Journal of Education and Practice
ISSN 2222-1735 (Paper) ISSN 2222-288X (Online)
Vol.8, No.27, 2017

Attitudes of Elementary Schools Students in Najran District towards Science

Abdulsalam Deal Amer Saif[1]* Abdulaziz Aboud Mohamed Asiri [2]

4. Faculty of Education, Najran University, PO box 1988, Najran 61441, KSA
5. Faculty of Education, Najran University, PO box 1988, Najran 61441, KSA

* E-mail of the corresponding author: profdael@gmail.com

Abstract

This study aims to explore the attitudes of elementary school students, in Najran district in Saudi Arabia, towards science. The modified Attitudes towards Science Inventory questionnaire was used to collect the raw data, with appropriate validity and reliability. The questionnaire of eight items measures only the construct of enjoyment in science using a 3-point Likert scale, which is appropriate for elementary students. This questionnaire was administrated to a sample of 95 students (49 males & 46 females) from two urban and two rural elementary schools. The findings indicated that while there was no significant difference in attitudes towards science between boys and girls. At the same time, grade 5 and 6 students were having more positive attitudes than grade 4 students. Additionally, the urban students showed higher level of attitudes towards science than the rural students. These findings are discussed in the context of science teaching and research.

Keywords: Elementary Students, Attitudes towards Science

1. Introduction

Scientific literacy, the most commonly use term in science education today has been one of the main goals of science education in many countries across the world (Roberts, 2007). The philosophy of science education in Saudi Arabia represents the aspiration to develop scientific literacy among Saudis by fostering a culture of science and technology, focusing on the development of an individual who is competitive, dynamic and is able to master the knowledge of science and technological competence. The definition of scientific literacy, as described in the Twenty First Century Science involves the ability to appreciate and understand the impact of science and technology on everyday life; take informed personal decisions about things that involve science; read and understand the essential points of media reports about matters that involve science; reflect critically on the information included in; and take part confidently in discussions with others about issues involving science (Laugksch, 2000).

Scientific literacy involves not only the cognitive domain, but also the affective or attitudinal domain which deals with appreciation, taking informed personal decisions, and taking part confidently in discussions on scientific issues. For this reason, scientific literacy is affected by a student's attitudes towards science, which in turn, contributes to how well he or she performs in a science class (Dalgety, Coll & Jones, 2003; George, 2000). Research also indicates that prior learning of, and past exposure to, science-based subjects have an impact on science achievement and attitudes (Baldwin, Ebert-May, & Burns, 1999; Wandersee, Mintzes, & Novak, 1994).

Research in academic achievement reveals that there is a strong association between science achievement and attitudes towards science (e.g., Nuttall, 1971; Simpson & Oliver, 1990; Papanastasiou & Zembylas, 2002; 2004). In TIMSS 2011 International Science Report, students' attitudes towards science was one of the ways to elicit information that could provide an educational context for interpreting the science achievement results (Martin, Mullis, Foy, & Stanco, 2012). The work by Germann (1988) indicates that students who have more positive attitudes towards science show increased attention to classroom instruction and participate more in science activities. The development of attitudes towards science in schools, particularly among elementary school students, is regarded as important because positive attitudes may contribute to the increased uptake of science and the sufficiency of scientists. Osborne, Simon, and Collons (2003) address that educating more elementary students in science is very unlikely to have a negative effect on the economic well-being of any society. Furthermore, research indicates that many latent scientists appear to make early decisions about their careers in the elementary years (Blatchford, 1992; Wellington, 1990; Woolnough, 1990).

2. Literature Review

Students' attitude towards science at elementary and secondary schools were extensively studied by Gardner (1975), Frazer and Walberg (1981); Hadden and Johnstone, (1983); Banu (1986); Kelly (1986); Myers and Fouts (1992); Ramsden (1998); Nisimov, (n.d.); Morrell and Lederman (1998); and George (2000) either by quantitative or qualitative method. The most of researches on attitude towards science (and science learning) have reported positive attitude of students towards science (Osborne et al, 2003). The importance of attitude towards science can be recognized from the findings showing positive relationship of attitude towards science and achievement, and students with more positive attitude towards science having sustainable learning that makes them want to continue with those subjects they enjoy (Pell & Jarvis, 2001). A dominant theme in this research area in recent years has been a negative attitude towards science and this is regarded as problematic for science education (Ramsden, 1998) and this forms the impetus for this study in that we want to investigate the reasons and causes for high and low attitude towards science learning in Saudi scenario.

The concept of attitude and its relation to academic achievement has been the targeted area of educational research since 1920s when Thurstone declared in an article that attitudes were measurable (Simpson, Koballa, Oliver, & Crawley, 1994). From 1920s till the early 1970s, the scope of attitudinal research was in one of the three areas, namely measurement of student attitudes; measurement of change in student attitudes resulting from various interventions or treatment methods; and identification of relationship in support of student attitudes and science-related behaviors (Simpson et al., 1994). In the early 1980s, research on attitude concentrated on documenting student attitudes and their relationship to science achievement (Koballa & Glynn, 2007). While there seemed to be a pause in attitudinal research in the period of 90s. The first decade of the 21st Century displayed an uptrend in attitudinal research which looks into a variety of student attitudes and beliefs that shape and are shaped by student classroom experience (Adams, Perkins, Podolefsky, Dubson, Finkelstein, & Wieman, 2006). This growth in such attitudinal research was due to the concern among science educators and researchers regarding the negative attitudes of students towards science after completing the elementary school grades (Osborne, Simon, & Collins, 2003).

The review of research into attitudes towards science by Osborne, Simon, and Collins (2003) indicates that the attitudes towards science are multidimensional in terms of construct, and that the sub-constructs, which contribute in varying proportions towards an individual's attitudes towards science, consist of the combination of the following measures: the perception of the science teacher; anxiety toward science; the value of science; self-esteem at science; motivation towards science; enjoyment of science; attitudes of peers and friends towards science; attitudes of parents towards science; the nature of the classroom environment; achievement in science; and fear of failure on course.

It seems that attitudes can be measured in two ways; 1) in terms of affective domain (attitude towards the object), while behavioral and cognitive components should be assessed separately as recommended by Ajzen and Fishbein (1980); and 2) in terms of affective, behavioral and cognitive components collectively (ABC model) as recommended by Germann (1962). The potential reason stated by Germann (1962), is that these three components are very closely associated and affect each other. Therefore, we measure all the components together to provide a better chance of capturing all the facets of the attitude.

Another recognizable feature of the attitudinal research, supported by meta-analyses of Schibeci (1984), Becker (1989), and Weinburgh (1995), and by subject preference study of Lightbody & Durndell (1996) in one school is that boys have a consistently more positive attitudes towards school science than girls. The acceptable thesis offered to explain this finding is that boys are generally being perceived as better suited and possessing higher ability for science careers than girls (Hill, Corbett, & St. Rose, 2010). Such thesis is supported by Corell (2004) whose study indicates that fewer girls than boys are interested in becoming scientists or engineers, and by Jovanovic and King (1998) who argue that girls' antipathy towards science is explained by their own comparative judgments across academic domains, perceiving that they are better at other subjects.

Attitudes in science education is very important because once the attitudes are formed they are long lasting and difficult to change (Ajzen & Fishbein, 1980). Attitudes towards science affect students' participation in science and impacting performance in science. Attitudes towards science have been broadly studied (Parkinson et al., 1998; Cokadar & Kulce, 2008) over the last decade and the promotion of favorable attitude towards science, and science learning is increasingly a matter of concern for the researchers (Osborne et al, 2003). Blalock et al (2008) in meta-analysis study have categorized attitude towards science into four areas; a) attitude towards science, b) scientific attitude, c) the nature of science, and d) scientific career interests.

An obvious aspect of the attitudinal research is the decline in attitudes towards science from age 11 onwards.

Yager and Penick (1986) found that students in elementary schools perceived science to be enjoyable, interesting and useful. However, a decline in attitude occurs throughout secondary school, resulting in young adults who do not feel positive about their school science. Osborne, Driver, and Simon (1998) noted that positive attitudes towards school science appear to peak at, or before, the age of 11 and decline thereafter by quite significant amounts, especially for girls. Lowery (1967) found that at the age of 10 to 11, science in children's mind was associated with difficult words, monsters, precious metals and jewels, and that science was unsafe. The results of the national survey in Australian schools undertaken by Rennie, Goodrum, and Hackling (2001) state that a significant number of adolescents view science as a difficult and boring subject.

Jarvis and Pell (2005) suggests that an intervention of visiting UK National Space Centre had positive significant effects on Year 10 and 11 children's attitudes towards science in terms of interest in space, science in a social context, and lowering anxiety. However, there was no significant effect on attitudes with regard to science enthusiasm. As to its long-term effect, while the space interest was not sustained, the attitudes towards science in a social context continued to remain at a high level and that the anxiety levels which showed a much lower score after the visit continued to decline for the remainder of the year. In terms of the impact on attitudes towards science deriving from intervention using student-centered strategies, the results seem to be mixed. While some studies suggest that the use of inquiry-based teaching does have positive impact on students' attitudes towards science (Gibson & Chase 2002; Jones, Gott, & Jarman, 2000; Lord & Orkwiszewski 2006; Sesen & Tarhan, 2013), other studies concluded that there was no significant impact of activity-based teaching or programmes (e.g., Gantreau & Binns, 2008; Turpin, 2000; Wideen, 1975) on students' attitudes towards science.

Once attitudes towards science and science learning was studied from the perspective of gender, four major categories were found between male and female respondents: male has more favorable attitude towards science than female students, female students showed higher attitude towards science learning, male and female students do not differ significantly in their attitude towards science learning, and, on the same scale, male students have better attitude towards science learning on some factors and on other factors female students had better attitude towards science learning. Gardner (1975) documented gender as the most important single variable related to attitude to science. Smail and Kelly (1984) reported the remarkable differences in liking for different branches of science between male and female students at the end of elementary school. Simpson and Oliver (1990) found that males frequently better scores on the sub-scales that measures attitude towards science than female students, but still argues that both genders believe and perform same way regarding science as a subject. Similarly, Crawley and Coe (1990) also reported in favour of males over female students while comparing their attitude towards science learning. Finding, from a meta-analysis by Weinburgh's (1995), reveals that high performing females had a more positive attitude than male students of the same group.

No significant difference in attitude is found among male and female students (Houtz, 1995). Johanson (1997) reports differential item functioning between the genders in an attitude to science measure. In an Irish context, Francis and Greer (1999) found that while boys and girls did not differ in their opinion of the importance of science, boys had a more positive attitude to science in the school curriculum and to science as a career. In general, studies have reported that males have more favorable attitude than females, but a minority of studies exist in which no difference was found between them.

However, while boys' attitudes towards science are significantly more positive than girls, the effect is stronger in physics than in biology. Such a bifurcation of interest in physical and biological science between boys and girls (i.e., Harvey & Edwards, 1980) has been given additional salience by the work of Ormerod, Rutherford, and Wood (1989) where boys were found to be far more interested in "space" and girls far more interested in "nature study". Meanwhile, by employing the use of focus groups to explore 16-year-old student's views and attitudes towards science, Osborne and Collins (2000) found that, to their surprise, chemistry was perceived as less appealing than physics, although the analysis by gender in Osborne, Simon, and Collins (2003) shows that the male to female ratio is approximately equal in chemistry as compared to 3.4:1 in physics, favoring the males, and 1.6:1 in biology, favoring the females.

Few studies have reported on locality and grade of the respondents. Urban schools respondents were marginally better in their attitude than rural schools respondents (Zacharia & Barton, 2004). So school's locality does not seem to be a significant predictor of attitude towards science learning. Ormerod and Duckworth (1975); Brown, (1976); Goodwin, Hardiman and Rees (1981); and Francis and Greer (1999) have reported that students' attitude towards science decreases with an increase in grade of individuals. Similarly, Hadden and Johnstone (1983) have also reported a decline in attitude towards science at the secondary school level. But Ye, Raymonds, Susan and Hanxia (1998) reported that attitude has no direct relationship with a change in grade.

This study will look at elementary students' attitudes towards science learning in Saudi Arabia. As a developing country, science education of elementary schools in Saudi Arabia is an important aspect of every educational policy. From 1st to 6th grades, science is taught as compulsory subject in schools. On the other hands, it seems that educational system is still unable to attract the attention of students' attitude towards science and science learning, while one of the major objectives of teaching science at school level is to develop students' attitude towards science.

Aim

This study aims to investigate the attitudes towards science among elementary school students, looking at the differences by gender and grade level. Accordingly, this study seeks to answer the following questions:

(1) Is there any difference in attitudes towards science between the girls and the boys?

(2) Are there any differences in attitudes towards science among the students in grades 4, 5 and 6?

3. Methodology

3.1. Population and Sampling

The population of this study is the elementary school students in Najran district. Of this population, 96 students were randomly chosen from four elementary schools (two urban schools and two rural schools). Because boys and girls in Saudi Arabia study in separate schools, it was necessary to have four elementary schools in this study in order to represent urban and rural students, and both boys and girls as well. Therefore, two f theses four schools were for girls (urban and rural) and the other two were for boys. Table 2 presents the number of students by gender and grade level in both urban and rural areas.

Table 1. Sample Distribution

Grads	Urban			Rural			Grand total
	males	females	Total	males	females	Total	
Fourth grade	9	8	17	8	8	16	33
Fifth grade	8	8	16	8	7	15	31
Sixth grade	8	7	15	8	8	16	31
total	25	23	48	24	23	47	95

3.2. Instrumentation and Procedures

The instrument that was used to gather the primary data for the study is the modified Attitudes towards Science Inventory (m-ATSI). This instrument was adapted from the Attitude towards Science Inventory (ATSI) (Gogolin & Swartz, 1992). However, the ATSI has 48 items measuring six constructs, namely perception of the science teacher, self-concept in science, enjoyment of science, anxiety towards science, value of science in society, and motivation in science, using a 5-point Likert scale of which some items are worded negatively, the m-ATSI is an 8-item inventory measuring only the construct of enjoyment in science using a 3-point Likert scale (1=Disagree, 2=Undecided, 3=Agree), where each item is positively worded. The adaptation took into consideration the age range, reading ability and the concentration time span of upper elementary students. The Cronbach's alpha for m- ATSI was 0.76, suggesting that the instrument has sufficient internal reliability (Field, 2005). Accordingly, the use of the 8-item m-ATSI justifies the use of summated-ratings procedure to measure students' attitudes towards science. The m-ATSI was administered to the participants during the first semester of the schooling year 2016/2017. Before responding to the items, a moderation session was held with the students in which they were tuned to what it means to agree, undecided, and to disagree by means of a simulation. Once students were accustomed or tuned to the three responses, the first item in the m-ASTI was then clearly read to the class, clarifying any question and explaining any meaning of a problematic word or phrase. The students then picked their self-perceived most suitable response by checking the corresponding box. This process was repeated for each of the eight items.

4. Results

As presented in table 2, a two-way ANOVA for attitudes towards science was carried out.

Table 2. Analysis of Variance for Attitudes towards Science between subjects

Source	Sum of squares	df	Mean square	F	Sig.	Eta
Gender (a)	14.611	1	14.611	1.423	.315	.009
Grade level (b)	197.451	2	98.725	6.941	.001	.159
a * b	6.606	2	3.303	.314	.215	.012
Error	978.102	89	10.989			
Total	31251.012	95				
Corrected total	1217.430	94				

4.1. One-way Gender Effect

As shown in table 2, the main effect of gender was not significant, F(1, 89) = 1.423, p = 0.287. Table 3 shows the means and standard deviations by gender for attitudes towards science.

Table 3. Means the Standard Deviations by Gender for Attitudes towards Science

	Males (n=49)		Females (n=46)		Difference
	Mm	SD	Mf	SD	Mf – Mm
attitudes towards science	17.95	3.75	18.08	3.11	0.13

4.2. One-Way Grade Level Effect

Based on table 2, the main effect of grade level was statistically significant, F(2, 89) = 6.941, p = 001 < .05 and accounted for 15.9 0f the total variance in the attitudes towards science. Table 4 shows the means and standard deviations by grade level for the attitudes towards science. By using Bonferroni Post Hoc Tests, significant differences towards science were found between the attitudes of grade 4 and 5 students favoring grade 5, and of grade 4 and 6 students, favoring grade 6. However, there was no significant difference in attitudes towards science between grade 5 and 6 students.

Table 4. Means and Standard Deviations by Grade Level for Attitudes towards Science

	Grade 4		Grade 5		Grade 6				
	M	SD	M	SD	M	SD	M4-M5	M4-M6	M5-M6
attitudes towards science	15.15	3.66	19.54	2.50	19.36	3.02	4.39 P=002	4.21 p=003	0.18 p=1.02

4.3. Two-Way Gender and Grade Level Interaction Effect

According to table 2, there was no statistically significant effect of interaction between gender and grade level, F(2, 89) = 0.314, p = . 215 > .05, for attitudes towards science. Table 5 shows the descriptive statistics by gender and grade level for attitudes towards science.

Table 5. Means and Standard Deviations by Gender Grade Level for Attitudes towards Science

Males (n=49)						Females (n=46)					
Grade 4 (n=17)		Grade 5 (n=16)		Grade 6 (n=16)		Grade 4 (n=16)		Grade 5 (n=15)		Grade 6 (n=15)	
M	SD	M	SD	M	SD	M	SD	M	SD	M	SD
15.07	3.67	19.38	3.15	19.40	3.44	15.24	2.79	19.70	3.11	19.32	2.76

4.4. Region Effect

An independent sample t-test was used to investigate the attitudes towards science between the urban and rural students. As presented in table 6, the analysis of t-test for attitudes towards science, shows significant differences between urban and rural students, favoring urban students. This indicates that the level of attitudes towards science among the urban students is statistically significant higher than the level of attitudes among the rural students.

Table 6. The Difference between Urban and Rural Students in Attitudes towards Science

Region	M	SD	t	*p*
Urban (n=48)	19.83	2.74	4.12	001
Rural (n=47)	16.20	3.91		

5. Discussion and Conclusion

The aims of this study were to explore the differences in attitudes towards science among elementary students in Saudi Arabia, specifically by gender, grade level, and region (urban & rural). The results indicate that there was no significant difference in attitudes towards science between the boys and the girls. This differs from the findings of previous research of Lightbody and Durndell (1996) and meta-analyses of Schibeci (1984), Becker (1989), and Weinburgh (1995) which indicate that boys have consistently more positive attitudes towards science.

At the meantime, there was a statistical significant difference by grade level in which grade 5 students had more favorable attitudes towards science than grade 4 students. Moreover, grader 6 students had more positive attitudes towards science than grade 4 students. However, there was no significant difference in attitudes towards science between grade 5 and grade 6 students. The findings of this study in which grade 4 (aged 10) students' level of attitudes towards science seems to increase as they progress to grade 5 (aged 11) and subsequently hovering around or rather paltering at similar level in grade 6 (aged 12), provide credence to Osborne, Driver, and Simon's (1998) observation that positive attitudes towards school science appear to peak at, or before, the age of 11. Such parallel findings were rather accidental because the participants in Osborne, Driver, and Simon's (1998) study were geographically, culturally, and socially dissimilar, albeit similar in age. Accordingly, this may suggest similar trend in students' attitudes towards science at ages 10-12 across boundaries, and that such attitudinal trend is not idiosyncratic to Saudi students. Further study is required to determine if similar trend in attitudes towards science can be found should a more representative sample be used. Since there was no two-way interactional effect between gender and grade level, the main effects for gender as well as grade level could therefore be interpreted in a straightforward manner without any concern of moderating effect. The findings of this study mostly argue that age is a more significant determinant than gender of elementary children's attitudes to science, and that these attitudes become less positive as the children reach the more senior elementary classes.

Regarding region effect, the findings indicate that the urban students have more positive attitudes towards science than the rural students. This difference can be explained by the educational circumstance of urban and rural students. Urban and rural students differed on the background characteristics of ethnicity, grade-point average, and educational level of parents. They also differed in aspirations, and this is consistent with the previous research of McCracken and Barcinas (1991).

Acknowledgment

Special thanks and gratitude are offered to the Deanship of Scientific Research at Najran University for their financial support. My gratitude thanks are also directed to the students, teachers, and principals for their cooperation.

References

Adams, W.K., Perkins, K.K., Pololefsky, N.S., Dubson, M., Finkelstein, N.D., & Wieman, C.E. (2006). New instrument for measuring student beliefs about physics and learning physics: The Colorado Learning Attitudes about Science Survey (CLASS). *Physics Review Special Topics: Physics Education Research, 2*(1), 1-14.

Ajzen, I, and Fishbein, M. (1980). *Understanding attitudes and predicting behaviour*, Englewood Cliffs: Prentice Hall.

Baldwin, J., Ebert-May, D., & Burns, D. (1999). The development of a college biology self efficacy instrument for non-majors. Science Education, 83(4), 397-408.

Banu, D.P. (1986). Secondary School Students' attitude towards science, *Research in Science and Technological Education*, 4*(2)*, 195-202.

Becker, B.J. (1989). Gender and science achievement: A re-analysis of studies from two meta-analyses. Journal of Research in Science Teaching, 26(2), 141-169.

Blalock, C.L., Lichtenstein, M.J., Owen,S., Pruski, L., Marshall, C. and Toepperwein, M. (2008). In Pursuit of validity: A comprehensive review of science attitude instruments 1935-2005. *International Journal of Science Education*. 30 (7), 961-977.

Blatchford, P. (1992). Children's attitudes to work at 11 years. *Educational Studies*, *18*, 107–118.

Brown, S. (1976). *Attitude goals in secondary school science.* Stirling: University of Stirling.

Cokadar, H. and Kulce, C. (2008). Pupils' attitude towards science: A case of Turkey. *World Applied Sciences Journal*. 3(1), 102-109.

Cokadar, H. and Kulce, C. (2008). Pupils' attitude towards science: A case of Turkey. *World Applied Sciences Journal*. 3(1), 102-109.

Corell, S.J. (2004). Constraints into preferences: Gender, status, and emerging career aspirations. American Sociological Review, 69(1), 93-113.

Dalgety, J., Coll, R., & Jones, A. (2003). Development of Chemistry Attitudes and Experiences Questionnaire (CAEQ). Journal of Research in Science Teaching, 40(7), 649-668.

Field, A.P. (2005). Discovering statistics using SPSS (2nd ed.). London: Sage.

Francis, L.J. and Greer, J.E. (1999). Measuring attitude towards science among secondary school students: the affective domain, *Research in Science and Technological Education.* 17(2), 219-226.

Gantreau, B., & Binns, I.C., (2008). Investigating student attitudes and achievements in an environmental place-based inquiry in secondary classrooms. *International Journal of Environmental & Science Education*, *3*(3), 167-195.

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

George, R. (2000). Measuring change in students' attitudes towards science over time: An application of latent variable growth modeling. Journal of Science Education and Technology, 9(3), 213-225.

George, R. (2000). Measuring change in students' attitudes toward science over time: an application of Latent Variable. *Journal of Science Education and Technology*. 9(3), 213-225.

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(8), 689-703.

Gibson, H., & Chase, C. (2002). Longitudinal impact of an inquiry-based science program on middle school students' attitudes toward science. *Science Education*, *86*, 693–705.

Hadden, R.A. and Johnstone, A.H. (1983). Secondary school pupils' attitudes to science: the year of decision. *International Journal of Science Education.* 5(4), 429-438.

Gogolin, L., & Swartz, F. (1992). A quantitative and qualitative inquiry into the attitudes toward science of non-science college students. Journal of Research in Science Teaching, 29(5), 487-504.

Hadden, R.A. and Johnstone, A.H. (1983). Secondary school pupils' attitudes to science: the year of decision. *International Journal of Science Education.* 5(4), 429-438.

Harvey, T.J., & Edwards, P. (1980). Children's expectations and realisation of science. British Journal of Educational Psychology, 50, 74-76.

Hill, C., Corbett, C., & St. Rose, A. (2010). Why so few? Women in science, technology, engineering and mathematics. Washington, DC: AAUW

Jarvis, T., & Pell. A. (2005). Factors Influencing Elementary School Children's Attitudes toward Science before, during, and after a Visit to the UK National Space Centre. *Journal of Research in Science Teaching*, *42*(1), 53-83.

Jones, M. E., Gott, R., & Jarman, R. (2000). Investigations as part of the key stage 4 science curriculum in Northern Ireland. *Evaluation and Research in Education*, *14*, 23–37.

Jovanovic, J., & King, S.S. (1998). Boys and girls in the performance-based science classroom: Who's doing the performing? American Educational Research Journal, 35(3), 477-496.

Kelly, A. (1986). The development of girls' and boys' attitudes to science: A longitudinal study. *International Journal of Science Education*. 8(4), 399-412.

Kelly, A. (1986). The development of girls' and boys' attitudes to science: A longitudinal study. *International Journal of Science Education*. 8(4), 399-412.

Laugksch, C. R. (2000). Scientific literacy: A conceptual overview. Science Education, 84(1), 71 – 94.

Lord, T., & Orkwiszewski, T. (2006). Moving from didactic to inquiry-based instruction in a science laboratory. *The American Biology Teacher*, *68*, 342–345.

Lowery, L.F. (1967). An experimental investigation into the attitudes of fifth grade students towards science. *School Science and Mathematics*, *67*, 569-579.

Martin, M.O., Mullis, I.V.S., Foy, O., & Stanco, G.M. (2012). TIMSS 2011 International Results in Science. Chestnut Hill, MA: Lynch School of Education, Boston College.

McCracken, J. & Barcinas, J, (1991) Differences Between Rural and Urban Schools, Student Characteristics, and Student Aspirations in Ohio> Journal of Research in Rural Education, 7(2), 29-40

Morrell, P. D., and Lederman, N. G. (1998). Students' attitudes toward school and classroom science: Are they independent phenomena'? *School Science and Mathematics*, 98, 76-82.

Myers, R. E., and Fouts, J. T. (1992). A cluster analysis of high school science classroom environments and attitude toward science. *Journal of Research in Science Teaching*, 29(9), 929-937.

Nisimov, S., (n.d.). 7th grade pupils' attitudes towards science and science education in Finnish and Russian Karelia. Retrieved on September 5th, 2009 from www.ipn.uni-kiel.de/projekte/esera/book/b022-nis.pdf

Nuttall, D. (1971). Administrator's manual for Science Attitude Questionnaire. Slough: NFER.

Ormerod, M.B. and Duckworth, D. (1975). *Pupils' Attitudes to Science* (Windsor, NFER).

Ormerod, M.B., Rutherford, M., & Wood, C. (1989). Relationships between attitudes to science and television viewing among pupils aged 10 to 13+. Research in

Science and Technological Education, 7(1), 75- 84.

Osborne, J. F. and Collins, S. (2000). Pupils' and parents' views of the school science curriculum. London: King's College London.

Osborne, J., Driver, R., & Simon, S. (1998). Attitudes to science: Issues and concerns. *School Science Review, 79*(288), 27-33.

Osborne, J., Simon, S., and Collins, S. (2003). Attitude towards science: a review of the literature and its implications. *International Journal of science Education*, 25(9), 1049-1079.

Papanastasiou, E., & Zembylas, M. (2002). The effect of attitudes on science achievement: A study conducted among high school pupils in Cyprus. International Review of Education, 48(6), 469-484.

Papanastasiou, E., & Zembylas, M. (2004). Differential effects of science attitudes and science achievement in Australia, Cyprus, and the USA. International Journal of Science Education, 26(3), 259-290.

Parkinson, J., Hendley, D., Tanner, H. and Stables, A. (1998). Pupil's attitudes to Science in Key Stage 3 of the National Curriculum: a study of pupils in South Wales. *Research in Science and Technological Education*, 16*(2)*, 165-176.

Pell, T. and Jarvis, T. (2001). Developing attitude to science scales for use with children of ages from five to eleven years. *International Journal of Science Education*. 23*(8)*, 847-862.

Ramsden, J. (1998). Mission Impossible?: Can anything be done about attitudes to science? *International Journal of Science Education*, 20, 125-137.

Rennie, L.J., Goodrum, D., & Hackling, M. (2001). Science teaching and learning in Australian schools: Results of a national study. *Research in Science Education, 31*, 455–498.

Roberts, D.A. (2007). Scientific literacy/science literacy. In S.K. Abell & N.G. Lederman (Eds.), Handbook of research on science education (pp. 729-780). Mahwah, NJ: Lawrence Erlbaum Associates.

Schibeci, R.A. (1984). Attitudes to science: An update. Studies in Science Education, 11, 26-59.

Sesen, B.A., & Tarhan, L. (2013). Inquiry-based laboratory activities in electrochemistry: High school students' achievements and attitudes. *Research in Science Education, 43*, 413-435.

Simpson, R. D., & Oliver, J. S. (1990). A summary of major influences on attitude toward and achievement in science among adolescent students. Science Education, 74, 1–18.

Simpson, R., Koballa, Jr. T., Oliver, J., & Crawley, F. (1994). Research on the affective dimension of science learning. In D. Gabel (Ed.), Handbook of research on science teaching and learning (pp. 211-234). New York: MacMillan Publishing Company.

Simpson, R., Koballa, Jr. T., Oliver, J., & Crawley, F. (1994). Research on the affective dimension of science learning. In D. Gabel (Ed.), *Handbook of research on science teaching and learning* (pp. 211-234). New York: MacMillan Publishing Company.

Simpson, R.D. and Oliver, J.S. (1990). A summary of major influences on attitude toward and achievement in science among adolescent students. *Science Education*, 74*(1)*, 1-18.

The Royal Society. (2006). Increasing uptake of science post-16. London: The Royal Society.

Turpin, T.J. (2000). *A study of the effects of an integrated, activity-based science curriculum on student achievement, science process skills, and science attitudes*. Unpublished EdD dissertation, University of Louisiana at Monroe, USA.

Wandersee, J., Mintzes, J., & Novak, J. (1994). Research on alternative conceptions in science. In D. Gabel (Ed.), Handbook of Research on Science Teaching and Learning (pp. 177-210). New York: MacMillan Publishing Company.

Weinburgh, M.H. (1995). Gender differences in student attitudes toward science: A meta-analysis of the literature from 1970-1991. Journal of Research in Science Teaching, 32(4), 387-398.

Wellington, J. (1990). Formal and informal learning in science. The role of the interactive science centres. Physics Education, 25, 247–252.

Wideen, M.F. (1975). Comparison of student outcomes for science – a process approach and traditional science teaching for third, fourth, fifth, and sixth grade classes: A product evaluation. *Journal of Research in Science Teaching, 12*(1), 31-39.

Woolnough, B.E. (1990). Making choices. Oxford, UK: Oxford University Department of Educational Studies.

Yager, R.E., & Penick, J.E. (1986). Perceptions of four age groups toward science classes, teachers, and the value of science. Science Education, 70(4), 355-363.

Zacharia, Z., & Barton, A. C. (2004). Urban Middle-School Students' Attitudes toward a Defined Science. *Science Education*, 88(2), 198-222.

McCracken, J. & Barcinas, J, (1991) Differences Between Rural and Urban Schools, Student Characteristics, and Student Aspirations in Ohio> Journal of Research in Rural Education, 7(2), 29-40