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The Effects of Problem-Based Active Learning in Science Education on Students' Academic Achievement, Attitude and Concept Learning

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The aim of this study was to determine the effects of problem-based active learning in science education on students' academic achievement and concept learning. In the study, both quantitative and qualitative research methods were utilized. Quantitative data were obtained via the pre/post-test, treatment-control groups test model. Qualitative data were obtained via document analysis. The research study was conducted on 50, 7th grade students in 2004-2005 school year, in a public school in Istanbul. The treatment process took 30 class hours in total. In the research, three measurement instruments were used: an achievement test, open-ended questions, and an attitude scale for science education. The reliability coefficient of the achievement test was calculated to be KR20=0.78. Cronbach α value of the attitude scale was 0.89. While the subject matters were taught on the basis of problem-based active learning in the treatment group, traditional teaching methods were employed in the control group. In the face of the data collected and the evaluations made in the research, it was determined that the implementation of problem-based active learning model had positively affected students' academic achievement and their attitudes towards the science course. It was also found that the application of problem-based active learning model affects students' conceptual development positively and keeps their misconceptions at the lowest level.

Keywords: Teaching Sociology, Science, Education, Problem-based learning, Active Learning, Concept Learning, Program Development

INTRODUCTION

The student-centered active learning process within which teacher is merely a guide is the focal point of contemporary education systems. The active learning is a learning process in which the learner takes the responsibility of his/her learning and s/he is given the opportunity to make decisions about various dimensions of the learning process and to perform self-regulation (Açıkgöz, 2003). In active learning process, learning is no longer a standard process, but it transforms into a personalized process. Here, the skills of problem-solving, critical thinking and learning to learn are developed. Humans face various problems in their lives and they try to find particular ways to solve these problems. In this respect, it is important for students to be prepared for the future by facing real or real-like problems in their learning environment and producing appropriate solutions to these problems. What is expected from education is to enable individuals to become an effective problem solver in their actual lives (AAAS, 1993; Brooks & Brooks, 1993; Tobin, 1993; Gallagher, 1997; Herreid, 1997; Walker & Lofton,

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2003; Chin & Chia, 2004). To learn problem solving is to learn how to learn. The most convenient approach with regard to reaching this aim in teaching and learning environments is the problem-based learning taken part in active learning. The basis of problem-based learning is rooted in Dewey's "learning by doing and experiencing" principle (Dewey, 1938). The problem-based learning is an active learning which enables the student to become aware of and determine his/her problem solving ability and learning needs, to learn to learn, to be able to make knowledge operative and to perform group works "in the face of real life problems".

The "Problem-Based Learning" being increasingly used in several areas recently was firstly implemented in medical science in the 1950s, specifically in the Medical School of Case W. University in the USA. It was begun to be implemented in the Medical School of the McMaster University in Canada at the end of the 1960s (Rhem, 1998; Herreid, 2003). Today, the problem-based learning model is used in pre-clinic classes within medical faculties of many universities such as the Harvard University, New Mexico University and McMaster University. This teaching model is put into practice in medical faculties of the Hacettepe University, Ankara University, Dokuz Eylül University and Pamukkale University in Turkey. In addition to medical faculties, the problem-based learning model is also implemented in other educational institutions comprised of fields like natural sciences, engineering and law. When the literature is examined, it is seen that the studies focused on the use of problem-based learning model in primary education, secondary education and high education have been reached by the 1980s (Duch, 1995; Gallagher, 1997; Kaptan & Korkmaz, 2002; Lambros, 2002; Şenocak, 2005). The problem-based learning is a learning model which centers on student, develops active learning, problem-solving skills and field knowledge, and is based on understanding and problem-solving (Barrows & Tamblyn, 1980; Maya *et al.*, 1993; Mechling, 1995; Skrutvold, 1995; Major *et al.*, 2000; Malinowski & Johnson, 2001). In the classrooms where problem-based learning model is used, learners take much more responsibility for their own learning progressively. They have become more independent from their teachers gradually. And they have become independent learners who can continue to learn in their whole lifetime.

PROBLEM-BASED LEARNING MODEL

The problem-based learning model turns the student from passive information recipient to active, free self-learner and problem solver, and it slides the emphasis of educational programs from teaching to learning. This model enables the student to learn new knowledge by facing him/her the problems to be solved, instead of burdened contents (Çuhadaroğlu *et al.*¸ 2003). By means of problem-based learning, some attitudes of students in relation to such areas as problem-solving, thinking, group works, communication, information acquisition and information sharing with others are affected positively. The basis of the problem-based learning is mainly comprised of 'Problem, Solution, Practice, Research, Questioning, Realism, Originality and Integration." The aim of this learning model is to provide acquisition of information based on facts. In order to achieve this aim, problems are chosen out of the real world. The individual is being developed by making possible the integration with information accumulation of the student. Even though some differences are observed in practice, the problem-based learning is performed in sessions within which there are small working groups comprised of 6 or 8 persons guiding by an education mentor. They deal with scenarios involving several problems in above-mentioned sessions and try to find appropriate answers to these problems. These sessions constitute the foundation of problem-based learning system. In these sessions, it is aimed to enable the student to learn by setting off the problems that explain the subject matter in best way (Yuzhi, 2003; Skrutvold, 2003; Kılıç, 2006). The most important role of the mentor in the problem-based learning being operated in a student-centered manner is to facilitate learning activities by guiding students. Teaching mentors fulfill this role by monitoring discussions, asking questions, helping the resolution of occasional conflicts, enabling the participation of each group member to classroom discussions, giving examples when required, preventing scatter of discussions and making evaluations (Maxwell & Dornan, 1995; Duffy & Cunningham, 1996; Rhem, 1998; Greenwald, 2000; Posner & Rudnitsky, 2001; Nakiboğlu & Altıparmak, 2002; Açıkgöz, 2003; Çuhadaroğlu *et al.,* 2003; Onargan *et al.,* 2004).

PROBLEM-BASED LEARNING AND SCIENCE EDUCATION

When the aims of science education are examined, it is seen that the problem-based learning is quite appropriate for realization of these aims (Tobin, 1986; AAAS, 1993). Today, many science educators considering this connection have increasingly started to apply problem-based learning approach in science education (Lazear, 1991; Treagust & Peterson, 1998; Gallagher *et al.,* 1999; Slavin, 1999; Greenwald, 2000; Yuzhi, 2003; Şenocak, 2005; Wilson, 2005; Kılıç, 2006). The facts that science education is based on both practice and interpretation, that it is so connected with real life and that it requires cooperation facilitate the problem-based learning practices.

Implementation of problem-based learning in science education

In using problem-based learning system, firstly the concepts, learning aims and duration of the subject matter are set. Before implementation of this system, students are informed about problem-based learning. Small student groups comprised of 5 or 7 persons are formed. Students are given opportunity to examine and recognize problems by distributing prepared problem scenarios to them. If students have information about the problem, they are expected to propose solutions to this problem. If they do not have information about the problem, they are encouraged to make research using various data sources. All of the information obtained in this process is shared, discussed and evaluated among group members. Then, the solution of the problem is reached. This solution is presented to other groups. All information related to the targeted concept is revealed by discussing the acquired results at the guidance of the teacher (Dori & Herscovitz, 1999; Duch, Groh & Allen, 2001; Kılıç, 2006). In problem-based learning model, main tools which are used can be stated as the case-study method, problem-solving based learning approach, project-based learning approach and cooperative learning approach. The problem-based learning model which is closely connected to these learning models and methods seems to be enriched by increasingly spreading new methods such as 'portfolio-based learning' and 'experimental learning' (Dicle, 2001).

The characteristics which call attention in problem-based learning

- Learning process must be started with a problem; especially a problem which is evidently critical/still unsolved must be used.
- Contents and practices must include situations which attract students' attention.
- Teacher must merely be a guide in the classroom.
- Students must be given necessary time to think or gather information and to set their strategies in problem solving, and their creative thoughts must be encouraged in this process.
- The difficulty of the subject matters to be studied must not be at a high level which could discourage students.
- A comfortable, relaxing and safe learning environment must be established in order to develop students' skills on thinking and problem-solving by themselves (Greenwald, 2000; Taşkıran *et al.,* 2001; Parim, 2002; Yaman & Yalçın, 2004).

The characteristics of the learning scenario that constitutes the basic education tool in problem-based learning are as follows (Çuhadaroğlu *et al.,* 2003);

- Problems must be chosen from among the problems which are the most fitting to the real world.
- Problem must be open-ended.
- It must arouse sense of curiosity.
- It must focus on only one issue.
- It must teach good and ethical behaviors rather than negative events and behaviors.
- It must help students to reflect on freely and express themselves.
- By making suitable personifications, students must be given the opportunity to treat the problem as if it were their problem and to be willing in solving it.

The advantages and limitations of problem-based learning can be stated in the following manner:

Advantages of problem-based learning

- Classes are student-centered instead of being teacher-centered.
- This learning model develops self-control in students. It teaches making plans prospectively, facing realities and expressing emotions.
- This model enables students to see events multi-dimensionally and with a deeper perspective.
- It develops students' problem-solving skills.
- It encourages students to learn new materials and concepts when solving problems.
- It develops sociability levels and communication skills of students by enabling them to study and work in a team.
- It develops students' high level thinking/critical thinking and scientific thinking skills.
- It unites theory and practice. It allows students both to merge their old knowledge with new knowledge and to develop their judging skills in a specific discipline environment.
- It motivates learning for both teachers and students.
- Students acquire the skills of time management, focusing, data collection, report preparation and evaluation.
- It paves the way for learning in whole lifetime (Dinçer & Güneysu, 1998; Treagust & Peterson, 1998; Kalaycı, 2001; Şenocak, 2005).

Limitations of problem-based learning

- It could be difficult for teachers to change their teaching styles.
- It could take more time for students to solve problematic situations when these situations are firstly presented in the class.
- Groups or individuals may finish their works earlier or later.
- Problem-based learning requires rich material and research.
- It is difficult to implement problem-based learning model in all classes. It is unfruitful to use this strategy with students who could not fully understand the value or scope of the problems with social content.
- It is quiet difficult to assess learning (Dinçer & Güneysu, 1998; Treagust & Peterson, 1998; Kalaycı, 2001; Şenocak, 2005).

By setting off the idea underlying the fact that life means to recognize problems faced, to be aware of the importance of these problems, to understand why these problems occur and to eradicate possible problems at an earlier stage, the problem-based learning serves the view that learning must be complete and must be based on adequacy. The efficiency level of problem-based learning should be examined in order to acquire the skills of reflecting on problems faced and of solving these problems, to increase critical thinking level and not to be afraid of possible or actual problems. Problem-based learning model orients students towards reflecting on, interpreting and searching solutions to the problems faced by them not only in science classes but also in their daily lives, instead of compelling them to ignore all these problems. In the classrooms within which problem-based learning model is applied, students are encouraged to access knowledge by themselves. The fact that the scenarios implemented as required by problem-based learning model are connected with students' daily lives enables students to understand how science classes are so interrelated with real life. Furthermore, since students find the events and characters pictured in these scenarios so close to themselves, science classes become attractive to them automatically. In problem-based learning model in which teaching activities are carried out with small groups composed of 6 or 8 students, it is achieved that these students could strengthen their interaction and communication with each other and their environment. Their skill to express themselves develops. In general, students define problems as incomprehensible, complicated, complex and abstract. This prevents students from reflecting on, interpreting and solving problems. In order to change this situation, it is necessary to concretize problems and associate them with students' lives. It is an issue of great importance that the science knowledge assumed to be learned through science education in school could not be transmitted to their actual lives by students and some misconceptions are carried again by them. In this respect, active learning models should be put into practice in primary education level. The aim of this research is to determine whether the implementation of problem-based learning model taking part in active learning applications in "The Meeting of Force and Motion—Energy" unit of 7th grade in primary education brings about significant differences with regard to students' academic achievement, their attitudes towards science class and their concept learning.

With this aim, following hypotheses were set:

1. Does teaching of 7th grade science classes by means of the Problem-Based Active Learning Model bring about significant differences with regard to students' academic achievement?
2. Does teaching of 7th grade science classes by means of the Problem-Based Active Learning Model bring about significant differences with regard to students' attitudes towards science class?
3. Does teaching of 7th grade science classes by means of the Problem-Based Active Learning Model have any impact on students' concept learning?

METHOD

Model of the research

Both quantitative and qualitative research methods were used in this study. In quantitative research dimension, the test model based on a pre-test and post-test with research-control groups was utilized. In qualitative research field, document analysis was executed.

Implementation

The research was conducted on the students who were at the 7th grade in primary schools in the county of Kadıköy located in the city of Istanbul during the 2004-2005 school year, and their academic achievement and concept learning levels in regard to "Everything in the Universe is Moving" and "How Do Matters Behave at Force Effect?" subject matters included by "The Meeting of Force and Motion—Energy" unit of the Science Program were considered. With this aim, a primary school was chosen randomly. By applying the pre-test including 25 questions prepared by the researcher to the 7th grade students, research and control groups at same level were formed. 50 students were participated in the research in total. Of 50 students having participated in the research, 30 of them were females and 20 of them were males. After research and control groups had been formed, 10 open-ended questions prepared by the researcher and "The Attitude Scale for Science Classes" developed by Akınoğlu (2001) were executed in each group. The study was carried out by the researcher. While classes were given by means of traditional method in the control group, following techniques were employed in the research group: Before subject matters were proceeded, information about the problem-based active learning model used in the research had been presented to the research group and thus, it was enabled the members of this group to recognize and approximate this model. The problem-based active learning model is comprised of scenarios. In this manner, some scenarios were prepared in accordance with the acquisition of the subject matters of "Everything in the Universe is Moving" which is composed of two sub-headings and "How Do Matters Behave at Force Effect?" which is composed of six sub-headings. Working groups comprised of 5 or 6 students were created in the research group. In the first session of the problem-based active learning model implemented in sessions, the scenarios prepared in relation to the subject matter were handed out to the members of all groups without having presented any information. These scenarios were also showed by using an overhead trajectory. By giving time to them, students were enabled to recognize problem and to organize their thoughts. After stimulating a brain storming activity about the causes and possible solutions of the problematic conditions in the scenarios, students' suggestions were evaluated. Here, the researcher made students to concentrate on important questions. In the second session of the model, firstly, the answers prepared by the groups were shared and personal preparations were presented by students. Group members were encouraged to adapt new knowledge to the original problem, to revise previous hypotheses and to re-adjust these hypotheses if necessary. Lastly, the working process of groups was assessed. With this model, it was achieved that students participated the class actively. Moreover, by employing the model through groups, it was accomplished that the knowledge could be learned properly and transferred among students. At the same time, students' skill of expressing themselves in the classroom and sense of self-confidence were supported. The research took 30 class hours (10 weeks) in total. At the end of the research, the post-test, open-ended questions and attitude scale were given to the students again. The results were assessed by the researcher by taking specialists' opinions.

Data collection and assessment

In the research, three main assessment tools including academic achievement test, open-ended questions and attitude scale towards science classes were used. The data acquired by using these assessment tools were transferred to computer environment and evaluated by means of SPSS 10.00 package program. Some detailed information about preparation, implementation and evaluation of the assessment tools used in data collection is given below.

The preparation, implementation and evaluation of the academic achievement test

The academic achievement test was prepared in accordance with the aims and acquisitions in the subject matters of "Everything in the Universe is Moving" and "How Do Matters Behave at Force Effect?" of the "The Meeting of Force and Motion—Energy" unit taken part in the Science Curriculum for Primary Schools of the Turkish Republic—National Education Ministry. The subject matter was divided into sub-concepts and then, 50 questions comprised of four options were asked by the researcher in conformity with the students' acquisitions with regard to these sub-concepts. At the end of a pilot study performed on 55 students, the reliability and validity of the questions were calculated. Then, by taking opinions of a specialist group comprised of four persons, namely a counselor, an academician working in the science teaching department of a reputable university and two science teachers, the questions which had low validity and reliability levels were excluded from the test and total question number was reduced to 25. When the reliability coefficient of the academic achievement test was calculated, it was found as KR20=0, 78. This expression indicates that the academic achievement test is reliable by 78%. When general difficulty level of the academic achievement test was computed, it was found as P_{ave}=11.76/25 = 0, 47. This figure shows that the academic achievement test is at medium-level in terms of difficulty. When the distinctiveness levels of the questions formed the academic achievement test were calculated, it is seen that 96% of these questions are at or above the value of 0, 40 which is desired. Average distinctiveness of the academic achievement test was found as D_{ave}=12.88/25 = 0, 51 and it was accepted that the academic achievement test whose reliability is detected has a high distinctiveness level. When the academic achievement test was implemented, the researcher was present in the classroom. Students were given 1 class hour (40 minutes) to answer this test.

The preparation, implementation and evaluation of the open-ended questions

At the beginning, twenty open-ended questions were prepared by the researcher by classifying the concepts chosen in accordance with the national education curriculum in the subject matters of "Everything in the Universe is Moving" and "How Do Matters Behave at Force Effect?" of "The Meeting of Force and Motion—Energy" unit. Later on, by taking recommendations of three specialists, namely an academician in the science teaching department of a reputable university and two science teachers, total question number was reduced to 8 in order to prevent students from getting misconceptions and to be able to determine adequately whether students learned concepts meaningfully or not. The subject matters which were assessed through open-ended questions are given in Table-1.

Table 1. The subject matters assessed by open-ended questions

Question number	The subject matter to be assessed
1	Motion- Moving matters-Motionless matters
2	Position
3	The way moved toward and The replacement made
4	Inactivity
5	Force and The effects of Force
6	Friction force
7	Scalar magnitude– Vectored magnitude
8	Gravity force

When open-ended questions were answered, the researcher was present in the classroom. Students were given 1 class hour (40 minutes) to answer these questions. The open-ended questions used in the research were encoded by means of open-encoding method in qualitative dimension. In open-encoding, the answers of all students were examined by the researcher. At the end of this, the codes reached were grouped with the codes resembled to them. And, some theses were created after giving names to these groups. The theses acquired in pre-implementation and in the post-implementation were compared with each other and interpreted.

The implementation and evaluation of the attitude scale

The 20-itemed "Attitude Scale for Science Classes" developed by Akınoğlu (2001) was used in the research in order to determine whether the problem-based active learning model affects students' attitudes towards science classes or not. The reliability of this scale developed by Akınoğlu is $\alpha = 0.89$. The 5-step Likert type attitude scale includes twenty positive and negative sentences aiming to probe students' views about science classes. Students were given 30 minutes to respond.

FINDINGS AND COMMENTS

The findings regarding the effect of problem-based active learning on academic achievement

In order to examine the effect of the "Problem-Based Learning model" employed during the implementation process on students' academic achievement, the findings acquired in pre- and post-application of the academic achievement test to the research and control groups were drawn in tables, and some comments were made in parallel to these findings.

As it can be seen in the Table 2, the arithmetic mean of the pre-test scores taken by the research group students was found 8.56 and the respected figure of the control group students was found 9.16. It is observed that there is a 0.6 point difference between group means and p value is more than 0.05. This indicates that there is no significant difference at the 0.05 confidence interval between the pre-test scores of the research group and control group students. By the fact that there is no significant difference between the pre-test scores of the research and control group students, the condition concerning the nearness of pre-knowledge level of the research and control groups before the research is fulfilled.

Table 2. The results of the detached "T" test carried out regarding the difference between the pre-test scores of students in the research group and in the control group

	GROUPS	N	X	Standard deviation	Standard error	Detached group "t" test sd	t	P
PRE-TEST	Treatment Group	25	8,5600	2,9451	,5890	48	0,822	p > 0,05
	Control Group	25	9,1600	2,1541	,4308			

Table 3. The results of the detached "T" test carried out regarding the difference between the post-test scores of students in the research group and in the control group

	GROUPS	N	X	Standard deviation	Standard error	Detached group "t" test sd	t	P
POST-TEST	Treatment Group	25	12,7600	4,2650	,8530	48	-2,273	p < 0,05
	Control Group	25	10,1200	3,9404	,7881			

Table 4. The results of the detached "T" test carried out regarding the difference between the pre-attitudes of students in the research group and in the control group

	GROUPS	N	X	Standard deviation	Standard error	Detached group "t" test sd	t	p
PRE-ATTITUDE	Treatment Group	25	77,1600	10,9418	2,1884	48	-1,649	p >0,05
	Control Group	25	71,7600	12,1802	2,4360			

Table 5. The results of the detached "T" test carried out regarding the difference between the post-attitudes of students in the research group and in the control group

	GROUPS	N	X	Standard deviation	Standard error	Detached group "t" test sd	t	P
POST-ATTITUDE	Treatment Group	25	73,8000	13,2225	2,6445	48	-2,343	p <0,05
	Control Group	25	65,6000	11,4673	2,2935			

As it can be seen in the Table 3, when post-test scores of the research group and control group students were examined, it was found that the arithmetic mean of the post-test scores taken by the research group students was 12.76 and the respected figure of the control group students was 10.12. It can be seen that there is a 2.64 point difference between group means and p value is less than 0.05. This indicates that there is a significant difference at the 0.05 confidence interval between the post-test scores of the research group and control group students on behalf of the former group. This result demonstrates that the problem-based active learning model plays a role in regard to increase in academic achievement.

The findings regarding the effect of the problem-based active learning on attitudes towards science classes

As it can be seen in the Table 4, the arithmetic mean of the pre-attitude scores revealed by the research group students was found 77.16 and the respected figure for the control group students was found 71.76. There is no significant difference between the pre-attitude scores of the research group and control group at the 0.05 confidence interval.

As it can be seen in the Table 5, the arithmetic mean of the post-attitude scores revealed by the research group students was found 73.80 and the respected figure for the control group students was found 65.60. In this respect, there is a significant difference between the post-attitude scores of the research group and control group at the 0.05 confidence interval on behalf of the former group. Namely, it is observed that there is a positive change in the attitudes of the research group students towards science class. In addition to the statistical data obtained, the opinions expressed by the research group students at the end of the applications performed also mirror the positive change in their attitudes. Some of the opinions expressed by students from this group during the activities carried out in the research process are given below.

> ***Ö.S:*** *"I liked this class very much. The scenarios were enjoyable. The scenarios made us to like problems. Group works were good as well. I was very contented with the applications. I believe that I will be successful with the help of these scenarios."*
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> ***Y.S.E:*** *"We spent a very good time with the scenario technique, which is the newly applied technique in science class, by both having fun and learning. In the problem-based method, it is so easy to answer questions and it is so good and fruitful to add our own ideas and discuss within group."*
>
> ***B.A:*** *"The problem-based learning attracted me. It is a good method. We both learn and have fun. We started to like solving problems. We are learning concepts with respect to animated characters. I advocate that the teaching should go on in such way."*

S.K: *"In my opinion, the class is enjoyable, because the scenarios are handed out and groups are formed. I like the distribution of problem-based scenarios."*

Y.S: *I like the scenario system in science class very much. I understand subject matters better. The problems seem to be so easy."*

General evaluation of the effect of problem-based active learning on concept learning in the scope of the qualitative findings obtained from the open-ended questions

When the answers given by the control and research groups to the open-ended questions which measure their conceptual development were examined in general, it can be said that there is no positive improvement in the control groups to which traditional teaching methods were applied. Yet, the teaching model employed in the research group brought about positive improvements in the conceptual development of the students. However, these changes were not taken place at the desired level. When the conceptual development levels of the control and research groups were compared, it was seen that the model applied in the research group had positive effects on the students. When the groups' answers to the 1st, 2nd, 5th and 7th questions asking conceptual definitions in order to measure concept learning level were examined, the success of the research group with regard to learning concepts and dispelling misconceptions is seen. In the scenarios prepared in accordance with the method applied to the research group, students do not receive the information from teacher passively. The questions prepared from easier to harder in connection with the scenarios enable students to access to the information by themselves. In relation to this, while the control group students express their answers on the required concept definitions with textual sentences, the research group students do so with their own sentences. When answers given to the open-ended questions were examined at the end of the research process, it was observed that the research group students reduced their misconceptions, but they could not dispel them completely. Nevertheless, the research group is more successful in dispelling misconceptions than the control group. In the research group in which a teaching model based on group work is applied, since students are in communication with their group members and other groups, they could find the opportunity to discuss and share their ideas. In this way, information transfer among students is accomplished. The examples given are chosen out of daily life and they are enriched by students. The scenarios applied in the model play an important role in the fact that the examples are so connected to daily life. It was considered that the scenarios should be prepared in connection with daily life so as to attract students' attention and to help keeping it alive. It was ensured that events were visualized through pictures in the scenarios. Furthermore, it was aimed that the method has positive effect on students' concept development by placing previously learned concepts in the successive scenarios. Thus, the concepts learned by students become enduring. To sum up, it is seen that the problem-based learning model applied is influential on students' conceptual development.

CONCLUSION AND DISCUSSION

In this study in which the effects of the Problem-Based Active Learning applications in the unit of "The Meeting of Force and Motion - Energy" in 7th grade science classes on students' academic achievement, concept learning and attitude changes were examined, following results were obtained. It was observed that the research group in which the problem-based learning model was used is more successful than the control groups to which traditional teaching methods were applied. When pre-test and post-test scores of the research and control groups were compared with each other, it was observed that there is a rise in success in both groups. However, the fact that this rise is significantly high in the research group shows that the model employed in this group is more successful than traditional methods. This result verifies the hypothesis constructed at the beginning of the research, which is "Teaching science classes in the 7th grade of primary schools through problem-based active learning has effect on student achievement." Kayalı *et al.* (2002) showed that the active learning methods are more effective than the classic method by relying on the findings of their research conducted on the basis of problem-based learning, brain storming and cooperative learning. Şenocak (2005) used problem-based learning approach in "The Gas State of Matter" unit. In the light of the findings, the researcher determined that the problem-based learning approach is more influential than the traditional teaching approach. The results of our research and of these studies seem to support each other.

In respect of the findings acquired via analyses of the open-ended questions applied to the students both at the beginning and at the end of the study, it is seen that conceptual development of the students was affected positively and their misconceptions were minimized through problem-based learning model. This is observed clearly in the 1st, 2nd, 5th and 7th open-ended questions by which conceptual definitions are asked. After examining respective answers, it was understood that examples in students' answers have diversified in the 1st question, that students have used concepts of direction when they are describing their place in the 2nd question, that their misconceptions concerning the concept of "force" has reduced in the 5th question, and that students could place the concepts given in pursuant to the concepts of "scalar magnitude" and "vectored magnitude" and they defined concepts accurately in the 7th question. This result proves the hypothesis that "Teaching science classes in the 7th grade of primary schools through problem-based active learning has effect on student achievement." In his study examining the effect of problem-based learning model on teaching of the gas state of matter, Şenocak (2005) found that the problem-based learning model is more effective than the traditional teaching approach in regard to learning concepts related to this topic by students. Throughout the application process, it was observed how students approached the problems they faced and how they solved these problems in the problem-solving stage of the scenarios used in problem-based learning model. Based upon these observations, it was seen that the research group students implemented the stages of problem-solving method and there was a positive change in their problem-solving skills. In the study titled as "Learning to Teach Primary Science through Problem – Based Learning" conducted by Treagust and Peterson (1998), it was commented that the problem-based learning model used in educating pre-service teachers affects pedagogical learning judging skill positively. The judging skill is one of the problem-solving and critical thinking skills. Since the first stage of problem-based learning is a problem to be solved, it is expected from students who study in a problem-based learning environment to have developed problem-solving and critical thinking skills. To give students the chance to solve problems they face ensures development of their problem-solving skills (Kaptan & Korkmaz, 2002). At the end of the research, written comments were asked from students. Students' opinions about problem-based learning approach and application are given below.

> ***T.Y:*** *"I liked this class very much. It has improved my problem-solving skill. I did not like solving problems before, but I like it now. Unlike others, these problems are not boring and they have pictures. They are enjoyable. I have liked picture side of this problem-based application for the most part. I am curious about what kind of picture and topic there would be in each paper. There is also group working. I take my friends' opinions in each problem and I learn new things. In short, we both learn and have fun with this application."*
>
> ***E.B:*** *I enjoy science class. The scenarios handed out makes this class more enjoyable. Learning through scenarios is both beneficial for me and my group in regard to understanding subject matters better and consolidating them more. We both learn and have fun in the class."*
>
> ***S.S:*** *"I have already liked science class, but I started to like it more with this method. This method embroidered with various animated characters increases my willingness to solve problems. I could understand subject matters better now."*
>
> ***H.S:*** *"I think that it is better for me to solve scenarios during the class. Solving scenarios with group members attracts my intention of studying. I understand better subject matters when I solved scenarios. Science class is better when solving scenarios. I like discussing with group decision very much. I understand problems more when I am solving them."*

When students' opinions about the classes in which problem-based learning model is used were examined, it is seen that the approximation with daily life of and the visualization through pictures of the scenarios utilized in problem-based learning model were successful in pulling the attention of students to the class. This is caused by the fact that students were enabled to participate actively to the class by expressing the problems taken part in scenarios' content with pictures. In the study titled as "The effects of multiple intelligence-based teaching on 9th grade students' achievement level in ecology class, attitudes towards ecology and multiple intelligence" conducted by Aşçı and Demircioğlu (2002), it was found that the achievement level in ecology class of the students from the classroom wherein multiple intelligence-based ecology lecture plans were implemented was higher than the students from the classrooms wherein traditional teaching methodology was employed. It was determined that choosing scenario contents out of daily life brought about removing students' fears of problem-solving, facilitating learning and making students be aware of the fact that science is a very part of life. Thus, this has been quite influential regarding students' developing positive attitudes towards science class. The hypothesis of "Teaching science classes in the 7th grade of primary schools through problem-based active learning has effect on student achievement" was verified with the results of analyses and observations. In their study upon determining effectiveness of problem-based learning model, Walker & Lofton (2003) found that students' willingness to learn increased and their attitudes improved in a positive manner. By benefiting from the problem-based learning model in teaching subject matters of analytic chemistry course to students, Ram (1999) came to the conclusion that there were positive progressions in students' attitudes towards the mentioned course at the end of his study. Besides in this study, students expressed that they found the opportunity to see practical fields of fundamental chemistry knowledge by transferring this knowledge to problems in daily life. The results of our research and of these studies seem to support each other.

At the end of the studies carried out by the students through problem-based learning model, it was observed that their cooperation with each other and social development were influenced positively and some positive changes occurred in their social tendencies such as making decisions together with other group members or acting in team spirit, etc (AAAS, 1993; Brooks& Brooks, 1993; Tobin, 1993; Gallagher, 1997; Herreid, 1997; Rhem, 1998; Greenwald, 2000; Chin & Chia, 2004). In the study conducted by Sharmann & Orth-Hampton (1995), the relationship between cooperative learning and self-efficacy belief levels of the pre-service teacher candidates on science was searched. At the end of this study, it was revealed that cooperative learning affected teacher candidates' self-efficacy levels on science positively. Problem-based learning is relied on group working and group solidarity in the same manner as cooperative learning. The rise in students' social development, information dissemination and activity in line with team spirit are unavoidable in the classroom wherein problem-based learning model involving group works and solidarity is used. These are qualities of great importance in terms of both social life and science education.

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