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Selected Research Dealing with Attitudinal Studies in Science Education

Fen Bilgisi Eğitiminde Tutumla İlgili Çalışmalardan Seçilmiş Araştırmalar

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Abstract

The importance of science education is increasing all over the world. One of the main objectives of science education is to make scientifically literate students or citizens rather than scientists. Despite this, science courses in schools tend to lose the students' interest. Many studies reveal that students' negative or positive feelings about science are related to their attitudes toward science. There are different factors shaping their attitudes. To understand and measure students' attitudes toward science, and in some cases, toward science teaching, researchers have so far developed numerous instruments. Studies have revealed that students' positive attitudes toward science begin to decrease from 5th grade to the upper grades, and this situation affects their achievements in science and their understanding of scientific concepts. In this context, elementary science, the other subject teachers, the school curriculum and environment play major roles in influencing students' attitudes toward science.

Key words: Science education, attitudinal studies.

Öz

Dünyada fen bilgisi eğitimine önem verme eğilimi artmaktadır. Fen bilgisi eğitiminin başlıca önceliklerinden birisi de fen bilgisi açısından okuryazar öğrenciler veya vatandaşlar yetiştirmektir, ama bilim adamı değil. Bunun yanında okullarda fen bilgisi dersine karşı öğrencilerin ilgisi azalmaktadır. Birçok çalışma, öğrencilerin fen bilimlerine karşı olumlu veya olumsuz tepkilerinin nedeninin, bu derse karşı tutumlarıyla ilgili olduğunu göstermiştir. Onların tutumlarını biçimlendiren birçok faktör vardır. Fen bilimlerine yönelik, bazı durumlarda fen bilgisi öğretmeye karşı tutumları anlamak ve ölçmek için araştırmacılar değişik araçlar geliştirmişlerdir. Öğrencilerin fen bilimlerine yönelik tutumlarının beşinci sınıftan itibaren azalmaya başladığı ve bu durumun öğrencilerin fen bilgisi dersindeki başarılarını ve bilimsel kavramları anlamalarını etkilediği, çalışmalar ile ortaya çıkmıştır. Bu bağlamda, sınıf, fen bilgisi ve diğer branş öğretmenleri, okul programları ve çevresi, öğrencilerin fen bilimlerine karşı tutumlarını etkilemede büyük bir rol oynamaktadır.

Anahtar sözcükler: Fen bilgisi eğitimi, tutumsal çalışmalar.

Introduction

The term "attitudes" can be used in different contexts. In education, it refers to the interests of students towards courses or certain subject areas. There are different definitions of "attitude". According to Openheim (1992, 174), attitude is "a state of readiness, a tendency to act or react in a certain manner when confronted with certain stimuli". In the world, almost every school curriculum has one science course, at least. On the other hand, mostly, for students, science and math courses are not easily welcome subjects. As a result, generally, students' interests are declining. Of course, there will be several reasons for this decline, but one of them is probably the students' attitudes toward science. Also, research has shown that science as well as elementary and other subject-area teachers play a vital role in influencing students' attitudes towards science. On this point, the question "what do science and elementary teachers think about teaching science courses?" has

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importance because one study conducted by Baykul (1990) revealed that Turkish students' attitudes toward science and math courses decrease while their grade levels increase, especially after 5th grade. The students in that study (Baykul, 1990) indicated that the contents of science books and attitudes of elementary and science teachers attitudes toward science courses affected their attitudes.

This paper presents a general literature review on attitudes toward science and science teaching, measuring attitudes including the Turkish dimension. In many countries, a Likert scale attitude measurement test toward science, as well as science teaching, is widely used as a translated or original version (SAI, STAI, SAI-II, STAI-II) (Moore and Sutman, 1970, Moore, 1973, Moore and Foy, 1997). Therefore, this review can be titled a selected research dealing with attitudinal studies in science education and it consists of three main considerations of attitudes in science education: (1) a history of measuring science-related attitudes including scientific attitudes, and attitudes toward science and science teaching, (2) a review of the scientific attitude inventory and science teaching attitude inventory/scale (SAI, STAI, SAI-II, and STAS-II) used in research, and (3) a review of the attitudes toward science and science teaching in Turkey. This literature review reveals the importance of encouraging positive attitudes toward science and science teaching, and the lack of research addressing attitudes toward science and science teaching in Turkey.

A History of Measuring Science-Related Attitudes

"The Immigrant Polish Peasant Attitude in the USA" (1918) might be accepted as the first attitude study in behavioral psychology (Shrigley, Koballa, and Simpson, 1988). However, in science education, one of the first studies came from the Wisconsin State of Science Committee. The committee prepared a statement regarding the philosophy of teaching and teaching of the scientific attitudes. As a result of this attempt, a "scientific attitude" journey began (Skewes, 1933). In the same year Hoff (1933) developed a test called "A Test For Scientific Attitude." Hoff (1933) raised the question "Can Scientific Attitudes be Measured?" In addition to raising this question, he defined scientific attitudes. The test included 150 items. It was a likert-type scale test even though the type of test was not mentioned. It was prepared for high school students. Hoff's test had five categories: "(1) Conviction of universal basic cause and effect relations rendering untenable, . . . (2) Sensitive curiosity concerning reasons for happenings, coupled with ideals, . . . (3) Habit of delayed response, holding views tentatively for suitable reflection (varying with the matter in hand), (4) Habit of weighing evidence with respect to its pertinence, soundness, and adequacy, and (5) Respect for another's point of view, an open-mindedness and willingness to be convinced by evidence" (pp. 763-764).

In the questionnaire, some categories reflected aspects of the nature of science. At that time, attitudes were not explicitly mentioned as a part of the nature of science. Currently, they can be so categorised. The main purpose of the test was to observe how secondary school students' attitudes change as a result of their science classes (Hoff, 1933).

Davis (1935) attempted to prepare an instrument to measure the scientific attitudes of science teachers rather than students. According to this test, 92% of Wisconsin science teachers were willing to change their idea based on evidence, 89% had a tendency to search for the whole truth regardless of personal, religious or social prejudice, and 81% possessed freedom from superstitious beliefs. In this research, Davis (1935) first defined the term "scientific attitudes." Another finding of this study was that science teachers had difficulties understanding the difference between theory and fact. Later, this test was adapted in studying high school students' scientific attitudes.

Ebel (1938) approached the definition of scientific attitude differently. He thought it was a fundamental obligation of teaching science. The important point here is that scientific attitude was considered to be a part of science teaching because it was believed that the scientists' attitudes could contribute to their scientific achievement. Also, Ebel (1938) indicated that although scientific attitudes cannot be observed directly, they can be seen through behavior. Therefore, characteristics of scientific attitude might be inferred from observed behavior. Ebel's final definition was that "a scientific attitude is an attitude which will tend to foster scientific achievement." As determined, scientific attitude was the reason for scientific achievement and was closely related to the scientific method (Ebel, 1938). With the

preparation of the Wisconsin philosophy of Science Teaching, scientific attitudes were to be one of the first priorities of science education in the last 60 years.

Between 1938 and 1952 there was no significant study dealing with scientific attitudes. However, Mason (1952) thought that scientific attitudes and thinking could be taught by applying different teaching methods in science courses. Therefore, he used two different instructional methods: (1) a descriptive, and (2) specific lessons in scientific thinking in order to measure changes in scientific thinking and attitudes in a normal semester college biology course. Mason (1952), also, assumed that although scientific attitude and thinking were very closely related to each other, they were separate and individual entities. In order to think scientifically, students should develop "(1) ability to recognize cause-effect relationships; (2) ability to interpret data and draw conclusions therefrom; (3) ability to recognize and test hypotheses; (4) ability to recognize and solve problems; and (5) ability to critically evaluate experimental procedures and real situations having scientific implications" (p. 271).

Two different instruments were used in this study: Nool's "What Do You Think Test?" and the Comprehensive Examination in Biological Science and Scientific Thinking Test. The findings of the study were surprising because the two methods did not show significant differences in teaching scientific attitudes. Their effectiveness was equal. In some cases, the descriptive teaching method was much better than the scientific teaching method (Mason, 1952).

Kahn (1962) investigated junior high school boys, between grades 7 and 8, to examine whether or not current science events positively change students' scientific attitudes. As a research instrument, Nool's "What Do You Think Test?" was used in this study. The purpose of Kahn's (1962) study, again, was to teach scientific attitudes by applying current science events in instruction. In the study, the findings revealed that students who took science courses at 7 and 8 grades showed significant differences from those who were taught using the normal method. Unlike Mason's (1952) study, Kahn's research indicated that if science teachers included some different methods, such as dealing with current scientific events, students' scientific attitudes might be positively changed (Kahn, 1962).

Dutton and Stephens (1963) came up with a different term called "attitudes toward science." Until then, the term "scientific attitudes" was used both for the attitudes which a person possesses, (such as open-mindedness) and attitudes toward science. Dutton and Stephens defined this term as how one feels toward science. First they chose a group of elementary teachers and asked them what they thought about science. Using these data, Dutton and Stephens (1963) converted their instrument to a Thurstone scale test. In Thurstone scale tests, subjects respond using a scale from dislike (1) to like (11). The final instrument contained 20 statements about science.

The study group comprised university students who would be elementary school teachers after graduation. Pre-service elementary teachers liked most of all "exploration, understanding the world and life, practical application" and disliked most of all "lack of participation, book learning, technical aspects, no opportunity to experiment." Interestingly, pre-service elementary teachers mostly disliked "work with animals and plants, for example dissecting and crawling bugs, snakes, and insects" (Dutton and Stephens, 1963).

Baumel and Berger (1965) also attempted to measure scientific attitudes. They clearly expressed that "scientific attitudes are one of the most important outcomes of science teaching and they are equal to the knowledge objective of science instruction." He suggested that teaching scientific attitudes might be a systematic part of the science curriculum. The results both of Noll (1935) with high school students and of Baumel and Berger with pre-service teachers (1965) show that there is no relationship between high grades in science courses and scientific attitudes. Therefore, according to Baumel and Berger (1965), every student is capable of developing scientific attitudes regardless of their achievement in science.

After the 1960's, the number of tests measuring scientific attitudes and attitudes toward science increased. Some were widely used for middle school, high school and college students, and elementary and science teachers. They can be classified into three categories: (1) understanding of science and the nature of science, (2) measuring intellectual, and (3) emotional reaction to science.

Cooley and Kloper (1961) developed an instrument to measure students' understanding of science and scientist. This test, known as the "Test on Understanding Science" or TOUS, contains 64 multiple choice items. By design, every statement only has one correct answer. The reported reliability of the test is 0.76. It encouraged development of another test known as the Nature of Science Scale (NOSS) by Kimball (1968). This instrument contains 29 Likert-scale items derived from extensive study of the literature and the nature and philosophy of science. The validity of this test was confirmed by panel judges and its reliability is 0.54. The answer for the statements was limited, such as agree, disagree, and neutral for NOSS. The Scientific Process Inventory (SPI) was prepared by Welch and Pella (1968). This inventory has 150 items asking respondents to "agree" or "disagree." The statements of SPI were validated by panel judges and the scoring of SPI was the number of agree responses for each respondent. Its reliability is 0.79. Lowery (1966) prepared a test called the Protective Tests of Attitudes (PTOA) which is an open-ended questionnaire. The purpose of this test is to measure attitudes overlooked by the usual techniques using scales such as the Likert or Thurndike scale. This test also has three different parts: "(1) the respondent needs to provide words associated with stimulus words, (2) the respondent gives meaning to a neutral situation presented in a picture, and (3) the respondent completes the sentence" (pp. 495-496). The reliability of test ranges from 0.81 to 0.94.

Vitrogen's (1967) and Schwirian's (1968) tests relate to intellectual reaction to science. Vitrogen's test, prepared to investigate high school students' attitudes toward science, contains 40 test items derived from scientific papers, philosophy and nature of science, and science educators. The items can be classified in two categories - negative and positive attitudes toward science (Vitrogen, 1967). There are ten statements for each pair of attitudes responses ranging from strong support to strong opposition as in a Likert type scale. Validity of this test is based on the discriminating ability of the items, and its reliability was reported to be 0.88. Vitrogen's test can be classified as reaction to science because the statements used in the instruments seem to be based on knowledge of the nature of science.

Schwirian (1968) developed a test, known as the Science Support Scale (SSS), containing 40 Likert-scale type statements reflecting five cultural values, such as the attitude of rationality and universalism in science. The reliability of SSS is, as reported for total scale, 0.873, which is quite high (Schwirian, 1968).

During the same years, tests were prepared to measure one's emotional reaction to science, such as feelings towards science. For example, Dutton and Stephens (1963) prepared a test that has 20 items scored using a Thurnstone-type scale. The test's reliability is 0.93. Moore (1969) noted that although there are different instruments developed to measure scientific attitudes and attitudes toward science, none deals with high school students or desires for a scientific career. Moore's Scientific Attitude Inventory (SAI) and Science Teaching Attitude Inventory (STAI) will be examined later.

Aiken and Aiken (1969) pointed out that although studies concerning attitudes in science education were increasing in number, they are not very highly consistent with the nature and causes of science attitudes. Aiken and Aiken (1969) drew attention to the fact that researchers, by using different terminology for attitudes, were confusing what they were studying. For instance, the literature contains title categories such as (1) science attitudes, (2) attitudes toward science and scientists, and (3) scientific attitudes. Moreover, in some cases, "scientific attitudes" may cover all types of attitude research in the science education area. Therefore, Aiken and Aiken (1969) tried to give exact definitions to the attitude-related terms used in science education. Moreover, they found that, generally, math education teachers are aware that attitudes are part of their instructional task but science teachers are not and they recommended preparing a precise instrument to measure attitudes in science education.

Hughes (1971) focused on elementary teachers' attitudes towards science because much research shows their critical role in developing positive attitudes toward science. In addition, the combination of teachers, curriculum, and science text books might be responsible for students' forming science misconceptions. That is why developing positive attitudes toward science in elementary and science teachers can be done by means of a science teaching method course at the college level.

Hughes' study (1971) showed that pre-service elementary teachers' attitudes toward science could be significantly improved if enough attention was given to attitudes and the nature of science. Schwirian and Thomson (1972) conducted a study at the college level. They compared the attitudes toward science of two different student groups, one enrolled in 1967 and one in 1971 in a Midwestern university. They used the Schwirian Science Support Scale as their instrument. In addition to analyzing attitudes, changes toward science between 1967 and 1971, they used two-way ANOVA to examine age, sex, religious preference, father's education, mother's education, father's occupation, academic major, home town size, and type of high school. As an independent variable, home town size showed significance in both 1967 and 1971 students.

Billey and Zakhariades (1975) prepared an attitude test called the Scientific Attitude Scale (SAS), a Thurnstone-Chave scale test. The SAS contained 36 items. One important feature is that it was the first foreign test prepared (Cyprus and Lebanon) outside the USA. The target population for this test involves every group, such as elementary and science teachers, college students, high and middle level schools students. Billey and Zakhariades (1975) explicitly itemized the scientific attitudes as: "(1) rationality, (2) curiosity, (3) open-mindedness, (4) aversion to superstitions, (5) objectivity-intellectual honesty, and (6) suspended judgment." The validity of SAS was controlled by panel judges from the American University of Beirut and Cyprus. The reliability of SAS was calculated by split-half technique and found to range from 0.55 to 0.74. The SAS indicated that the amount of science knowledge affected positively the scientific attitudes.

In American universities and colleges, science courses are part of the general education requirements for all students (Sadava, 1976; Kuhn, 1973). In recent years, many universities and colleges have designed some science courses for non-science majors. One of the important reasons for this is to affect students' science attitudes positively (Kuhn, 1973). Sadava (1976) compared students with non-science majors to the general public to determine if science courses positively affected their attitudes toward science. The results of this study were surprising. Students exposed to a science course in three liberal art colleges had more negative attitudes toward science than previously. They also had more negative attitudes than the general public. One of the reasons for these results might be that the science course did not involve the nature of science and scientific methods.

Kozlow and Nay (1976) noted that many of the numerous tests of science related attitudes have shortcomings such as their use of Likert and Thurnstone scales. For these reasons, they designed another test called the Test on Scientific Attitudes (TOSA). This is a multiple choice, cognitive test developed for high school students (Kozlow and Nay, 1976), but its reliability (0.55) seems to be too low for general acceptance. However, they found that, generally, science teachers tend to ignore the teaching of the nature of science, scientific thinking, and methods of science although one of the important objectives of science education is improvement of science attitudes (Gardener, 1975; Kozlow and Nay, 1976).

Fraser (1978) prepared a Likert-scale test called Test on Science Related Attitudes (TOSRA). The test contains seven different categories: "(1) Social Implications of Science, (2) Normality of Scientist, (3) Attitude Toward Scientific Attitude, (4) Adoption of Scientific Attitudes, (5) Enjoyment of Science Lessons, (6) Leisure Interest in Science, and (7) Career Interest in Science." These subscales make the test different. The reliability (test-retest method) of TOSRA is 0.78. Fraser suggests this Australian test be used to monitor students' achievement of attitudinal aims over a period of time (Fraser, 1978).

In addition to Aiken and Aiken's (1969) first time classification of science related attitudes, Gauld and Hukins (1980) clearly distinguished "attitudes toward science" from "scientific attitudes" (e.g., open mindedness, honesty, and skepticism). They classified Moore and Sutman's (1970) Scientific Attitude Inventory (SAI) under attitudes toward science. If improved attitudes are beneficial to classroom teachers, Gauld and Hukings (1980) recommend giving more attention to studying the effects of particular teaching strategies and to student teachers.

Hough and Piper (1982) and Gauld (1982) directed attitudinal research in science education to science achievement. They used the "Hough Attitude Inventory" and "Hough Pupil Process Test." Following directed

instructions to elementary and middle level science students, they found a significant relationship between the pupils' residualized gain scores in achievement and their residualized gain score in attitudes (Hough and Piper, 1982).

Cannon and Simpson (1985) investigated relationships of attitude, achievement, gender, and time in middle level science and life science courses. They found that students' attitudes toward science were more positive at the beginning than at the end of school year regardless of gender. On the other hand, they found that male and female students' attitudes were significantly different; boys generally had much more positive attitudes toward science. Moreover, these results paralleled student achievement in life science courses (Cannon and Simpson, 1985). Smith and Erb (1986) reported attitude differences in gender, that female students' attitudes toward science could be changed positively by teachers giving and showing examples of female scientists in community and society by teachers.

Koballa and Crawley (1985) provided clear definitions of attitudes toward science such as "I like science" or "I hate science." Responses to these kinds of statements indicate a general positive or negative feeling toward science or scientists. In addition to these, attitudes are not inherited but learned over a period of time. Changing them sometimes takes years. Teachers, parents, peers of students, and classroom environment bear responsibility for perpetuating and changing those attitudes (Koballa, 1988; Koballa and Crawley, 1985; Shrigley, Koballa and Simpson, 1988).

Tamir and Amir (1987) investigated "the relationship between instructional strategies, study practices, and attitudes toward biology." They studied 10th grade Israeli high school students taking high school biology courses. They also used the Description of Science Instruction and Learning Inventory (DES) and the Attitude to Biology Scale (ABS) as their tests. There were two variables, teaching by inquiry and organized instruction. The results showed that students taught by inquiry had increased achievement and had more positive attitudes toward science than those taught by organized instruction. However, when the students got older, their positive attitudes declined.

Germann (1988) developed a new test called the Attitude toward Science in School Assessment (ATSSA) containing 24 items, Likert-scale type test. Validity was tested by panel judges and Cronchbach's alpha reliability was 0.93. Using the ATSSA, Germann found that attitudes toward science were influenced by several factors: teachers, classroom environment including physical conditions and environments, the subject matter, labs, lab reports, science homework, the science text, and science reading. Also, he showed that social factors' relations such as a student's peers, family, belief systems, and school are important. Moreover, students who have positive attitudes toward science are more involved in classroom instruction, lab exercises, studying, and home work than those who have none or have negative attitudes toward science (Germann, 1988). This could be another explanation of positive relationships between achievement and attitudes in science education.

Oliver and Simpson (1988) studied the relationship between achievement and attitudes toward science in a longitudinal manner between grades 6 and 10. They found that attitude was not only a predictor of achievement (accounting for a large part of achievement in science courses), but also that affective behaviors, including positive attitudes toward science, in the science classroom, are strongly related to achievement. A cross-cultural study revealed that while 47% of American students disbelieve human evolution and believe in lucky numbers, 12% of Japanese students disbelieve human evolution, and 34% of them believe in lucky numbers. This indicates that different belief, value, and cultural systems influence the understanding of science (Holden, 1988).

Eichinger (1992) studied whether or not career choice is affected by (1) the number of science courses taken during high school, (2) science teachers, (3) science achievement, and (4) classroom environments. This study showed that students who chose science as their major in higher education possessed highly positive attitudes toward science. The study also showed that career choice of science major students was influenced mostly by science teachers and classroom environment (Ebenezer and Zoller, 1993; Eichinger, 1992; Myers and Fouts, 1992).

In addition to the gaining of positive attitudes toward science, another major goal of science education during the past 15 years has been "Science, Technology, and

Society" (STS) (Tamir, 1994). While most research with science related attitude in education come from the USA and, in some cases, from Australia, the United Kingdoms, and Israel, there are studies relating attitude toward science in the other parts of the World.

The Scientific Attitude Inventory and Science Teaching Attitude Inventory (SAI, STAI, SAI-II, and STAS-II) Used in Research

Munby (1983) reported that since 1970, there have been at least 30 studies using the Scientific Attitude Inventory (SAI) developed by Moore and Sutman (1970). Although there are several instruments to measure science related attitudes, most investigators prefer to use the SAI. This choice has received some criticism by science educators (Munby, 1983; Munby, 1997).

Each research instrument prepared by science educators and used to measure science related attitudes covers some of the elements listed below:

"1. Preparation based upon specification of the particular attitude to be assessed.
2. Use of several items to assess each attitude.
3. Provision for the respondent to indicate the extent of his acceptance or rejection of an attitude statement.
4. Concern with intellectual and emotional scientific attitudes." (Moore and Sutman, 1970, 85)

SAI covers all the characteristics of an instrument measuring students' attitudes toward science. The original instrument uses a Likert-type scale, has 60 items with six sub-scales, each of which has two parts (A and B), worded as positive and negative statements about science. For instance, "1-A: The laws and/or theories of science are approximations of truth and are subject to change (positive); 1-B: The laws and/or theories of science represent unchangeable truths discovered through science (negative)." Half of the statements are negative and the other half are positive. Subjects can respond in four ways: "strongly agree, agree, disagree, and strongly disagree". The scores of SAI range between 60-240 points. Scores between 60-120 indicate that the respondent has a negative attitude toward science; scores greater than 120, indicate positive attitude toward science. Panel judges (science educators and science teachers) confirmed its content validation. A study was designed to understand construct validity by randomly forming a control and experimental group from high school students. A field test of the SAI showed that students' pre- and post-test scores were significantly different in an experimental group given special instruction emphasizing the nature and methods of science. The reliability of the SAI was 0.93 as determined by test-retest method (Moore & Sutman, 1970).

Moore (1973) also developed an instrument called the Science Teaching Attitude Inventory (STAI) to examine attitudes of those teachers teaching science in elementary and secondary schools. The STAI covers four sub-scales of the SAI, and has a total of 70 statements, forty of which belong to the SAI as well. The teaching part has three sub-scales with the same format as the SAI. For example, "2-A: There are certain processes in science which children should know, i.e., children should know how to do certain things; 2-B: There are certain facts in science that children should know." Content validity of the STAI was reviewed by nine panel judges and elementary school teachers. Validity of the STAI was examined using a field study during an in-service elementary teachers' summer workshop. The teachers exposed to special instruction by the investigator showed significant pre- and post-F ratio tests (beyond 0.01 level). The reliability of the teaching part of the STAI was found to be 0.816 using the test-retest method (Moore, 1973).

Moore assessed 672 ninth-grade students' attitudes toward science using the SAI (Moore, 1971). In this study, four positive and negative sub-scales were mildly accepted and rejected by the high school students. This student group was neutral on one negative scale (the laws and/or theories of science are unchangeable truths) and accepted one negative scale (science is a technological activity to be valued for its practical uses and service to man). In summary, these students did not strongly accept reject positive and negative attitudes toward science; nor did they seem to understand the nature of science correctly (Moore, 1971).

Gieger (1973) conducted a study of 142 students in three different junior colleges in Mississippi. Those college students accepted all positive sub-scales as well as rejecting negative sub-scales. Also, other school variables, for example number of science courses taken

in high school, race, gender, school year (freshman and sophomore students), science majors, and non-science majors were examined. However, the author did not use statistical techniques on this data so no relationships between these school variables were determined. Nevertheless, Gieger (1973) found a positive relationship between attitude toward science and mathematics among junior college students.

Moore (1975) used the STAI to assess the attitudes of 31 elementary teachers in the Cooperative College School Science (CCSS) project. The 31 elementary teachers participated in a workshop during the summer of 1971. Their post-workshop attitudes toward science and science teaching were determined using the STAI. In the following years (1972 and 1973), the STAI was readministered and the scores were compared with the 1971 post test scores. The results showed that there was a significant decrease in their attitudes toward science and science teaching. On the other hand, after the summer workshop of 1971 their post-test scores increased significantly (One-way repeated ANOVA, $P < 0.05$). In conclusion, the change of attitudes during a summer workshop might not be permanent (Moore, 1975).

Lawrenz (1975) used multiple instruments, one of which was SAI, to examine teacher characteristics and student outcomes in science courses. The study used 236 secondary school science teachers randomly selected from 14 different states. These teachers' and their students' attitudes toward science were examined with different instruments. This research showed that students' achievement and attitudes were correlated with teachers' ($r = 0.61$) characteristics. Students' knowledge of the science process and of science subject matters are not related to their achievement.

Earl and Winkeljohn (1977) examined the different attitudes toward science and science teaching between elementary school teachers teaching in self-contained classrooms and elementary school science teachers working in a cooperative setting. In this study, 101 elementary teacher volunteers were selected in a six-county area of Western Ohio, and their attitude toward science and science teaching were evaluated using the STAI. These two groups did not differ in their attitudes toward science but differed significantly in their science teaching attitudes (T-test, $p < 0.05$). That is, elementary school teachers responsible for teaching science in a cooperative format had significantly more positive attitudes toward science teaching than those who teach in a self-contained format (Earl and Winkeljohn, 1977).

Gabel (1980) studied the attitudes toward science and science teaching of the science, non-science, and elementary education major students. The attitudes of 198 students were assessed using the STAI in a university. Science majors and non-science major students taking more than four science courses were significantly more positive toward science and science teaching than the others. Elementary teacher candidates who generally took two science courses were not significantly different from those who were non-science majors (Gabel, 1980).

Bonnstetter (1984) studied the characteristics of teachers associated with exemplary programs in high school. One of the purposes of this research was to determine what constitutes the exemplary teachers' attitudes toward science. Two-hundred and thirty-one exemplary teachers were chosen nationwide. The SAI was one of the instruments used. Generally, exemplary science teachers possess more positive attitudes toward science than the average science teachers. However, they had difficulty differentiating science from technology.

Finson and Enochs (1987) examined whether extracurricular activities in the context of STS (Science Technology and Society) could change attitudes toward science. Their results showed that students taking part in some extra activities (such as visiting a science and technology museum) had significantly more positive attitudes to science than other students. Other variables examined such as grade level, school type, and gender showed no effect (ANCOVA, $p < 0.05$).

The STAS was translated into Arabic by Ateaq (1995) who used it to study the attitudes of pre-service male elementary science teachers in Riyadh Teachers college. Because of the Islamic law in Saudi Arabia, he was not allowed to carry out his study in a female teachers college. Hence the findings in his dissertation cover only 200 male pre-service teachers' attitudes toward science and science teaching. Saudi Arabian pre-service male elementary science teachers had positive attitudes toward science with no significant differences between any classes such as freshmen and sophomores.

However, the freshmen's attitudes toward science teaching were significantly less than those of sophomore, junior, and senior pre-service elementary science teachers. The results of the sub-scales of the STAS were not reported in this study.

After Munby's (1983) criticism of the SAI with respect to its validity and reliability, Moore and Foy revised both the SAI and STAI both of which were renamed as SAI-II and STAS-II, respectively. The major revisions were: (1) decreasing the number of statements from 60 to 40 items; (2) removing or changing gender bias statements; (3) putting in a neutral choice for respondents; and (4) increasing its content, construct validity and reliability (split half coefficient = 0.805) after several field tests. Moore and Foy (1997) reported that the SAI and STAI were requested by some investigators in foreign countries and translated to their languages, e.g., Spanish, Hebrew, and Thai.

Attitudes toward Science and Science Teaching in Turkey

It is difficult to find Turkish studies related to attitudes toward science and science teaching. Although there are some attitude tests and studies, they have been mostly conducted in the social science area. The most comprehensive attitude test related to scientific attitude is that of Baykul (1990). Baykul, between 1985-1986, conducted a study of 6,131 students from 5th grade to 11th grade. Students were chosen from three provinces (Bursa, Elazıg, Isparta) of Turkey. These provinces are located in different parts of country, Bursa being a northwestern province, Elazığ an eastern province, and Isparta an inland Mediterranean province. Baykul developed as an instrument with a Likert-type scale, having 30 statements, half of which are positive, and half of which are negative statements. Some examples of this test statements (translated from Turkish to English by Türkmen) are as follows:

1. In the future, I want to choose a scientific career. . .

6. I do not like science courses. . .

23. I think science courses are the most interesting courses in schools. . .

29. I do not believe that scientific subjects are important in daily life... (Baykul, 1990, 62).

As shown by these examples, the statements do not deal with the nature of science and the method of science. Its content validity was confirmed by educators, and science and elementary teachers. The reliability coefficient (alpha) is 0.94.This study showed that students' attitudes toward science dramatically decrease from 5th grade to 11th grade. Another important finding of this study was that high school students have more positive attitudes toward science than other vocational high school students (Note: in Turkey, there are different types of high schools: general high schools, girls vocational high schools, preacher and religious high schools, vocational high schools, and commerce high schools).

In recent years, the number of studies related to attitudes toward science or science teaching seems to be increasing. There should be some reasons for this increase, one of which is that teachers' colleges (colleges of education) in Turkey were reorganized so that most science education departments were constrained to teach science education subjects but not the pure science subjects. As a result, every year, the number of science educators, research projects and academic studies seems to be increasing. It is necessary to report some of these studies related to attitudes toward science and science teaching. Kaptan (1995) studied attitudes of pre-service elementary teachers in Hacettepe University toward elementary teaching. The results indicated that female pre-service elementary teachers had more positive attitudes toward elementary teaching than their counterparts.

Some studies are not directly related to attitudes toward science or science teaching but it is necessary to report some of them here to some extent. Berberoğlu and Tosunoğlu (1995) developed a 4-dimensional Environmental Attitude Scale. In their study, they tried to reveal Turkish university students' attitudes to the environment and tried to compare their findings with those of western studies. They found some cultural differences in this matter.

Some early studies dealing with attitudes toward science considered the areas of computer-assisted instruction or education in science. Generally, in these studies, the effectiveness of computer assisted instruction was compared, based on the pre and post test results and looking for any attitudinal change between pre and post test session toward science as well as computers. For example, Yalçinalp, Geban and Özkan (1995) compared computer-assisted instruction in

chemistry education covering the mole concept, with traditional instruction in an Anatolian high school in the province center of Ankara. Students with CAI (computer assisted instruction) gained more achievement in the mole concept and positive attitudes toward chemistry and CAI by means of CAI software package. In another study done by Geban, Aşkar, and Özkan (1992), the same kind of results were found, that is, that computer simulated experiments and a problem solving approach changed students attitudes toward chemistry positively and produced greater achievement in chemistry.

When the Republic of Turkey was proclaimed, one of the most important aims of the young Turkish republic was to develop a society which evaluates and criticizes everything scientifically, and to reach the level of civilized western nations (Türkmen and Bonnstetter, 1997). Hence, after proclaiming the Turkish republic, the first priority became the changing of traditional Turkish society to a modern society. For example, the founder and the first president of the Republic of Turkey, Mustafa Kemal Atatürk, said "The most true and real path in life is science, and to seek other paths is heedlessness and not worthy" (Türkmen and Bonnstettler, 1998). This shows the insight of the Turkish revolution of the 1930's. Similar explicit statements can be found in Turkish Basic Educational Law and the Turkish Constitution. Despite the special attention given to science education in Turkey for more than one hundred years, such as scientifically oriented citizens as well as literate people, in recent years the achievement in science courses is going down very fast. For example, the 2001 Student Selection Examination (ÖSS 2001, by ÖSYM) revealed that high school graduate students had an average of 3,4 correct answers from 45 science-related questions. It could be said that after 11 years of formal education of Turkish students, their average achievement is around 10% in science. There may be several reasons. For instance, there may be a general feeling that science courses are not needed for their future careers and examinations, believing there are difficulties in science courses, and not having very positive attitudes toward science.

It can be easily seen that there are several reasons to study Turkish students' attitudes toward science and science teaching. In the broad sense, it should, also, help to understand how they conceive of the nature of science and why their average science achievement seems to be low. Another crucial point is that science and elementary teacher preparation programs mostly ignore science teaching method courses due to the shortage of science educators in Turkey as well as there being a shortage of Turkish studies concerning pre-service and science teachers' and college students' attitudes toward science. Moreover, generally, this coming century has been called an information age and in order to compete with other nations in this century, every nation needs scientifically literate citizens with positive attitudes toward science. Therefore, there might be a need to conduct research into college, high school and primary school students' attitudes toward science and for the science and, elementary teacher candidates, toward science teaching.

Summary

For the past 60 years, teaching positive attitudes toward science has been one of the top priorities of science education in the USA. Lately, this trend in science education has disseminated to different parts of the world. The belief is that attitudes toward science and scientific attitudes can be taught, they are neither instinctive nor inherited behavior. The issue is complicated by difficulties in measuring and revealing the attitudes of teachers and students toward science. Since the 1960's, many different instruments have been applied to measure scientific attitudes, and attitudes toward science and science teaching for students, teachers and teacher candidates in science. Many of these instruments use Likert-type scales, mainly in the USA, e.g., the Scientific Attitude Inventory (SAI) and the revised version of SAI called SAI-II by Moore (1969) and Moore and Sutmann (1970). These studies have shown that important elements (factors) are the science and elementary teachers' own attitudes in science classes, besides science textbooks, science curriculum, school environment, peers, and parents. Hence, some test instruments such as the Science Teaching Attitude Inventory (STAI) and the latest version of STAI named STAS-II by Moore (1973), and Moore and Foy (1997) measure attitudes toward science teaching as well as toward science.

Some research results show that elementary and science teachers tend to overlook teaching the nature of science, scientific thinking, methods of science, and positive attitudes toward science in science classes. Generally, students have a tendency progressively to lose their interests in science and have positive attitudes toward science from the 5th grade through the 11th grade. Science and elementary science teacher education programs have begun making pre-service science and elementary teachers aware of the importance of acquiring positive attitudes toward science. Although teachers can change attitudes toward science positively, it sometimes takes a long time to change established attitudes toward science, especially to change negative attitudes in science toward more positive ones. One controversial point in science education is whether having higher positive attitudes toward science helps one to attain better achievement in science. Some study results support this idea but some do not. However, one point seems to be clear: students having positive attitudes toward science tend to make careers in science areas or to be supporters of science throughout their lives. Despite extensive research in the USA on attitudes toward science and science teaching, research in this area seems to be ignored in Turkey.

References

Ateaq, O. A. (1995). *The attitudes of pre-service, male, elementary, science teachers in Riyadh Teachers College, Saudi Arabia, toward science and teaching science.* Unpublished Doctoral Dissertation, University of Pittsburgh, Pennsylvania.

Aiken, L. R. & Aiken, D., R. (1969). Recent research attitudes concerning science. *Science Education, 53,* 295-305.

Baumel, H. B. & Berger, J. J. (1965). An attempt to measure scientific attitudes. *Science Education, 49,* 267-268.

Baykul, Y. (1990). *İlkokul beşinci sınıftan lise ve dengi okulların son sınıflarına kadar matematik ve fen derslerine karşı tutumda görülen değişmeler ve öğrencilerin seçme sınavındaki başarı ile ilişkili olduğu düşünülen bazı faktörler.* Ankara: ÖSYM Yayınları.

Berberoğlu, G. & Tosunoğlu, C. (1995). Exploratory and confirmatory factor analyses of an environmental attitude scale (EAS) for Turkish university students. *Journal of Environmental Education, 26,* 40-43.

Billey, V. Y. & Zakhariades, G. A. (1975). The development and application of a scale for measuring scientific attitudes. *Science Education, 59,* 155-165.

Bonnstetter, R. J. (1984). *Characteristics of teachers associated with an exemplary program compared with science teachers in general.* Unpublished Doctoral Dissertation, The University of Iowa, Iowa.

Cannon, K. R. & Simpson, R. D. (1985). Relationship among attitude, motivation, and achievement of ability grouped, seventh-grade, life science students. *Science Education, 69,* 121-138.

Cooley, W. W. & Kloper, L. E. (1961). TOUS, *Test on understanding science: Manual for administering , scoring and interpreting scores.* Princeton: Educational Testing Service.

Davis, I. C. (1935). The measurement of scientific attitudes. *Science Education, 19,* 117-122.

Dutton, W. H. & Stephens, L. (1963). Measuring attitudes toward science. *School Science and Mathematics, 63,* 43-49.

Earl, R. D. & Winkeljohn, D. R. (1977). Attitudes of elementary teachers toward science and science teaching. *Science Education, 6,* 41-45.

Ebel, R. L. (1938). What is the scientific attitude? *Science Education, 22,* 1-5.

Ebenezer, J. V. & Zoller, U. (1993). Grade 10 students' perceptions of and attitudes toward science teaching and school science. *Journal of Research in Science Teaching, 30,* 175-186.

Eichinger, J. (1992). College science majors' perceptions of secondary school science: An exploratory investigation. *Journal of Research in Science Teaching, 29,* 601-610.

Finson, K. D. & Enochs, L. (1987). Student attitudes toward science-technology-society resulting from visitation to a science-technology museum. *Journal of Research in Science Teaching, 24,* 593-609.

Fraser, B. J. (1978). Development of a test of science-related attitudes. *Science Education, 62,* 509-515.

Gabel, D. (1980). Attitudes toward science and science teaching of undergraduates according to major and number of science courses taken and the effect of two courses. *School Science and Mathematics, 80,* 70-76.

Gardener, P. L. (1975). Attitudes to science: A review. *Studies in Science Education, 2,* 1-41.

Gauld, C. (1982). The scientific attitude and science education: A critical reappraisal. *Science Education, 66,* 109-121.

Gauld, C. F. & Hukins, A. A. (1980). Scientific attitudes: A review. *Studies in Science Education, 7,* 129-161.

Geban, Ö., Aşkar, P. & Özkan, İ. (1992). Effects of computer simulations and problem-solving approaches on high school students. *Journals of Educational Research, 86,* 5-10.

Germann, P. J. (1988). Development of the attitude toward science in school assessment and its use to investigate the relationship between science achievement and attitude toward science in School. *Journal of Research in Science Teaching, 25,* 689-703

Gieger, M. M. (1973). *A study of scientific attitudes among junior college students in Mississippi.* Unpublished Doctoral Dissertation, The University of Southern Mississippi, Mississippi.

Hoff, A. G. (1933). A test for scientific attitude. *School Science and Mathematics, 33,* 763-770.

Holden, C. (1988). Japanese views on science compared to U.S. attitudes. *Science, 34,* 277.

Hough, L. W. & Piper, M. K. (1982). The relationship between attitudes toward Science and science achievement. *Journal of Research in Science Teaching, 19,* 33-88.

Hughes, E. F. (1971). Role playing as a technique for developing a scientific attitude in elementary teacher trainees. *Journal of Research in Science Teaching, 8,* 113-122.

Kahn, P. (1962). An experimental study to determine the effect of a selected procedure for teaching the scientific attitudes to seventh and eight grade boys through the use of current events in science. *Science Education, 46,* 115-120.

Kaptan, F. (1995). *Öğretmen adaylarının öğretmenlik mesleğiyle ile ilgili tutumları,* Hacettepe Üniversitesi Araştırma Fonu (95.01.140.001), Ankara.

Kimball, M. E. (1968). Understanding the nature of science: A comparison of scientists and science teachers. *Journal of Research in Science Teaching, 3,* 110-120.

Koballa, T. R. (1988). Attitude and related concepts in science education. *Science Education, 72,* 115-126.

Koballa, T. R. & Crawley, F. E. (1985). The influence of attitude on science teaching and learning. *School Science and Mathematics, 85,* 222-232.

Kozlow, M. J. & Nay, M. A. (1976). An approach to measuring scientific attitudes. *Science Education, 60,* 147-172.

Kuhn, D. (1973). Value systems in life science instruction. *Science Education, 56,* 343-351.

Lawrenz, F. (1975). The relationship between science teacher characteristics and student achievement and attitude. *Journal of Research in Science Teaching, 12,* 433-437.

Lowery, L. (1966). Development of an attitude measuring instrument for science education. *School Science and Mathematics, 66,* 494-502.

Mason, J. M. (1952). An experimental study in the teaching of scientific thinking in biological science at the college level. *Science Education, 36,* 270-284.

Moore, R. W. (1969). *The development, field test and validation of the scientific attitude inventory.* Unpublished Doctoral Dissertation, Temple University, Ohio.

Moore, R. W. (1973). The development, field test, and validation of scales to assess teachers' attitudes toward teaching elementary school science. *Science Education, 57,* 271-278.

Moore, R. W. (1971). A profile of the scientific attitudes of 672 ninth-grade students. *School Science and Mathematics, 71,* 229-232.

Moore, R. W. (1975). A two-year study of a CCSS group's attitudes toward science and science teaching. *School Science and Mathematics, 75,* 288-299.

Moore, R. W. & Sutman, F. Y. (1970). The development, field test and validation of an inventory of scientific attitudes. *Journal of Research in Science Teaching, 7,* 95-102.

Moore, R. W. & Foy, H. L. R. (1997). The scientific attitude inventory: A revision (SAI-II). *Journal of Research in Science Teaching, 34,* 327-336.

Munby, H. (1983). Thirty studies involving the Scientific Attitude Inventory: What confidence can we have in this instrument? *Journal of Research in Science Teaching, 20,* 141-162.

Munby, H. (1997). Issues of validity in science attitude measurement. *Journal of Research in Science Teaching, 34,* 337-341.

Myers, R. E. & Fouts, J. T. (1992). A cluster analysis of high school science classroom environments and attitude toward science. *Journal of Research in Science Teaching, 29,* 929-937.

Noll, V. H. (1935). Measuring the scientific attitude. *The Journal of Abnormal and Social Psychology, 30,* 145-154.

Oliver, S. & Simpson, R. D. (1988). Influence of attitude toward science, achievement motivation, and science self concept on achievement in science: A longitudinal study. *Science Education, 72,* 143-155.

Oppenheim, A. N. (1992). *Questionnaire design, interviewing and attitude measurement.* London: Pinter Publishers.

Sadava, D. (1976). Attitudes toward science of nonscience major undergraduates: Comparison with the general public and effect of a science course. *Journal of Research in Science Teaching, 13,* 79-84.

Schwirian, P. N. (1968). On measuring attitudes toward science. *Science Education, 52,* 172-179.

Schwirian, P. M. & Thomson, B. (1972). Changing attitudes toward Science: Undergraduates in 1967 and 1971. *Journal of Research in Science Teaching, 9,* 253-259.

Shrigley, R. L., Koballa, T. R. & Simpson, R. D. (1988). Defining attitude for science educators. *Journal of Research in Science Teaching, 25,* 659-687.

Skewes, G. (1933). What is a scientific attitude? *School Science and Mathematics, 33,* 964-968.

Smith, W. S. & Erb, T. O. (1986). Effect of women science career role models on early adolescents' attitudes toward scientists and women in science. *Journal of Research in Science Teaching, 23,* 667-676.

Tamir, P. & Amir, R. (1987). The relationship between instructional strategies, study practices, and attitudes toward biology. *Journal of Biological Education, 21,* 291-295.

Tamir, P. (1994). Israeli students' conceptions of science and views about the scientific enterprise. *Research in Science and Technological Education, 12,* 99-116.

Türkmen, L. & Bonnstetter, R. J. (1997). Science education developments in Turkey. *Science Education International, 8,* 12-16.

Türkmen, L. & Bonnstetter, R. J. (1998). Inclusion of the nature of science in Turkish science education curriculum (K-11): As a different approach. *Science Education International, 9,* 15-19.

Vitrogen, D. (1967). A method for determining a generalized attitude of high school students toward science. *Science Education, 51,* 170-175.

Welch, W. W. & Pella, M. O. (1968). The development of an instrument for inventorying knowledge of the process of science. *Journal of Research in Science Teaching, 5,* 64-68.

Yalçınalp, S., Geban, Ö. & Özkan, İ. (1995). Effectiveness of using computer-assisted supplementary instruction for teaching the mole concept. *Journal of Research in Science Teaching, 32,* 1083-1094.

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