



The Effect of Scientific Studies on Students' Scientific Literacy and Attitude

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The purpose of this study was to investigate the effect of scientific studies on students' scientific literacy and attitude towards science course. For the study, a middle school science study group was established by randomly selecting 30 students from the 6th, 7th, and 8th grades. Participating students were given information about the programme. Students worked regularly for 12 weeks on topics of scientific research and held discussions on them. Students did research on information they collected during interviews. As a result, many students involved in the science group studies were able to increase their skills through discussion and exchange of views. Before the application, the students in the program were given a test which incorporated scientific literacy and attitude towards science course. Their attitudes about science were assessed and scored using a questionnaire. During the program of study, students were provided with discussion topics by the researcher. An additional goal was to encourage student participation in scientific processes. Twelve weeks after the application, the students were given the same questionnaire and test again. The data obtained were analysed using an SPSS program. Statistical results indicated that the students' scientific literacy had increased significantly, and that their attitudes towards science were more positive. In terms of both gender and class level of the students, a significant difference emerged after the application, when compared to before the application.

Key Words: Attitude; science education; scientific literacy; scientific study; elementary school.

Introduction

Attitude

Attitude can be defined and recognized as "a positive or negative position towards a situation, an object or an action" (Turanlı et al., 2008).

Attitude is not an observable behaviour; it is a trend which prepares the behaviour. It is associated with effectiveness of instruction and may be defined as 'positive or negative feelings about an object, human or subjects' (Petty and Cacioppo, 1996). At the same time, attitude can be a situation that prepares one's mental and neural state in response to anti-ideas. Pratkanis et al. (1988), define attitude as the evaluation of a person's knowledge about some objects (Bilgin and Karaduman, 2005).

According to Zacharias and Barton (2004) attitude:

- is resistant to time,
- can be learned.

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- is related to behavior and
- may be changed by personal beliefs.

The effect of students' attitudes on academic achievement in their lessons is generally well known. However, attitude plays a more important role in science classes as they involve the teaching of deep and complex concepts (Akıllı, 2008). The educational situation of students who reject the subject or are disinterested may be affected since they will not be participating in active learning, and this, in turn, may affect academic achievement. For this reason, for both teaching and learning the subject, willingness is an important prerequisite (Geba, 1996). According to this explanation, attitude may lead student behaviour (Tavşancıl, 2006). When a student develops a positive attitude towards classes in science and technology, it affects his future learning at the same time (Hamurcu and Özyılmaz, 2001). Students' attitudes towards science and technology lessons may influence their curiosity, critical thinking, creativity and cooperation (Harlen, 1998). Students' attitudes are effective when they are prepared (Akyol, 2007). Middle school education plays a most important role since at this level, students encounter science and technology classes for the first time and they develop their first impressions according to the environment and events they encounter (Çepni, et al., 2003). Therefore, developing positive students' attitudes is very important. To assess effective attitudinal characteristics which cannot be directly observed, indirect measurement is generally preferred. In addition, these characteristics are associated with the person's own willingness, not the person's own potential, so either long-term observations or simulations are used. Interest inventories as well as attitude and concept scales are examples of simulation assessment techniques (Özçelik, 1988).

A person's behaviour or work is observed or investigated in order to measure attitude which is not observed directly. Attitude is learnt and may be developed as behaviour as well. Parents are the most influential individuals in forming a child's attitude. Peer groups and teachers also influence children. In the absence of important experiences or events, the attitude acquired at an early age is quite stable and is not easily changed (Freedman et al., 1989; Kağıtçıbaşı, 1988).

Observation of effective characteristics over a long time period is difficult and thus presents problems in application; therefore, subjects are asked to specify what they would do in different given situations. Moreover, their attitudes need to be identified in these different situations. In this way, it is assumed that they will show the same behaviour in real life as they did in the simulations.

Attitude consists of three components:

- a. The central or emotional component
- b. The cognitive component
- c. The behavioural component (Atalay, 1998).

The emotional (central) component is verbal knowledge about an attitudinal matter; the cognitive component is an observable verbal response to an attitudinal matter; the behavioural component identifies all observable behaviours towards an attitudinal matter.

There are many factors that influence students' attitudes. These include gender, age, parents' educational level and occupation, the number of students in the classroom, the relationship with the lecturer, the desire to have a career in the science/ education field, the educational approach of the lecturer, etc. (Bilgin and Karaduman, 2005).

The emotional component, on which almost all the attitude scales are based, generally emphasises respect for others. This component explores subjects including like/dislike and approval/disapproval (Atalay, 1998). Ramnarain and Fortus (2013) drew attention to emphasis on the importance of academic studies as seen in different countries and regions.

Scientific Literacy

Scientific literacy includes literacy in science and technology. There are many definitions of scientific literacy as it is a very comprehensive subject with a very long history.

Turgut (2007) defines scientific literacy as 'the basic knowledge and skills needed by an individual to participate in democratic processes'. The term 'scientific literacy' was introduced at the end of the 1950s by Paul DeHart (Hurd, 1958). Hurd defines scientific literacy as 'making a decision which includes responsibility for science and technology, and having the intellectual knowledge and skills for cognitive movement' (Hurd, 1985).

Mathematical literacy, computer literacy, biology literacy, chemistry literacy, communication literacy, etc., have all emerged after the definition of scientific literacy (Çepni et al., 2006). Despite all these studies, there is no common definition of scientific literacy (Comfort, 1999; DeBoer, 2000).

Scientific literacy is the ability to live in a satisfying manner in harmony with the cultural environment. Hurd (1988) defines scientific literacy as 'a talent that enables people to think logically in the event of possible personal, political, or economic problems in their lives' (Mbajorgu and Ali, 2003).

Many countries attempt to make scientific literacy the main purpose of education. For example, Ramsuran and Malcolm (2006) discussed the policy-making process and established how policy writers had conceived the notion of scientific literacy in Curriculum 2005 in South Africa. Even though there are different definitions for scientific literacy, they all commonly include the talent for using scientific knowledge as well as thinking for personal and societal objectives. According to 'National Science Education Standards,' scientific literacy includes understanding scientific concepts and supporting cultural and economic production and the decision-making process (Mertoğlu and Öztuna, 2004).

Scientific literacy has been defined firstly as being familiar with natural life and knowing both its diversity and unity. In addition, it includes understanding the main concepts and principles of science, becoming aware of the relationship between science, mathematics and technology, comprehending that science, mathematics and technology are the production of human beings and recognising their power and limitations in various fields, having the capacity for scientific thinking, and using science and the way of scientific thinking for personal and societal objectives (YÖK, 1997: 1.9).

Scientific literacy can be defined as employing skills, attitudes, values and knowledge which are associated with science for critical thinking, problem-solving and decision-making processes, and being a lifelong learner (MEB TTKB, 2004).

Shamos (1995) divides scientific literacy into three sections:

- a) cultural scientific literacy,
- b) functional scientific literacy and
- c) true scientific literacy.

According to Shamos (1995), in cultural scientific literacy, an individual can recognize names, dates, places and words. A functionally scientific literate individual can write and read scientific concepts and discuss a science article by using scientific terms. According to Shamos' model, true scientific literacy, which is the highest level of scientific literacy, contains all science initiatives. A person who is at this level is aware of important concepts and theories, of how they are developed and the reasons they are accepted, and of the role of scientific experiments. In addition, the individual understands the importance of being impartial, asking proper questions, thinking analytically and using deductive reasoning to answer these questions (Turgut, 2005).

Showalter (1974) identified related literature covering a 15-year period and identified seven different dimensions of scientific literacy:

1. Understanding the nature of science
2. Using scientific concepts, principles, laws and theories in daily life
3. Using scientific processes for problem solving, decision making and developing a perception of the universe
4. Relating science and environment by using values which form the basis of science
5. Understanding the relationship between science, technology and society
6. Directing science education towards developing deeper and more satisfactory universal concepts
7. Developing skills which are particularly associated with science and technology (Turgut, 2005).

Miller (1983) divided scientific literacy into three dimensions:

- Understanding scientific method and laws (the nature of science)
- Understanding scientific terms and concepts
- Understanding the effect of science and technology on society (Science-Technology-Society Relationship).

The importance of scientific literacy is increasing daily; therefore, it is important that skills should be acquired in the early years of education. The expectation is that this developmental process will be enhanced for students who are educated in schools where systematic scientific literacy activities are implemented.

The assumption is that when scientifically literate attitudes are developed, development of problem-solving skills and academic success will follow.

Aim of the Study

The aim of this study was to investigate the effect of science programmes on scientific literacy and on students' attitudes towards the field of science.

Importance of the Study

Active learning methods play an important role in achieving the goal of science education. When students are educated in schools only to prepare them for real life, this situation actually hinders their preparation for life. The purpose of education is both to give information to the individual and at the same time to teach the individual how problems are solved. Those who are scientifically literate should be able to overcome difficulties in daily life, be sensitive to the environment, predict the results of globalisation and take appropriate measures. For this reason, science education should be started at an early age. The present study could be seen as having the characteristics of a camp that prepares students for their future lives. Students gain problem-solving skills and different perceptions and this works towards creating a scientifically literate society. In the present research project, students experienced a positive interaction between their school and their environment. Aldridge et al. (2011) suggested a link between the school-level environment and student outcomes.

The Problem

The problem identified in this study was: "What is the effect of science education on scientific literacy and on students' attitudes towards the field of science? The sub-problems covered were:

- a. Do science lessons have any effect on attitudes towards science?
- b. Does science education have any effect on scientific literacy levels?
- c. Do gender and class level have any effect on scientific literacy?

Method

In this study, a pre-experimental method was used. The group was given the same test before and after the study programme. The design of the pre-experimental model was used to achieve the objectives of the study. In analyzing the data, each individual's pretest score was subtracted from his or her post-test score, thus permitting the analysis of "gain" or "change" (Fraenkel et al., 2012; Karasar, 2012). The data were analyzed using the t-test and ANOVA.

Participants

This study involved 30 students (16 girls, 14 boys) in the 6th, 7th and 8th grades. Ten students were randomly selected from each class level. As all attended the same school, the socio-economic levels of the students were assumed to be fairly equal.

Variables

The variables of this study were the attitude towards the field of science and the level of scientific literacy. The attitude towards the field of science was measured by an attitude scale and scientific literacy was measured by a scientific literacy test.

Material development and Application Process

Firstly, the aims and goals of the study were identified. After determining the methods and steps, the process of gathering information was begun. In light of the obtained data, the method and all stages of the project were determined. Then, the steps were applied:

1. All tests and questionnaires were given to all students in the school and students were selected randomly for the programme group.
 2. The working process of the group was explained.
 3. The topics provided were studied regularly over a 12-week period and students were required to attend regularly. Students were given weekly topics. Group members reviewed the articles and took notes. Every week, a group of three or four students held an interview with members of the public on the current issue. In this way, students had the chance to compare the views of people who were uninformed on the subject. The group sessions started by reading the article of the week. Students expressed their views about the article and stated their ideas, some being incomplete or incorrect and others pertinent and thoughtful. At the end of the session, they received the following week's article. They also used the Internet to share views which they did not express at the meeting. Before the meeting, the results of the previous session were shared with the group.
 4. A planned work schedule was generally followed and the discussions did not exceed the level of the students.
 5. After 12 weeks, the questionnaire and test were given again and the study was completed.
- Finally, the results of the questionnaires and tests were evaluated and a report was prepared.

Applied test and scale

Science Attitude Scale (SAS)

The Science Attitude Scale (SAS), which is a Likert-type scale, was developed by Geban et al. and involves 10 positive questions and five negative questions. The results, calculated using Cronbach alpha, were 0.83.

The Science Attitude Scale was used to determine Students' attitudes towards science. Each statement on the questionnaire was scored as: "I: totally agree, agree, am not sure, do not agree and strongly disagree".

Scientific Literacy Test (SLT)

In order to measure the students' scientific literacy levels, a test consisting of 34 multiple-choice questions was given, with a reliability value of 0.81 (Keskin, 2008). The 34 questions included in the scientific literacy test were related to 17 features possessed by scientifically literate people.

Each question had three options. If students wrote D for their opinions in the application, these were evaluated by the researcher according to the closest answer. Answers scored as a true answer had 2 points; answers closer to a true answer had 1 point; and a wrong answer had no points (0). Questions 17- 22 involved graphics and each had only one correct answer. For the scientific literacy levels, the values were scored as: 0-0.66 (low), 0.67-1.32 (middle range) and 1.33-2.00 (high).

Results

a. Do science lessons have any effect on attitudes towards science?

It was observed that attitudes after the application were higher on the scale than before the application (see Table 1). There was a significant positive difference after the application. The study programme increased student attitude scores.

Table 1: Paired Sample t test results of Pre and Post-test According to Attitude toward Science

	N	\bar{X}	S	sd	t	p
Pre-test	30	38,50	3,026			
Post-test	30	44,03	2,953	29	-30,066	,000*

* p< .05

A more positive attitude goes hand in hand with an increased interest in the lessons and academic success.

b. Does science education have any effect on scientific literacy levels?

It was shown that scientific literacy level scores were higher post-application than pre-application. There was a significant positive difference after the application (see Table 2). The study programme increased student scientific literacy levels.

Table 2: Paired Sample t test results of Pre and Post-Test according to Scientific Literacy Level

	N	\bar{X}	S	sd	t	p
Pre-test	30	1,20	,1159			
Post-test	30	1,52	,1156	29	-19,839	,000*

* p< .05

When the concept of scientific literacy is considered as the main purpose of education, the contribution of studies like this will become more apparent. Scientific literacy involves the capability to use scientific knowledge and thought for personal and societal objectives. Accordingly, an increase in the level of scientific literacy serves social objectives.

c. Do gender and class level have any effect on scientific literacy?

There was no significant difference between female and male students when the pre-test mean scores were compared (see Table 3).

Table 3: Independent t test results of SLT pre-test according to gender variability

Gender	N	\bar{X}	S	sd	t	p
Girl	16	1,212	,114			
Boy	14	1,214	,094	29	-,046	,964*

*p> .05

Similarly, on the SLT, there was no significant difference between female and male students when the post-test mean scores were compared (see Table 4). These findings showed that such studies can be done regardless of gender variability.

Table 4: Independent t test results of SLT post-test according to gender variability

Gender	N	\bar{X}	S	sd	t	p
Girl	16	1,532	,145			
Boy	14	1,500	,110	29	-,262	,796*

*p> .05

On the SLT, there were no significant differences between female and male students when pre-and post-test mean scores compared (see Tables 3 and 4).

In addition, there was no significant difference according to classroom level pre and post-application (Table 5). These findings showed that such studies can be done regardless of class level variability.

Table 5: ANOVA results of SLT pre-test according to classroom variability

Variance Source	Sum of Squares	sd	Squares Mean	F	p
Intergroup	,001	2	,000	,029	,972*
	,314	27	,012		
Total	,315	29			

*p>.05

According to pre-test results, when the students' scientific literacy scores were investigated, there was no significant difference of SLT scores ($p = 0.972$) according to class level (see Table 5).

Table 6: ANOVA results of SLT post-test according to classroom variability

Variance Source	Sum of Squares	Sd	Squares Mean	F	p
Intergroup	,013	2	,006	,367	,696*
	,466	27	,017		
Total	,479	29			

*p>.05

Similarly, when the students' scientific literacy scores were evaluated, there was no significant difference of SLT scores ($p = 0.696$) according to class level (see Table 6).

Discussion

It is extremely important to provide more open environments for students where they can express their thoughts and feelings. The creation of debate opportunities supports and encourages the personal development and creativity of students. In this study, the students voiced their opinions about scientific issues in a debate setting.

Today, scientific literacy has gained great importance, and it seeks to systematically enable students. Studies which are based on constructivism should be done, but problem-solving skills, creativity and scientific literacy levels should be developed in the students as well. In this way, the self-confidence and personal development of the students will be supported and increased.

The activities in this study programme had a positive effect on student scientific literacy. Thus, similar applications can also make a positive impact on student scientific literacy. Özdemir and Üstündağ (2007) stated that the creative drama method helped students grow in their scientific literacy. Turgut and Fer (2006) noted that the constructivist instructional design application successfully developed the level of scientific literacy in prospective science teachers. According to the findings of Anagün's research (2011), 'spending time for learning' is the most predictive variable for the scientific literacy level of 15-year-old students. Other influencing variables such as performing experiments and employing inquiry-based learning activities can be used in the student scientific literacy level teaching-learning process.

During the study programme, students listened to their friends and commented on each other's ideas, therefore increasing their self-confidence. Students developed themselves by performing different tasks and recognising their interests and skills in certain areas. In order to develop student talents, these types of programmes should be implemented.

Student self-confidence increased during the programme since they shared their work with their friends.

In time, student interest increased and some students who actively participated in debates took on more responsibility. The students indicated that they felt differently about studying in school and about this programme that they were privileged to participate in. These kinds of study programmes could be increased and organised for all students in order to encourage them to be self-confident and willing to take more responsibility.

Increased development of student reasoning skills was also observed during the programme, evidenced by the fact that the students specifically declared that they did not believe news which did not depend on scientific knowledge. To increase student reasoning powers, these kinds of skills need to be developed. The students also declared that they were pleased when their work was presented in front of their friends, so they tended to study more. Consequently, they did not want to waste their accomplishments and they wanted to increase their academic success. The most important objective of this study was to increase student scientific literacy levels and as well as to support the students in becoming inquisitive, self-confident, problem-solving individuals. When a suitable environment is prepared, then achieving such objectives is not difficult. Stears and Gopal (2010) suggested that different approaches to teaching and assessment are required to accommodate the various ways in which learners construct knowledge in social settings.

According to the results of this study; science studies programmes have positive effects on the attitude toward science. Because this attitude has a positive effect on academic achievement, the results of the study are more meaningful. Developing positive attitudes towards science is one of the main goals of science education. Demonstrating positive attitudes towards science would increase scientific success and interest in scientific fields (Lavoie, 1999; Cannon and Simpson, 1985; Schibeci and Riley, 1986). Students should be allowed to ask questions and to do more research. Ramnarain (2011) stated that by asking questions and making inquiries, students in South African schools were encouraged in making scientific investigations.

The findings of the present study have been examined and show that science studies positively affect student development and that appropriate systematic studies should be planned. Therefore, the desired level for student objectives can be reached. Similar studies should be done at every class level, for all ages, and in associated courses. Fazio and Spagnolo (2008) believe that experimental considerations of this type can supply useful indications for deeper theoretical-experimental knowledge about epistemology, the history of science, and future teachers' conceptions with respect to the discipline they are going to teach. Botha and Reddy (2011) suggested that this type of research, if used in undergraduate teacher education programmes, would enable a better uptake of various knowledge domains and improve pedagogical content knowledge development. Ndlovu (2011) advanced the idea that this type of research would make a good university-school partnership project.

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Bilimsel Çalışmaların Öğrencilerin Bilimsel Okuryazarlıklarına ve Fen Bilimleri Dersine Karşı Tutumlarına Etkisi

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Bu çalışmanın amacı; ilköğretim okullarında öğrenim gören öğrencilerle yapılan bilimsel çalışmalarının öğrencilerin bilimsel okuryazarlıklarına ve fen bilgisine karşı tutumlarına etkisini araştırmaktır. Çalışmanın araştırma grubunu ilköğretim 6., 7. ve 8. sınıflardan öğrenim gören 30 öğrenci oluşturmaktadır. Her sınıf düzeyinden 10'ar öğrenci rasgele seçilerek çalışma grubu kurulmuştur. Araştırma deseni öntest-sontest tek gruplu modeldir. Öğrencilere Bilimsel Okuryazarlık Testi ve Fen Tutum Ölçeği öntest olarak uygulanmıştır. Öğrencilere düzenli olarak 12 hafta boyunca bilimsel bir makale verilmiştir. Öğrenciler makale konusu hakkında araştırma yapıp sınıf ortamında tartışmalarda bulunmuşlardır. Çalışmalar boyunca öğrencilere tartışma konuları araştırmacı tarafından verilmiştir. Oturumları araştırmacı yönetmiştir. 12 haftalık uygulamadan sonra aynı ölçek ve test sontest olarak uygulanmıştır. Araştırma sonuçlarına göre, bilim kurulu çalışmalarının öğrencilerin, fen bilgisine karşı tutumlarına ve bilimsel okuryazarlıklarına olumlu etkisi olduğu görülmüştür. Çalışmaya katılan öğrencilerin cinsiyet ve sınıfları bakımından, uygulama öncesi ve uygulama sonrası aralarında anlamlı bir fark olmadığı belirlenmiştir.

Anahtar Kelimeler: Tutum; Fen Eğitimi; Bilimsel Çalışma, Bilimsel Okuryazarlık, Tutum.

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