Investigating pre-service teachers' attitudes towards science in Bahrain: Positive or negative?

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Contents

Abstract

The purpose of this study was to investigate pre-service teachers' attitudes towards science by using the Test of Science-Related Attitudes (TOSRA) Scale (Fraser, 1981). The 70-item scale was completed by 75 first year pre-service teachers in their foundation year. Dimensions of the scale, which are Social implications of Science, Normality of Scientists, Attitude to Scientific Inquiry, Adoption of Scientific

Attitudes, Enjoyment of Science Lessons, Leisure Interest in Science, and Career Interest in Science were investigated and the results showed that pre-service teachers held negatives attitudes towards science and science-related careers. The results guide educators to be aware of their students' negative attitudes towards science so that they can help their students to develop positive attitudes towards science.

Keywords: Science; Science attitudes; TOSRA

Introduction

One of the most important goals of science education in many countries is to promote positive attitudes towards science that is highly considered because science has a prominent role to establish a strong knowledge-based economy and advanced information society in the 21st century. A knowledge-based economic future and advanced information society also depend on an energized knowledge in science and engineering. Globalization of the marketplace and the rapid pace of technology development, which has meant greater competition, call for nation-states to raise the standard of skills and competencies in the future. Traditional industry factory-driven production has declined and has given way to new forms of wealth production through increased marketing, the growth of service industries, electronic communications and e-commerce markets. This new marketing asks for intellectual and creative capabilities, ICT-skills and other competencies.

The role of science in developing knowledge-based economy is related to new competencies and literacy-oriented goals needed in industry and labor market in general. These competencies relate to Constructivist-inquiry approaches (NRC, 2000) based on interactive-engagement approaches (Hake, 2002), knowledge construction (Bodner, 1986; Bruner, 1961; Piaget, 1950), PBL (AAAS, 1989), multiple intelligences (Gardner, 2006; Gardner & Hatch, 1989). Scientific literacy-oriented goals ensure "the capacity to use scientific knowledge, to identify questions and to draw evidence-based conclusions in order to understand and help make decisions about the natural world and the changes made to it through human activity." (OECD PISA, 2006). For example, daily we read and hear stories about global warming, cloning, genetically modified foods, space exploration, the collection and use of DNA evidence and new drugs that will improve the quality of life and make us look years younger. Furthermore, scientifically literate people would know that energy

can be neither generated nor destroyed, but can be transferred from one form to another such as from solar radiation to electrical current. They do not have to be able to analyze the suitability of a particular blend of semiconductors in the construction of a solar photovoltaic cell. As a consumer, and as a citizen, we need to critically evaluate the claims made in the name of science and make informed decisions and choices about these and other science based issues. In short, we need to be scientifically literate and more importantly we need to develop scientifically literate students (OECD, PISA, 2006).

With the purpose to promote science and favorable science- related attitudes to recruit and retain students in science and science related fields, science curricula has been revised or changed in many countries. Scientific literacy, nature of science, history of science, constructivist-inquiry approaches, multiple intelligences are included in science curricula. Scientific literacy consists of knowledge, skills, attitudes (Bybee, 1997; Koballa, Kemp & Evans, 1997; Wright & Wright, 1998; De Boer, 2000; Sutman, 1996; 2001; Kress, 2003). Attitudes have vital importance in science because positive science-related attitudes are the precursors to interest in science and science course selection (Farenga & Joyce, 1998). Attitude towards science can be described as the feelings, beliefs, and values held about something which might be the endeavor of science, school science, the impact of science and technology on society, or scientists (Akcay, Yager, Iskander, & Turgut, 2010).

There are various studies in literature to measure students' attitudes toward science, chemistry, math or the other fields (Chabalengula, Mumba and Chitiyo, 2011; Çakıroğlu & Işıksal, 2009; Lateh & Muniandy, 2013; Maag, Losinski & Katsiyannis, 2014; Rech, 1993; Timur, 2012). The main idea for all these kinds of studies is to determine students' attitudes by using the most appropriate measurement instruments, scales, forms or models. By this way, they aim to change students' attitudes positively towards science and to develop higher cognitive processes through problem solving strategies etc. One of these studies was done by Adesoji (2008) by applying the four-stage (logical) model of solving Chemistry problems as suggested by Ashmore, Casey, and Frazer (1979).

Fraser (1981) classified scientific attitudes by highlighting affective domains such as social implications for science, normality of scientists, attitude of scientific inquiry, adaptation of scientific attitudes, enjoyment of science lessons, leisure interest in

science, and career interest in science. The TOSRA has been carefully developed and extensively field tested and has been shown to be highly reliable. There are some studies which employed the TOSRA to measure students' attitudes towards science (Demircioğlu, Aslan & Yadigaroğlu, 2014; Joyce & Farenga, 1999; Lang, Wong & Fraser, 2005; Osborne, Simon, & Collins, 2003; Salta, & Tzougraki, 2004; Welch, 2010; White & Richardson, 1993). Most research reveals that students develop more negative or less favorable attitudes towards science.

Studies on students' attitudes towards science were widely investigated in the literature, however this still continues to be an issue and so this topic should be investigated all the time to be able to find our students' attidues towards science and propose contemporary science teaching approaches so that science can be promoted and also it is very important to investigate their attitudes towards science for teaching and learning of science. In addition, the students have difficulty to understand science consisting of abstract concepts, it becomes important to investigate students' attitudes toward science. Moreover, in PISA 2015 (PISA, 2015), stduents' attitudes were examined through students' anwers to questions in the survey conducted. It is very important to investigate their sttitudes towards science becasue students' attitudes towards science can influence their level of interest in science, their motivation, and their engagement (Osborne, Simon, & Collins, 2003; Schibeci, 1984). According to the results of PISA 2015 (PISA, 2015), 57% of students were not interested in science-related fields. 8.8% of students were interested in science-related fields such as physics, engineering. 1.5% of students were interested in science-related technicians and associate professions like electrical or telecommunications engineering technician.

Positive or more favorable attitudes towards science results in achievement in science. Therefore, educators should have students engage with science and scientific issues in the world so that motivation and interest in science can be established for students. These positive attitudes and interest can lead students to future careers related to science fields.

Applicability and Benefits

This study represented an initial step in the exploration of pre-service teachers' attitudes towards science in Bahrain. Pre-service science teachers' attitudes towards science have a potential influence their science teaching and learning, as well as their

future students' attitudes and achievement. Teachers pass on their attitudes to their students whether they are negative or positive. So, it is necessary to identify pre-service science teachers' attitudes towards science. If their attitudes are negative, science educators should find a way to develop positive attitudes before they start their science teaching career. Promoting positive attitudes towards science teaching in pre-service science teachers appears as an important task for science teacher educators.

Therefore, attitudes towards science need to be integrated within different context/contents to address the importance of science in curricula.

This study might have implications not only for the development of modules, but also for science teacher educators, science teachers, and instructors who wish to design modules for science.

Measuring pre-service teachers' science-related attitudes and the results will make an influential contribution to the literature because not only Arab students' science related attitudes are lacked in the literature but also science educators will be aware of their students' attitudes and help them to build up positive attitudes towards science.

Purpose of the Study and Research Question

The purpose of the study was to investigate pre-service teachers' attitudes towards science by using the TOSRA Scale. Within the scope, the following research question was addressed:

1. What were Bahraini pre-service teachers' attitudes towards science?

Methodology

The survey method as descriptive research method was used to be able to collect quantitative data. Jackson (2011) stated: "The essence of survey method can be explained as "questioning individuals on a topic or topics and then describing their responses." Data were collected by using TOSRA English version to investigate pre-service teachers' attitudes towards science.

Participants

Participants (75 out of 92) were from the first year of Bachelor of Education students at Bahrain Teachers College, University of Bahrain in Bahrain in the 2008-2009 academic year. 26 of them were in Math & Science programme to become Math & Science teacher in primary schools. The rest was in the English and Arabic Education programme. The students graduated from different high schools were agreed to participate in the study. Their socio-economic background was different, but Bahrain Ministry of Education awarded all of them scholarships to study and become a teacher to serve in Bahrain.

Data Collection and Analysis

Data were collected by using the TOSRA English version. Participants' attitudes toward science were assessed by using the Test of Science Related Attitudes (TOSRA). The TOSRA was used to assess changes in participants' attitudes towards science and science related issues. Fraser (1978) developed the survey to measure seven science related attitudes among secondary school students. Social implications of Science (S), Normality of Scientists (N), Attitude to Scientific Inquiry (I), Adoption of Scientific Attitudes (A), Enjoyment of Science Lessons (E), Leisure Interest in Science (L), and Career Interest in Science (C) are attitude scales. These scales are suitable for group administration and all can be administered within the duration of a normal class lesson.

Each scale contains 10 items scored from 1 to 5. So, on each of the seven scales of the TOSRA, scores could range from 10 to 50; therefore, a score below the midpoint of 30 indicated a generally negative attitude for that scale. In Table 1 and Table 2, the TOSRA's scale names and their description are shown.

Table 1. Scale Names and Their Descriptions

Scale name	Description of scale
Social implications of Science(S)	Students' attitude regarding the positive and negative effects of science society
Normality of Scientists(N)	Students' belief about scientist lifestyles
Attitude to Scientific Inquiry (I)	Attitude to scientific experimentation and inquiry as ways of obtaining information about the natural world

Adoption of Scientific Attitudes (A)	The specific attitudes (e.g. open-mindedness, willingness to revise opinions, etc.)
Enjoyment of Science Lessons (E)	Students' level of enjoyment of classroom science lessons
Leisure interest in science (L)	Students' desire to participate in out-of-school science-related activities
Career Interest in Science (C)	Students' future interest in science

Table 2. Scales and item numbers

Scale	Item
1. Social implications of Science(S)	1, 8, l5, 22, 25, 36, 43, 50, 27, 64
2. Normality of Scientists(N)	2, 5, 16, 23, 30, 37, 44, 51, 58, 65
3. Attitude to Scientific Inquiry (I)	3, l0, 17, 24, 3l, 38, 45, 52, 52, 66
4. Adoption of Scientific Attitudes (A)	4, 11, 18, 25, 32, 35, 46, 53, 60, 67
5. Enjoyment of Science Lessons (E)	5, 12, l 9, 26, 33, 40, 47, 54, 61, 68
6. Leisure Interest in Science (L)	6, 13, 20, 27, 34, 4l, 48, 55, 62, 69
7. Career Interest in Science (C)	7, 14, 21, 28, 35, 42, 49, 56, 63, 70

Descriptive statistics was used to analyze the data. Scores for each question range from 1 to 5, with lower values indicating more negative attitudes toward science. The TOSRA test scores could range from 70 to 350, a range of 280 (350-70=280) points. A score higher than the midpoint of 210 indicated a relatively positive attitude toward science; lower than 210 indicated a relatively negative attitude.

The TOSRA can be used by teachers, curriculum evaluators, or researchers to monitor student progress towards achieving attitudinal aims. Although it is possible to use the TOSRA for assessing the progress of an individual student, the TOSRA is likely to be the most useful for examining the performance of groups or classes of students (e.g.in curriculum evaluation). Furthermore, as well as providing information about attitudes at a particular time, the TOSRA could also be used as a

pre-test and a post-test (perhaps over the time of a school term or year) to obtain information about changes in students' attitudes (Fraser, 1981).

Results

On each question, participants indicated their level of agreement with statements on seven subscales related to science attitudes. Both each scale score mean and total score mean were calculated and shown in the following tables.

In Table 3, the TOSRA Total Score Means is tabled.

Table 3. Test of Science Related Attitudes (TOSRA) Total Score Means

	Test Score	
Participants	Mean	SD
All participants (N=75)	186.45	11.39

According to results in Table 3, Participants had total mean score 186.45 which is below the midpoint of 210 so they had overall negative attitudes towards science.

Table 4. Test of Science Related Attitudes (TOSRA) Score Means for All Participants by Scale

	Test Score	
Scale	Mean	SD
Social Implications nce of Scie	27.5	8.6
Normality of Scientists	24.7	8.3
Attitude to Inquiry	24.9	8.0
Adoption of Scientific Attitudes	26.9	8.4
Enjoyment of Science Lessons	24.5	8.2
Leisure Interest in Science	24.9	8.0
Career Interest in Science	24. 7	8.3
Mean of seven scales	25.44	8.3
Note. N=75		

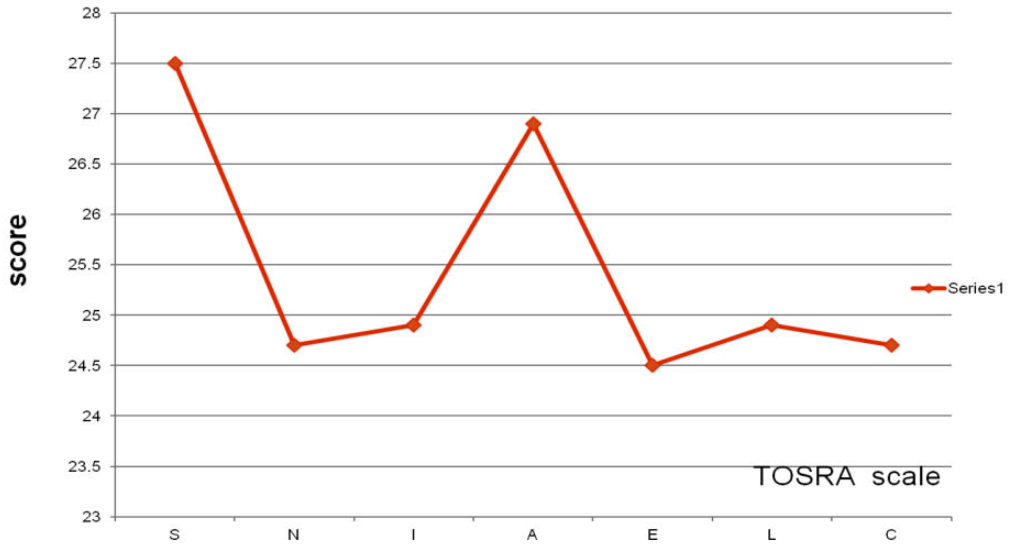

Figure 1. Profile of mean scores obtained on each TOSRA subscale

According to Table 4 and Figure 1, the participants gave overall negative responses toward the social value of science (mean scale score of 27.5, which is below the midpoint of 30), normality of scientists (M=24.7, which is below the midpoint of 30), attitudes toward inquiry (M=24.9, which is below the midpoint of 30), adoption of scientific attitudes (M=26.9, which is below the midpoint of 30), attitudes toward science classes (M=24.5, which is below the midpoint of 30), leisure interest in science (M=24.9, which is below the midpoint of 30), and attitudes toward careers in science (M=24.7, which is below the midpoint of 30).

Based on the results of total mean scores and each scale score, the participants had overall negative attitudes towards science.

Conclusion and Discussion

This study investigated pre-service teachers' attitudes towards science. As it is known scientific attitudes towards science has a key role in achieving science literacy which is the vision of the curriculum of science courses that have been put into practice since there has been a decline in the number of students studying the science or science-related fields. There is a discussion about this fundamental problem is that the declining percentage of students in science, technology, engineering, and mathematics (STEM) graduate programs (Ortega, 2003) and steady decline in student interest in the physical sciences (Astin,1997). There are many factors for

these problems stated as: students' low interest and negative attitudes towards science course teaching methods, teacher's attitude, influence of parents, gender, age, cognitive styles of students, career interest, societal view of science and scientists, social implications of science and achievement (Jelinek, 1998; Osborne, Simon & Collins, 2003; Slee, 1964). In addition, teaching style is also noted to be linked with students' attitudes toward science and science teaching (Wood, 1998). As many researchers have pointed out the reality that students' attitudes and feelings toward science and science courses, students' decisions about their future career choices, and students' achievement in science courses correlate with their attitudes toward science (Haladyna, Olsen & Shaughnessy, 1982; Oliver & Simpson, 1988; Rodrigues, Jindal-Snape & Snape, 2011; Shrigley, 1990; Turkmen, 2013). However, many factors could contribute to students' attitudes towards studying science (Adesoji, 2008). Therefore, educators believe that they should promote science and mathematics so that students can choose science, mathematics, or science-related careers; in addition, they must increase students' interest in science, technology, mathematics, and engineering (STEM) (Welch, 2010).

As this study focused on Bahraini pre-service teachers' attitudes towards science, it is embarking on a challenge which has been one of the current foci of educational research. Several researches suggest that students' positive attitudes towards science are linked with academic achievement (Freedman, 1997; Salta &Tzougraki, 2004; Simpson & Wasik, 1978; Wilson, 1983; Weinburgh, 1995). As Koballa (1988) stated, we are continuing to study attitudes for three reasons: attitudes are enduring and seem to remain relatively stable over time; attitudes are learned: students are not born liking or disliking the study of science and attitudes are related to behavior, that is, students' actions reflect their feelings toward objects and issues. Attitudes have been a very difficult concept to describe since it cannot be directly observed (Fraser, 1994). Affective dimension acts as a bridge between behavioral and cognitive dimensions in learning. When teacher is unable to build this bridge on her/his students, s/he could not perform an effective learning (Demircioğlu, Aslan & Yadigaroğlu, 2014). Attitudes have been crucial importance in science. For this reason positive science-related attitudes are the precursors to interest in science and science course selection. Therefore, the accurate acquisition of attitudes is recommended to improve the quality of teaching science (Krylova, 1997; Turner & Lindsay, 2003). There is considerable consensus of opinion that the promotion of favorable attitudes towards

science is an important aim of science education (Fraser, 1981; Aiken & Aiken, 1969; Kobolla, 1988; Laforgia, 1988).

However, the results of the study showed that pre-service teachers held negative attitudes towards science and science-related careers. Their attitudes impacted on their selection. So, they did not prefer to study science or science-related subjects. Mostly, these negative attitudes stem from individual and intrinsic interest and/or extrinsic interest which are related to classroom and teaching approaches (Osborne, J., Simon, S., & Collins, S., 2003). If students are disinterested in the subject then they become unmotivated. So their attitudes towards science become unfavorable. Also, the recent study (Hacieminoglu, 2016) supports our results that teachers' different teaching approaches and classroom environment can cause that students might have negative attitudes towards science.

The results of this study will offer valuable insights about Bahraini pre-service teachers' science-related attitudes and how their attitudes affect their choices in their future careers. As Simpson and Oliver (1990) pointed out students enter junior high school with a less than positive attitude toward science and that this attitude do not improve through high school. This view may be one of the reasons why students hold negative attitudes towards science or science-related fields. The results of this study will contribute in pedagogy, teaching practice, and curriculum development in science education. There is an agreement among educators on the importance of students' attitudes toward science courses in school (Osborne, Simon, & Collins, 2003). Moreover, that is why in science teacher preparation, increasing positive attitudes toward science and possessing scientific attitudes are important for science teacher candidates (Turkmen, 2013). It is revealed that science teachers with positive attitudes toward science and science teaching should influence students' attitudes to positive direction. Moreover, this influence could increase students' achievement in science courses (Pigge & Marso, 1997).

Positive views toward science are viewed as an important correlate to help students achieve in science and improve students' attitudes and interest in science besides motivation and attitude (Welch, 2010). The positive attitudes and interest may also lead to future careers in science related fields (Welch, 2010). There are many studies show that if science teachers improve students' attitudes toward science, students increase their achievement in science courses (Osborne, Simon, & Collins, 2003;

Brickhouse, 1992; Bloom, 1989; Friend, 1985; Gabel, 1980; Moore & Foy, 1997). There are some studies to demonstrate a positive correlation between the classroom environment and attitudes toward science (Chuang & Cheng, 2003; Lee & Fraser, 2002 in Smith & Ezeife, 2010; Smith & Ezeife, 2010; Telli, Cakiroglu, & Rakici, 2003), examine the relationship between teachers' attitudes, beliefs, and their perceptions of students' attitudes about Science and Technology (S&T), gender differences in students' patterns of S&T learning (Haase, 2009) and examine the effects of the programs and project-based activities that engage students in authentic science related learning activities to improve students' attitudes, views of science and overall achievement in science (Haase, 2009; Turkmen, 2013; Welch, 2010). In addition, important factors to success in the classroom are motivation and attitude, class climate, characteristics and skills of the teacher, and physical environment, a high level of involvement, very high level of personal support, strong positive relationships with classmates, and use of a variety of teaching strategies and unusual learning activities (Myers & Fouts, 1992; Welch, 2010). Fraser (1986) accepts the influence of classroom environment as a significant determinant of attitude.

As several studies cited the most positive attitudes to science held by students were associated with a high level of personal support by the teacher and the comments teachers made in their classes (Bloom, 1989; Osborne et al., 2003). Consequently, based on the results we recommend using these kinds of challenging instructional situations. The present study might have implications for science teacher educators and instructors in the colleges of sciences and education who wish to design modules for science courses to promote science and positive science attitudes. Science educators agree on the main aims of the programs is improving students' attitudes in science (Koballa, 1988; Laforgia, 1988).

To date many researcher and teacher have used the TOSRA to monitor student progress towards achieving attitude. Fraser (1981) recommends that a teacher might employ the TOSRA to obtain information about the science-related attitudes of a student or, preferably, whole classes (Fraser, 1981). A major advantage of the TOSRA is to yield a separate score for a number of distinct attitudinal aims instead of a single overall score. It is possible to obtain a profile of attitude scores for groups of students with the TOSRA and interpret scores obtained on the TOSRA; relative interpretations can be more meaningful than absolute ones for teachers (Fraser, 1981).

In conclusion, we recommend some future directions as following:

Future research could examine the effect of the one the factors such as teaching methods, teacher's attitude, influence of parents, gender, age, cognitive styles of pupils, career interest, societal view of science and scientists, social implications of science and achievement. Moreover, whether the pre-service teachers' attitudes change over their study or long-term impact of the recommended programs to improve students' attitudes in science may be found out. For example finding out the effect of the gender differences regarding other cognitive and affective domains and studying the developmental process of those variables could yield valuable implications for further studies.

It should not be forgotten that attitudes of teachers and students toward science and science teaching do not change easily especially in a short time period (Akande, 2009; Turkmen, 2013). As a result, science education and science teacher preparation, increasing positive attitudes toward science and understanding and possessing scientific attitudes are important for science teacher candidates.

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