were secondary education graduates and 12.5% (n=69) were licensed graduates.

2.2 Procedure

In terms of the research, 27 classes were defined from nine different schools as two experiment groups and one control group in every three classes. In experiment group 1, courses continued with concept cartoon integrated problem based learning, while in experiment group 2 courses continued with problem based learning only; the control group courses continued with science and technology programme content. In experiment group 1, modules consisted of scenarios appropriate to the objectives of the education programme and concept cartoons integrated into scenarios were used.

Ali and his summer friends decided to play in park. Ali met with his friends in park after he wore his black shirt. From Ali's friends, Bahar wore a shiny shirt while Batu wore a white shirt. Three friends realised that weather was so hot after playing under sun. But they could not decide who feel more heat and why.

Figure 1. The examples of scenario and concept cartoon used in the study

In experiment group 2, modules consisting only of scenarios were used. Experimental practice was conducted on a sixth grade "matter and heat" unit. The modules prepared for these groups were appropriate to 16 hours experimental practice and each module took 4 hours in a week. Courses continued with the same science and technology teachers who were familiar to the students. Students in experiment group 1 searched for solutions to problems in the scenarios in terms of the views in the concept cartoons. Students in experiment group 2 group approached scenarios without the aid of concept cartoons. Experimental practice in the control group continued with textbook content and activities in the science and technology education programme. An "Inquiry learning skills perception scale" and a "Knowledge-daily life relating open ended questions" were applied pre-test and post-test, before and after experimental practice.

2.3 Data Collection Tools

2.3.1 Inquiry Learning Skills Perception Scale

An inquiry learning skills perception scale developed by Taşkoyan (2008) was used in this study to determine students' inquiry learning skills perceptions. A pilot study of this scale was applied to 246 female and 255 male students: a total of 501 students. After analysis of the pilot study data, three factors have been defined in the scale. Reliabilities of these factors were determined as .67, .73 and .77; the reliability coefficient of the full scale was .94. The maximum score that can be taken from the scale is 110, while the minimum score is 22. In this study, the cronbach alpha coefficient of the scale was recalculated and found as 0.88 for pre-test and 0.89 for post-test.

2.3.2 Knowledge-Daily Life Relating Open Ended Questions

In this study, "knowledge-daily life relating open ended questions" were prepared in order to determine students' existing level of knowledge of "matter and heat" in daily life. Expert views were taken from three academics and one science and technology teacher in order to determine the validity of open ended questions. The corresponding values of experts were .86 for the questions' scientific knowledge adequation, and .90 for language-writing-explanation rules' adequation. After expert views, the questions were formed into the final version and given to 35 students to determine if they were adequate, or if corrections were required. Questions that could not have been understood by students were extracted or corrected, and a final version of the form produced. The final version of the open ended questionnaire consisted of 5 questions. In data anaylsis of open ended questions, a four point scoring system was used in the form. In this system a completely correct answer was given 3 points; a partially correct answer was given 2 points; a partially correct and partially wrong answer was given 1 point; and completely wrong answer or no answer was given 0 point. The data from the knowledge-daily life relating open ended questions was analysed by experts. Data from each of the 9 schools was given to one expert for analysis. Thirty, random, open ended question forms were analysed by each of experts (n=9) to determine reliability. The expert aggrement percentage was calculated with correlation analysis. According to the results of the analysis, the aggrement correlation coefficient of "Knowledge-daily life relating open ended questions" was calculated and found to be .82 and the pearson correlation coefficient was found to be .94. Open ended questions asked to students were given as follows.

- Our mothers turn jars upside down and put in hot water when they can not open them. By this way jar's cover expands and opens easily. Why do you think jar's cover expand?
- In a cold winter day, we prefer to sit down on wooden seats instead of stone or metal seats. Why do you think we feel cold less on wooden seats?
- What is the reason of lining inside of thermos with shiny surface in order to keep drinks warm?
- In winter time we can see that curtain on a heater moves, why do you think curtain moves?
- Why do you think outside of modern buildings are lined with shiny windows like mirrors?

3. Findings

In this part of study, findings and comments about research question "What is the effect of the using of the concept cartoon integrated problem based learning method (experiment group 1), the only problem based learning method (experiment group 2), and the science and technology programme content (control group) in science teaching on students' levels of relating knowledge with daily life and inquiry based learning skills?" were presented. Parametric statistic methods were used because the amount of data were adequate (n=553) and the distrubiton of data is similar to normal distribution. Descriptive statistics about quantitative data collected from study were given in Table 2.

Table 2. Descriptive data about quantitative findings of the study

Dependent variable	Experiment group 1* (n=177)				Experiment group 2* (n=187)				Kontrol Grubu (n=189)			
	Pretest		Posttest		Pretest		Posttest		Pretest		Posttest	
	$\bar{X}$	S	$\bar{X}$	S	$\bar{X}$	S	$\bar{X}$	S	$\bar{X}$	S	$\bar{X}$	S
ILSP*	96,15	10,90	99,17	10,54	94,20	11,63	97,17	11,25	94,68	10,60	95,83	11,33
RKDL*	2,02	2,26	4,98	3,80	1,27	1,64	4,14	3,32	1,12	1,60	4,03	3,38

* Experiment 1=Problem Based Learning and Concept Cartoons, Experiment 2=Problem Based Learning, ILSP=Inquiry Learning Skill Perceptions, RKDL=Relating Knowledge with Daily Life

Results show that there is a significant difference between groups' pre-test levels of relating knowledge with daily life scores ($F(2,552)=12.23$, $p=.000$) while there is no significant difference between groups' inquiry based learning skill perception scores ($F(2,552)=1.52$, $p=.220$). Therefore, MANCOVA was used in analysis of data obtained from participants. In addition, effect sizes were determined to evaluate the effect of teaching method on dependent variables as independent from sample. According to first analysis results of Box' M test and Levene test, data were determined as same covariance matrix and error variances ($p>.01$). Thus, the effects of independent varibles on dependent variables were examined by using MANCOVA. Results were given in Table 3.

Table 3. MANCOVA results according to quantitative data obtained from research

		Sum of Mean Squares	**df**	**Mean square**	**F**	**p**	**Partial eta square**
Corrected model	Posttest ILSP	42083,627	6	7013,94	146,254	.000	.616
	Posttest RKDL	2274,633	6	379,10	45,208	.000	.332
Pre-test ILSP	Posttest ILSP	11838,04	1	11838,04	246,84	.000	.311
	Posttest RKDL	4,52	1	4,52	.539	.463	.001
Pre-test RKDL	Posttest ILSP	200,74	1	200,74	4,18	.041	.008
	Posttest RKDL	477,92	1	477,92	56,99	.000	.095
Group	Posttest ILSP	336,51	2	168,25	**3,50**	**.031***	**.013**
	Posttest RKDL	11,78	2	5,88	**.70**	**.496**	**.003**
Error	Posttest ILSP	26184,61	546	47,95			
	Posttest RKDL	4578,63	546	8,38			

* $p<.05$ significant

Results show that there was a significant difference between groups' post test inquiry based learning skill perceptions, no significant difference between participants' post test relating knowledge with daily life scores. Corrected MANCOVA scores of groups were given in Table 4.

Table 4. Participants' corrected post test score means according to MANCOVA results

	Post test ILSP	Post test RKDL
Experiment 1 (PBL+CC)	98,14	4,51
Experiment 2 (PBL)	97,96	4,17
Control	96,28	4,44

In the result of statistical analysis of quantitative data, acquired results and interpretations of each sub problems were given as follows.

3.1 First Sub-Question Findings

Data was analysed using MANCOVA to answer the sub-problem of this research: "Is there any significant difference between the concept cartoon integrated problem based learning experiment group, the only problem based learning experiment group, and the science and technology programme content control group, on students' post-test inquiry learning skill perceptions?". According to the results of the analysis, it was found that the participants' post-test inquiry learning skill perceptions differed significantly ($F(2,546)=3.50$, $p=.031$, $\eta p2=.013$). When statistics between the groups were examined significant differences in favour of the experiment groups were found. For example, significant differences were found between the concept cartoon integrated problem based learning experiment group 1 and the control group (MD=1.85, SE=.74, p=.012), and between the only problem based learning experiment group 2 and the control group (MD=1.41, SE=.72, p=.050). When the results between the experiment groups were examined, no significant difference was found (MD=.442, SE=.74, p=.551). According to the results, we can say that concept cartoon integrated problem based learning and only problem based learning can cause a significant difference on students' inquiry learning skill perceptions. In addition, we can say that using concept cartoons integrated into problem based learning has no direct effect on students' inquiry learning skill perceptions.

3.2 Second Sub-Question Findings

Data was analysed using MANCOVA to solve the sub-problem of this research: "Is there any significant difference between the concept cartoon integrated problem based learning experiment group, the only problem based learning experiment group, and the science and technology programme content control group, on students' post test levels of relating knowledge with daily life?", According to the results, it was found that participants' scores on the post-test open ended questions differed significantly ($F(2,546)=.70$, $p=.496$, $\eta p2=.003$). When comparative statistics between the groups were examined no significant difference was found in favour of the experiment groups. For example, there were no significant differences between the concept cartoon integrated problem based learning experiment group 1 and the control group (MD=.08, SE=.31, p=.791), or the only problem based learning experiment group 2 and the control group (MD=.27, SE= .30, p=.378). According to the results, we can say that concept cartoon integrated problem based learning and only problem based learning have no significant effect on students' levels of relating knowledge with daily life.

4. Discussion and Conclusion

This study aimed to determine the effects of concept cartoon integrated problem based learning on students. In the first sub question of this research, significant differences were found between the mean scores of the experiment and control groups' corrected inquiry learning skill perception scale. When comparative statistics between the groups were examined, significant differences were found in favour of the experiment groups. For example, between the concept cartoons integrated problem based learning experiment group 1 and the control group, and the only problem based learning experiment group 2 and the control group. When the results between experiment groups were examined, no significant differences were found. The results have shown that the inquiry learning skill perceptions of students in the experiment groups develops better than students in the control group. According to this result, we can say that using concept cartoon integrated problem based learning and only problem based learning have a positive effect on students' inquiry learning skill perceptions. However, no significant difference between the experiment groups indicates that concept cartoons have no additional effect on students' inquiry learning skill perceptions. Studies indicating the positive effects of concept cartoons on logical thinking, inquiry learning, discussing and questioning, can be found in the literature (Naylor, Keogh, & Downing, 2007; Balım, İnel, & Evrekli, 2008; Özyılmaz-Akamca & Hamurcu, 2009; Şengül & Üner, 2010). However, in those studies concept cartoons were used, or were suggested to be used, as a technique for all learning processes. In the current study, the learning process was formed on problem based learning, and concept cartoons were used as a support tool to make a connection between problem based learning and primary education students. Thus, we can say that the concept cartoon is a supportive tool for increasing student inquisition but does not make a direct contribution on students' inquiry learning skill perceptions when used with problem based learning.

As a summary, according to the results of the first sub question, it was found that students can use their inquiry learning skills in problem based learning environments. In the literature there are studies about the positive effects of problem based learning on students' higher-order thinking skills, such as problem solving skills (Kaptan & Korkmaz, 2002; Yaman & Yalçın, 2005), critical thinking skills (Sönmez & Lee, 2003; Sungur & Tekkaya, 2006) and scientific process skills (Gürses et al., 2007). We can say that an inquisitive learning skill is a lifelong learning skills, like critical thinking, creative thinking and problem solving skills. Individuals use their

inquiry skills while assessing problems, events and situations. Therefore, lifelong learning skills are related and affect each other's development in a positive way. Parallel to this view, Kamin et al. (2001) indicated that defining problems in problem solving process and evaluating solutions logically would increase students' attitudes towards inquiry. Chin and Chia (2004) indicated that problem based learning has an important potential for increasing inquiry in science classrooms. The inquiry process is important in problem based learning environments because it encourages students to question, research, work in cooperation, and question the knowledge they have obtained. According to Wilkinson (2009) research-inquiry is important in the problem based learning process. Students need inquiry learning skills in a learning process with inquiry. In a similar view, in order to solve problems in problem based learning, inquiry skills, basic cognitive skills, problem solving skills are required and the problem solving process improves these skills (Schmidt et al., 2009). Therefore, we thought that students in the experiment groups who used inquisitive learning skills in problem based learning processes, had their perceptions affected in a positive way and this was supported by the current results.

In the second sub question of this research, no significant difference was found between the groups' levels of relating knowledge with daily life. When comparative statistics between the groups were examined, no significant difference was found between the concept cartoon integrated problem based learning experiment group 1 and the control group, nor the only problem based learning experiment group 2 and the control group. When the results between the experiment groups were examined no significant difference was found. The results have shown that using concept cartoon integrated problem based learning and only problem based learning have no significant effect on students' levels of relating knowledge with daily life. According to this result, we can say that concept cartoon integrated problem based learning or only problem based learning have no positive or negative effect on students' levels of relating knowledge with daily life.

One of the main objectives of a science and technology education programme is to increase students' level of knowledge in relation to daily life. In problem based learning, students work in cooperative groups to solve problems from daily life (Neville & Britt, 2007). These groups receive problem situations with scenarios about real life. Relating students' knowledge with real life situations is the main aim of problem solving (Dalhgren & Öberg, 2001; Massa, 2008). However, revealing the effect of knowledge and daily life may require a long process. Sweller (2006) indicated that one of the limitations of problem based learning is cognitive overload. Students have to obtain too much information and it might not be possible for them to process all knowledge. Students might need to use the knowledge they gather from problem based learning process in a daily life situation. One other possible reason for the current result is teachers' inadequate background in the relationship between knowledge and daily life. The effect on students in the experiment groups' levels of relating knowledge with daily life might be revealed in future events. In interviews made within the scope of this study, teachers have indicated that problem based learning modules have a positive effect on students' levels of knowledge in relation to daily life. What is more, in interviews, students indicated that scenarios given in problem based learning encouraged them to relate their knowledge with their daily life and provided a different point of view. We can say these findings are not in parallel with the interview results.

In the literature, there are views indicating that concept cartoons have a positive effect on students' levels of knowledge in relation to daily life (Chin & Teou, 2009; Feasey, 2007; Hatzitaskos & Karacapilidis, 2010; Keogh & Naylor, 1999a; Long & Marson, 2003). In addition, concept cartoons can be used for both encouraging participations in courses and solving daily life problems (Balım, İnel, & Evrekli, 2008; Long & Marson, 2003). From the concept cartoons' point of view, we can say these findings are not in parallel with the literature. When the findings are examined, it can be said that the current result was caused by cognitive overload and concept cartoons' capacity of a limited view. Parallel to this, Hatzitaskos and Karacapilidis (2010) indicated that concept cartoons include a limited number of views. Also, interviews with teachers and students are parallel to this view. In interviews, teachers indicated that concept cartoons include a limited number of views and this might limit students. These limitations might be the reason for the current result. In terms of results and discussions, recommendations of this study were given as follow:

- In order to determine the effects of problem based learning and concept cartoons, future studies should allow sufficient time and have a longer experimental practice.
- The effects of problem based learning and concept cartoons on different variables and with different workgroups can be examined.
- In order to increase the use of problem based learning and concept cartoons, textbooks and internet sites can include examples of problem based learning and concept cartoons.

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References

Abou-Elhamd, K. A., Rashad, U. M., & Al-Sultan, A. I. (2011). Applying problem-based learning to otolaryngology teaching. *The Journal of Laryngology and Otology*, *125*(2), 117-120. http://dx.doi.org/10.1017/S0022215110001702

Akamca, G. Ö., Ellez, A. M., & Hamurcu, H. (2009). Effects of computer aided concept cartoons on learning outcomes. *Procedia Social and Behavioral Sciences*, *1*, 296-301. http://dx.doi.org/10.1016/j.sbspro.2009.01.054

Amador, J. A., Miles, L., & Peters, C. B. (2006). *The Practice of Problem Based Learning: A quide to implementing PBL in the college classroom*. Bolton: Anker Publishing Company.

Annerstedt, C., Garza, D., Huang-DeVoss, C., Lindh, J., & Rydmark, M. (2010). Research-able through problem-based learning. *Journal of the Scholarship of Teaching and Learning*, *10*(2), 107-127.

Balcı, A. (2005). *Sosyal Bilimlerde Araştırma*. Ankara: PegemA Yayıncılık.

Balım, A. G., İnel, D., & Evrekli, E. (2008). Fen öğretiminde kavram karikatürü kullanımının öğrencilerin akademik başarılarına ve sorgulayıcı öğrenme becerileri algısına etkisi. *İlköğretim Online*, *7*(1), 188-202.

Balım, A. G., Inel, D., Evrekli, E., & Kesercioğlu. (2008). *The use of concept cartoons in constructive science and technology education: "The examples about the subject of pressure"*. Izmir, Turkey: XIII. IOSTE Symposium.

Belland, B. R. (2010). Portraits of middle school students constructing evidence-based arguments during problem-based learning: The impact of computer-based scaffolds. *Educational Technology Research and Development*, *58*(3), 285-309. http://dx.doi.org/10.1007/s11423-009-9139-4

Belland, B. R., Glazewski, K. D., & Richardson, J. C. (2011). Problem-based learning and argumentation: Testing a scaffolding framework to support middle school students' creation of evidence-based arguments. *Instructional Science*, *39*(5), 667-694. http://dx.doi.org/10.1007/s11251-010-9148-z

Bulduk, S. (2003). *Psikolojide Deneysel Araştırma Yöntemleri*. İstanbul: Çantay Kitabevi.

Cavagnetto, A. R. (2010). Argument to foster scientific literacy: A review of argument interventions in K-12 science contexts. *Review of Educational Research*, *80*(3), 336-371. http://dx.doi.org/10.3102/0034654310376953

Cengizhan, S. (2011). Modüler öğretim tasarımıyla entegre edilmiş kavram karikatürleri hakkında öğretmen adaylarının görüşleri. *Eğitim ve Bilim*, *36*(160), 93-104.

Charlin, B., Mann, K., & Hansen, P. (1998). The many faces of problem-based learning: A framework for understanding and comparison. *Medical Teacher*, *20*(4), 323-330. http://dx.doi.org/10.1080/01421599880742

Chaves, J. F., Baker, C. M., Chaves, J. A., & Fisher, M. L. (2006). Self, peer and tutor assessments of MSN competencies using the PBL-evaluator. *Journal of Nursing Education*, *45*(1), 25-31.

Chen, N. C. (2008). An educational approach to problem-based learning. *The Kaohsiung Journal of Medical Sciences*, *24*(3), 23-30. http://dx.doi.org/10.1016/S1607-551X(08)70090-1

Chin, C., & Chia L. G. (2004). Problem-Based Learning: Using Students' Questions to Drive Knowledge Constructions. *Science Education*, *88*(5), 707-727. http://dx.doi.org/10.1002/sce.10144

Chin, C., & Teou, L. Y. (2009). Using concept cartoons in formative assessment: Scaffolding students' argumentation. *International Journal of Science Education*, *31*(10), 1307-1332. http://dx.doi.org/10.1080/09500690801953179

Chin, C., & Teou, L. Y. (2010). Formative assessment: Using concept cartoon, pupils' drawings, and group discussions to tackle children's ideas about biological inheritance. *Journal of Biological Education*, *44*(3), 108-115. http://dx.doi.org/10.1080/00219266.2010.9656206

Chou, F. H., & Chin, C. C. (2009). Experience of problem-based learning in nursing education at Kaohsiung Medical University. *The Kaohsiung Journal of Medical Sciences*, *25*(5), 258-263.

http://dx.doi.org/10.1016/S1607-551X(09)70071-3

Christensen, L. B. (2004). *Experimental Methodology*. Boston, MA: Pearson Allyn and Bacon.

Cohen, L., Manion, L., & Morrison, K. (2005). *Research methods in education* (5th ed.). London, NewYork: Routledge Falmer.

Dabell, J. (2008). Using concept cartoons. *Mathematics Teaching Incorporating Micromath*, *209*, 34-36.

Dahlgren, M. A., & Oberg, G. (2001). Questioning to Learn and Learning to Question: Structure and Function of Problem-Based Learning Scenarios in Environmental Science Education. *Higher Education*, *41*(3), 263-282. http://dx.doi.org/10.1023/A:1004138810465

Dalacosta, K., Kamariotaki-Paparrigopoulou, M., Palyvos, J. A., & Spyrellis, N. (2009). Multimedia application with animated cartoons for teaching science in elementary education. *Computers and Education*, *52*(4), 741-748. http://dx.doi.org/10.1016/j.compedu.2008.11.018

Delisle, R. (1997). *How to Use Problem-Based Learning in The Classroom*. Alexandria, Virginia: Association for Supervision and Curriculum Development.

Demirel, M., & Turan, B. A. (2010). The effects of problem based learning on achievement, attitude, metacognitive awareness and motivation. *Hacettepe Üniversitesi Eğitim Fakültesi Dergisi*, *38*, 55-66.

Distlehorst, L. H., Dawson, B. K., & Klamen, D. L. (2009). Supervisor and self-ratings of graduates from a medical school with a problem-based learning and standard curriculum track. *Teaching and Learning in Medicine*, *21*(4), 291-298. http://dx.doi.org/10.1080/10401330903228364

Doğru, M., Keles, O., & Arslan, A. (2010). *Use of concept cartoons with 5e learning model in scinece and technology course*. International Conference on New Trends in Education and Their Implications, Antalya, Turkey (11-13 November).

Drake, K. N., & Long, D. (2009). Rebecca's in the dark: A comparative study of problem-based learning and direct instruction/experiential leraning in two 4th-grade classrooms. *Journal of Elementary Science Education*, *21*(1), 1-16. http://dx.doi.org/10.1007/BF03174712

Ertmer, P. A., Glazewski, K. D., Jones, D., Ottenbreit-Leftwich, A., Göktaş, Y., Collins, K., & Kocaman, A. (2009). Facilitating technology-enhanced problem-based learning (PBL) in the middle school classroom: An examination of how and why teachers adapt. *Journal of Interactive Learning Research*, *20*(1), 35-54.

Feasey, R. (2007). *Primary Science for Teaching Assistants*. USA-Canada: Routledge.

Finch, P. M. (1999). The effect of problem-based learning on the academic performance of students studying podiatric medicine in Ontario. *Medical Education*, *33*(6), 411-417. http://dx.doi.org/10.1046/j.1365-2923.1999.00347.x

Gijselaers, W. H. (1996). Connecting Problem-Based Practices with Educational Theory. In L. Wilkerson, & W. H. Gijselaers (Eds.), *Bringing Problem-Based Learning to Higher Education: Theory and Practice* (pp. 13-21). San Francisco: Jossey-Bass Publishers. http://dx.doi.org/10.1002/tl.37219966805

Gürses, A., Açıkyıldız, M., Doğar, Ç., & Sözbilir, M. (2007). An Investigation into The Effectiveness of Problem-Based Learning in a Physical Chemistry Laboratory Course. *Research in Science & Technological Education*, *25*(1), 99-113. http://dx.doi.org/10.1080/02635140601053641

Hatzitaskos, M., & Karacapilidis, N. (2010). *Fostering learning through the use of argumentative serious games*. In A. Villafiorita, R. Saint-Paul, & A. Zorer (Eds.), *E-infrastructures and e-services on developing countries* (pp. 1-10). Germany, Berlin: Springer. http://dx.doi.org/10.1007/978-3-642-12701-4_1

Hatısaru, V., & Küçükturan, A. G. (2009). Vocational and technical education problem-based learning exercise: Sample scenario. *Procedia Social and Behavioral Sciences*, *1*, 2151-2155. http://dx.doi.org/10.1016/j.sbspro.2009.01.378

Hung, W. (2009). The 9-step problem design process for problem-based learning: Application of the 3C3R model. *Educational Research Review*, *4*(2), 118-141. http://dx.doi.org/10.1016/j.edurev.2008.12.001

Kabapınar, F. (2005). Effectiveness of teaching via concept cartoons from the point of view of constructivist approach. *Kuram ve Uygulamada Eğitim Bilimleri*, *5*(1), 135-146.

Kaptan, F., & Korkmaz, H. (2002). *Probleme Dayalı Öğrenme Yaklaşımının Hizmet Öncesi Fen Öğretmenlerinin Problem Çözme Becerileri ve Öz yeterlilik İnanç Düzeylerine Etkisi*. Orta Doğu Teknik Üniversitesi, Ankara:

5, Ulusal Fen Bilimleri ve Matematik Eğitimi Kongresi.

Kamin, C. S., O'Sullivan, P. S., Younger, M., & Deterding, R. (2001). Measuring Critical Thinking in Problem-Based Learning Discourse. *Teaching and Learning in Medicine*, *13*(1), 27-35. http://dx.doi.org/10.1207/S15328015TLM1301_6

Karasar, N. (2006). *Bilimsel Araştırma Yöntemi*. Ankara: Nobel Yayınevi.

Keogh, B., & Naylor, S. (1999a). Concept cartoons, teaching and learning in science: An evaluation. *International Journal of Science Education*, *21*(4), 431-446. http://dx.doi.org/10.1080/095006999290642

Keogh, B., & Naylor, S. (1999b). Science goes underground. *Adults Learning*, *10*(5), 3-6.

Keogh, B., & Naylor, S. (2000). Teaching and learning in science using concept cartoons: Why Dennis wants to stay in at playtime. *Australian Primary and Junior Science Journal*, *16*(3), 10-14.

Keogh, B., Naylor, S., & Wilson, C. (1998). Concept cartoons: A new perspective on physics education. *Physics Education*, *33*(4), 219-224. http://dx.doi.org/10.1088/0031-9120/33/4/009

Kinchin, I. (2004). Investigating students' beliefs about their preferred role as learners. *Educational Research*, *46*(3), 301-312. http://dx.doi.org/10.1080/0013188042002773 59

Lee, H., & Bae, S. (2008). Issues in implementing a structrured problem-based learning strategy in a volcano unit: A case study. *International Journal of Science and Mathematics Education*, *6*(4), 655-676. http://dx.doi.org/10.1007/s10763-007-9067-x

Likic, R., Vitezic, D., Maxwell, S., Polasek, O., & Francetic, I. (2009). The effects of problem-based learning integration in a course on rational drug use: A comparative study between two Croatian medical schools. *European Journal of Clinical Pharmacology*, *65*(3), 231-237. http://dx.doi.org/10.1007/s00228-008-0592-5

Lim, L. A. Y. L. (2011). A comparison of students' reflective thinking across different years in a problem-based learning environment. *Instructional Science*, *39*(2), 171-188. http://dx.doi.org/10.1007/s11251-009-9123-8

Lin, C. F., Lu, M. S., Chung, C. C., & Yang, C. M. (2010). A comparison of problem-based learning and conventional teaching in nursing ethics education. *Nursing Ethics*, *17*(3), 373-382. http://dx.doi.org/10.1177/0969733009355380

Long, S., & Marson, K. (2003). Concept cartoons. *Hands on Science*, *19*(3), 22-23.

Marczyk, G., DeMatteo, D., & Festinger, D. (2005). *Essentials of research design and methodology*. Canada: John Wiley & Sons.

Massa, N. M. (2008). Problem-Based Learning. A Real-World Antidote to the Standards and Testing Regime. *The New England Journal of Higher Education*, *22*(4), 19-20.

McCall, I. (2010). Online enhanced problem-based learning: Assessing a blended learning framework. *The Law Teacher*, *44*(1), 42-58. http://dx.doi.org/10.1080/03069400903541336

Morris, M., Merritt, M., Fairclough, S., Birrell, N., & Howitt, C. (2007). Trialling concept cartoons in early childhood teaching and learning of science. *Teaching Science*, *53*(2), 42-45.

Naylor, S., Downing, B., & Keogh, B. (2002). *An empirical study of argumentation in primary science, using concept cartoons as the stimulus*. USA, New Orleans: Annual Meeting of the National Association for Research in Science Teaching (7-10 Nisan).

Naylor, S., Keogh, B., & Downing, B. (2007). Argumentation and primary science. *Research in Science Education*, *37*(1), 17-39. http://dx.doi.org/10.1007/s11165-005-9002-5

Neville, D. O., & Britt, D. W. (2007). A Problem-Based Learning Approach to Integrating Foreign Language Into Engineering. *Foreign Language Annals*, *40*(2), 226-246. http://dx.doi.org/10.1111/j.1944-9720.2007.tb03199.x

Oluk, S., & Özalp, I. (2007). The teaching of global environmental problems according to the constructivist approach: As a focal point of the problem and the availability of concept cartoons. *Educational Sciences: Theory and Practice*, *7*(2), 881-896.

Özyılmaz-Akamca, G., & Hamurcu, H. (2009). Analojiler, kavram karikatürleri ve tahmin-gözlem-açıklama teknikleriyle desteklenmiş fen ve teknoloji eğitimi. *E-Journal of New World Sciences Academy*, *4*(4), 1186-1206.

Raupach, T., Münscher, C., Pukrop, T., Anders, S., & Harendza, S. (2010). Significant increase in factual

knowledge with web-assisted problem based learning as part of an undergraduate cardio-respiratory curriculum. *Advances in Health Sciences Education: Theory and Practice*, *15*(3), 349-356. http://dx.doi.org/10.1007/s10459-009-9201-3

Şahin, M. (2010). Effects of problem-based learning on university students' epistemological beliefs about physics learning and conceptual understanding of Newtonian Mechanics. *Journal of Science Education and Technology*, *19*(3), 266-275. http://dx.doi.org/10.1007/s10956-009-9198-7

Schmidt, H. G., Van der Molen, H. T., Te Winkel, W. W. R., & Wijnen, W. H. F. W. (2009). Constructivist, problem-based learning does work: A meta-analysis of curricular comparisons involving a single medical school. *Educational Psychologist*, *44*(4), 227-249. http://dx.doi.org/10.1080/00461520903213592

Searight, H. R., & Searight, B. K. (2009). Implementing problem-based learning in an undergraduate psychology course. *A Journal of Scholarly Teaching*, *4*, 69-76.

Şendağ, S., & Odabaşı, H. F. (2009). Effects of an online problem based learning course on content knowledge acquisition and critical thinking skills. *Computers & Education*, *53*(1), 132-141. http://dx.doi.org/10.1016/j.compedu.2009.01.008

Şengül, S., & Üner, İ. (2010). What is the impact of the teaching "Algebraic Expressions and Equations" topic with concept cartoons on the students' logical thinking abilities? *Procedia Social and Behavioral Sciences*, *2*, 5441-5445. http://dx.doi.org/10.1016/j.sbspro.2010.03.887

Severiens, S. E., & Schmidt, H. G. (2009). Academic and social integration and study progress in problem based learning. *Higher Education*, *58*(1), 59-69. http://dx.doi.org/10.1007/s10734-008-9181-x

Sexton, M. (2010). *Using concept cartoons to access student beliefs about preferred approaches to mathematics learning and teaching*. Western Australia: 33rd Annual Meeting of the Mathematics Education Research Group of Australasia (July 3-7).

Sexton, M., Gervasoni, A., & Brandenburg, R. (2009). Using a concept cartoon to gain insight into children's calculation strategies. *Australian Primary Mathematics Classroom*, *14*(4), 24-28.

Shamir, A., Zion, M., & Levi, O. S. (2008). Peer tutoring, metacognitive processes and multimedia problem-based learning: The effect of mediation training on critical thinking. *Journal of Science Education and Technology*, *17*(4), 384-398. http://dx.doi.org/10.1007/s10956-008-9108-4

Sockalingam, N., Rotgans, J., & Schmidt, H. G. (2011). Student and tutor perceptions on attributes of effective problems in problem-based learning. *Higher Education*, *62*(1), 1-16. http://dx.doi.org/10.1007/s10734-010-9361-3

Sönmez, D., & Lee, H. (2003). Problem-Based Learning in Science. *ERIC Clearinghouse for Science, Mathematics, and Environmental Education*.

Stephenson, P., & Warwick, P. (2002). Using concept cartoons to support progression in students' understanding of light. *Physics Education*, *37*(2), 135-141. http://dx.doi.org/10.1088/0031-9120/37/2/306

Sungur, S., & Tekkaya, C. (2006). Effects of problem-based learning and traditional instruction on self-regulated learning. *The Journal of Educational Research*, *99*(5), 307-320. http://dx.doi.org/10.3200/JOER.99.5.307-320

Sweller, J. (2006). The worked example effect and human cognition. *Learning and Instruction*, *16*(2), 165-169. http://dx.doi.org/10.1016/j.learninstruc.2006.02.005

Tarmizi, R. A., Tarmizi, M. A. A., Lojinin, N. I., & Mokhtar, M. Z. (2010). Problem-based learning: Engaging students in acquisition of mathematical competency. *Procedia Social and Behavioral Sciences*, *2*, 4683-4688. http://dx.doi.org/10.1016/j.sbspro.2010.03.750

Taşkoyan, N. S. (2008). *Fen ve teknoloji öğretiminde sorgulayıcı öğrenme stratejilerinin öğrencilerin sorgulayıcı öğrenme becerileri, akademik başarıları ve tutumları üzerindeki etkisi* (Unpublished master thesis). İzmir: Dokuz Eylül Üniversitesi, Eğitim Bilimleri Enstitüsü.

Turan, S., Elcin, M., Odabası, O., Ward, K., & Sayek, I. (2009). Evaluating the role of tutors in problem-based learning sessions. *Procedia Social and Behavioral Sciences*, *1*, 5-8. http://dx.doi.org/10.1016/j.sbspro.2009.01.005

Uğurel, I., & Moralı, S. (2006). Karikatürler ve matematik öğretiminde kullanımı. *Milli Eğitim Dergisi*, *170*, 32-46.

Wang, S. Y., Tsai, J. C., Chiang, H. C., Lai, C. S., & Lin, H. J. (2008). Socrates, problem-based learning and critical thinking-a philosophic point of view. *The Kaohsiung Journal of Medical Sciences*, *24*(3), 6-13. http://dx.doi.org/10.1016/S1607-551X(08)70088-3

Williams, B., & Pace, A. E. (2009). Problem based learning in chronic disease management: A review of the research. *Patient Education and Counseling*, *77*(1), 14-19. http://dx.doi.org/10.1016/j.pec.2009.03.004

Wilkinson, J. M. (2009). Is problem-based learning a suitable curriculum model for training complementary and alternative medicine practitioners? *Explore: The journal of Science and Healing*, *5*(6), 341-344. http://dx.doi.org/10.1016/j.explore.2009.08.003

Woltering, V., Herrler, A., Spitzer, K., & Spreckelsen, C. (2009). Blended learning positively affects students' satisfaction and the role of the tutor in the problem-based learning process: Results of a mixed-method evaluation. *Advances in Health Sciences Education*, *14*(5), 725-738. http://dx.doi.org/10.1007/s10459-009-9154-6

Yaman, S., & Yalçın, N. (2005). Fen Eğitiminde Probleme Dayalı Öğrenme Yaklaşımının Problem Çözme ve Öz-yeterlilik İnanç Düzeylerinin Gelişimine Etkisi. *Hacettepe Üniversitesi Eğitim Fakültesi Dergisi*, *29*, 229-236.

Yew, E. H. J., & Schmidt, H. G. (2009). Evidence for constructive, self-regulatory, and collaborative processes in problem based learning. *Advances in Health Sciences Education*, *14*(2), 251-273. http://dx.doi.org/10.1007/s10459-008-9105-7

Yuan, H., Williams, B. A., & Fan, L. (2008). A systematic review of selected evidence on developing nursing students' critical thinking through problem based learning. *Nurse Education Today*, *28*(6), 657-663. http://dx.doi.org/10.1016/j.nedt.2007.12.006