

Pupils' Attitudes Towards Science: A Case of Turkey

Hulusi Çokadar and Cansu Külçe

¹Pamukkale University, Faculty of Education, Department of Elementary Education,
Science Teacher Training Program, Incilipinar Campus - Denizli / Turkey
²Artı Dershanesi, Chemistry Teacher Aydın / Turkey

Abstract: This study was conducted to understand pupils' attitudes towards school science. For this purpose, a questionnaire composed of two sections was administered to 503 pupils at six public schools in the city of Aydın, in Turkey. In the first section of the questionnaire, pupils were asked about demographic information; in the second part, they were given a scale to measure their attitudes towards school subject, instruction and science in three-sub dimensions. According to the results of this study, pupils' attitudes towards science were found at medium level. Pupils' favorite subject, attended school, grade, families' monthly income and perception of self-achievement relate to the pupils' attitudes toward science. The pupils' attitudes towards science differ depending on pupils' the favorite subject, attended school, grade, family's monthly income and perception of self-achievement. On the contrary, there were no significant differences at the pupils' attitudes towards science relating to gender, parents' educational background and job and social self-perception of the pupil.

Key words: Attitudes towards science • lower secondary education • psychosocial characteristics • socioeconomic status

INTRODUCTION

Society expects learning to result from education in the school and the results of education are achieved in a specific place within schools. Education is provided in the classroom. The classroom is the nucleus where other influences on the students' learning and results from their education are found. These influences can include: classmates, peer groups, teachers and textbooks. As pointed out by Webster and Fisher [1], all the variables that contribute to educational outcomes exist in one-way or another in the classroom. The concept of 'attitude' is widely used in the science educational literature. Oliver and Simpson [2] have defined 'attitude' simply as the degree to which a student *likes* science. Salta and Tzougraki [3] have summarized that 'attitude' is a *tendency* to think, feel, or act positively or negatively toward objects in our environment.

The investigation of students' interest and attitudes towards science has been a substantive feature of the work of science education research community for the past 30-40 years. Research studies have identified a number of factors influencing students' attitudes toward science in general. Most frequently, researchers have compared gender (girls versus boys) and/or age (primary, lower secondary, secondary level) and/or schools'

(private versus state schools) or peer influences toward school science. A considerable amount of attitude research in science education has been reported in the literature.

Research in science education indicates that gender may also influence attitudes towards science. Overwhelmingly, the results have shown that boys' attitudes are significantly more positive than girls' attitudes school science (Ramsden [4], Weinburgh [5], Simpson and Oliver [6]). In a meta-analysis of attitude studies from 1970 to 1991, Weinburgh [5] indicated that boys show more positive attitudes towards science than girls in all types of science. These positive attitudes for boys have not always been evident when the populations have been subdivided further. For example, Greenfield [7] found that grade 4 to grade 6 girls liked science more than boys of a similar age. Whereas both groups' interest levels declined during lower grade 7 to grade 8, boys' interest rose again during grade 9 to grade 12, but the interest of girls didn't. Similarly, Weinburgh [5] and Tal *et al.* [8] found that high-performance girls showed more positive attitudes than did boys at all levels. Ahu [9] in his study found that girls are better than boys in science; think that science is interesting; feel that science content is not difficult and enjoy science. Attitudes to science with children aged from 5-11 years, Pell and Jarvis

[10] reported that both boys' and girls' enthusiasm for science declines progressively with age alongside a similar decline in their perception that science is difficult. Barrington and Hendricks [11] found no gender differences with respect to attitudes toward science with gifted and average students. Similar results were found by George [12] and Henry [13]. The conflicting results from different studies make it difficult to generalize whether there are gender differences in students' attitudes towards science.

Several studies have focused on the relationship between students' grade level and attitudes towards science. For example, the attitude towards science becomes less positive from grades 6 through 10 and throughout each school year in those grades [7, 8, 10, 14]. The basic education studies were enthusiastic, looking forward to a year of experimenting and finding out interesting things about the natural world but when they reached secondary education; they did not enjoy science. Typically science lessons in senior high school witnessed students playing a passive role such as listening and copying teachers' notes from the blackboard. Under such learning environments, it is not surprising that the students' attitudes towards science declines as students move to higher grades.

Subject preferences of pupils have been an extensively investigated domain in science education. The typical measurement of attitudes towards school science can be obtained by asking pupils to rank their liking of school subjects, or just to name the most and the least favorite subject. A study by Colley *et al.* [15] using a sample of 11-13 years old indicated that boys gave significantly higher rankings to physics education and *science and technology* than girls, while girls gave significantly higher rankings to English. The investigation of attitudes of pupils (age 13-14) in the UK towards mathematics, English, science and technology carried out by Hendley *et al.* [16] indicated that out among these three core subjects, science and technology was the least popular. Teppo [17] reported that the boys expressed a more positive attitude towards mathematics and *science and technology*, while girls' preferred English. Talton and Simpson [18] investigated the relationship between peer and individual attitudes towards science and they showed that the strength of the relationship increased during each school year (from grades 6 to 9); as the year progressed, individual attitudes became more like peer attitudes.

ROSE (The Relevance of Science Education) is an international comparative research project with an objective to investigate 15-16 years old students' experiences, interests, priorities, images and perceptions

that are of relevance for their learning of *science and technology* and their attitudes towards the subjects from a wide range of countries all over the world (Sjøberg and Schreiner [19]). Teppo [17] summarizing the findings of this project said that students' interest, attitudes or opinions related with *science and technology* have a lot of similarities between countries, but on the other hand, several differences exist depending highly on the culture, economical and social development of state, educational system etc. Therefore in the eyes of students in different countries is not the same. The most important component for relevant science education was the manner in which science issues were presented to students. Students need to be provided the scientific and technological information and processes that can be utilized for a lifetime.

Much has been written in the literature on how to make science learning more interesting, useful and meaningful for students. Holbrook [20] suggested that this could be achieved through science education meeting one, or all, of the following three criteria: (i) it directly relates to concerns in the students' immediate environment or area of interest; (ii) it is a perceived need for society; (iii) it is shown to be an interesting and useful component of the curriculum, especially for the more able students.

Teachers have an important role to play in the sequencing and executing of their teaching in a relevant manner; policy makers have a responsibility for an appropriate vision for science education and curriculum developers need to put this vision into a curriculum that reflects the defined goals. Tobias [21] indicated that adapting instruction to student interests improved student attitudes and increased learning and these outcomes tended to be long lasting.

The purpose of this study was to determine if there were statistically significant differences among the pupils' attitudes towards school subjects, instruction and science in three-sub dimensions in sixth, seventh and eighth grades. The pupils' attitudes toward science were examined thorough the pupils' personal information (*grade, attended school, gender*), psychosocial properties (*favorite subject, perception of self-achievement, social self-perception*) and their families' socioeconomic status (*parents' educational background, parents' job, families' monthly income*).

Goals of the research

This research aims to determine:

Research Goal 1: the pupils' perception of school subject, instruction and science.

Research Goal 2: if the pupils' perception of subject, instruction and science differ with the pupil's personal information variables (*grades, attended school, gender*).

Research Goal 3: if the pupils' perception of subject, instruction and science differ with the pupil (*the favorite subject, perception of self-achievement, social self-perception*).

Research Goal 4: if the pupils' perception of subject, instruction and science differ with socioeconomic status of the family (*parents' educational background, parents' job, monthly income*).

MATERIALS AND METHODS

The Context of the Study and the Sample: Turkish schooling system consists of three main components: basic education (elementary schools, age 6-14; 8 years), which is compulsory; secondary education (senior high schools, age 14-17; 3 years); and higher education (colleges and universities). A total of 503 pupils (276 girls, 227 boys) of basic education (grade-6, N=182; grade-7, N=169; grade-8, N=152) participated in this study during the second semester of the 2004-2005 school year. Six public schools were selected based on the achievement levels in two categories (three mid and three high). Most of their parents are agriculturists who cultivate olives and figs in the city of Aydın.

Instrument: This study employed a data collection instrument that is consisted of fixed-response and open-ended questions. The first section of the instrument included fixed-response questions to compile background information about the demographic and psychosocial characteristics of the participants. The second part of the instrument was formed by 14 items which aim to determine pupils' school science attitudes. The attitude scale, developed originally by Henry [13], adapted into Turkish and used. The scale includes three-sub dimensions: *perceptions of science class* (1, 6, 12, 13, 14th items, e.g. Item 1. Science classes are fun), *perceptions of teachers/instruction* (2, 4, 5, 7, 8th items, e.g. Item 2. Science classes increase my curiosity) and *perception of discipline of science/usefulness* (3, 9, 10, 11th items, e.g. Item 3. Things studies in science classes are useful to me in daily living). The Cronbach alpha reliabilities of the sub-scales were found by a pilot test (with 56 pupils at grade 7) as $\alpha=0.86$, $\alpha=0.69$ and $\alpha=0.58$ respectively. The participants were asked to respond to the items with a five-point Likert-type scale (1=never,

2=rarely, 3=sometimes, 4=frequently, 5=always). Before the survey was conducted, permission was obtained from the Ministry of Education.

Method: The major question this study addressed was: "What was the pupils' attitudes towards school science and how science attitudes changed by the pupils' psychosocial and socioeconomic variables?" The design used for this study was a comparative research method. The comparative method was used to explore relationship between variables. This method was appropriate for the comparative study of the pupils' attitudes toward science at grades six to eight [22].

Data Analysis Procedure: After the application of the survey, the responded questionnaires were analyzed by using inferential statistical analysis of the research questions of the study. SPSS (Statistical Package of Social Sciences) version 11.0 statistical program was used to analyze and calculate the scores. The mean score of the pupil responses for each item on the questionnaire was calculated and ANOVA was then conducted to determine if there was a statistically significant difference among the mean scores of the pupils in the schools selected. After then Tukey test was used to find the sources of differences [23]. Significance level was decided by taking p values into consideration $p > 0.05$, meant there was not a meaningful difference, $p < 0.05$ meant there was a meaningful difference.

RESULTS

The findings of the study were shown on the tables listed below.

Research Goal1: What are the pupils' perception of subject, instruction and science in three-sub dimensions?

The mean scores of the pupils' attitudes towards science are given in Table 1. The pupils' perception of science sub-dimension mean score (3.73) is the highest and perception of instruction sub-dimension mean score (3.16) is the smallest among the sub-dimensions. The mean score of the pupils' attitudes towards instruction of science is the smallest among the sub-dimensions, which

Table 1: The mean scores of the pupils' science attitudes

Perception of subject		Perception of instruction		Perception of science	
N	M (SD)	N	M (SD)	N	M (SD)
498	3.57 (0.99)	487	3.16 (0.86)	495	3.73 (0.82)

Table 2: The mean scores of pupils' science attitudes with regard to grades

Grades	Perception of subject		Perception of instruction		Perception of science	
	N (%)	M (SD)	N (%)	M (SD)	N (%)	M (SD)
6 th grade	180 (36.1)	3.87* (0.87)	175 (35.9)	3.43* (0.97)	177 (35.8)	3.86* (0.80)
7 th grade	168 (33.7)	3.38 (1.05)	163 (33.5)	2.97 (.86)	166 (33.5)	3.78 (0.77)
8 th grade	150 (30.1)	3.43 (0.97)	149 (30.6)	3.05 (.88)	152 (30.7)	3.54 (0.87)

* The highest scores in all of the sub-dimensions

Table 3: The mean scores of pupils' attitudes with regard to attended school

Attended school	Perception of subject		Perception of instruction		Perception of science	
	N	M (SD)	N	M (SD)	N	M (SD)
School 1	67	3.43 (1.02)	65	3.05 (0.78)	67	3.57 (0.80)
School 2	45	3.33 (0.91)	45	2.90 (0.76)	43	3.56 (0.76)
School 3	123	4.08* (0.72)	121	3.64* (0.65)	122	4.07*(0.65)
School 4	93	3.59 (0.97)	88	2.95 (0.90)	92	3.69 (0.89)
School 5	85	3.49 (0.93)	84	3.32 (0.74)	86	3.72 (0.85)
School 6	85	3.13 (1.11)	84	2.76 (0.96)	85	3.51 (0.86)

* The highest scores in all of the sub-dimensions

Table 4: The mean scores of pupils' attitudes with regard to favorite subject

Subjects	Perception of subject		Perception of instruction		Perception of science	
	N (%)	M (SD)	N	M (SD)	N	M (SD)
Turkish	170 (34.6)	3.29 (0.95)	162	2.99 (0.87)	169	3.62 (0.84)
Social science	76 (15.4)	3.65 (0.95)	75	3.29 (0.74)	76	3.78 (0.75)
Mathematics	139 (28.3)	3.62 (0.96)	139	3.10 (0.88)	137	3.72 (0.83)
Science	70 (14.2)	4.44* (0.55)	69	3.78* (0.61)	71	4.17* (0.71)
Other	37 (7.5)	2.93 (0.83)	36	2.75 (0.65)	37	3.35 (0.79)

* The highest scores in all of the sub-dimensions

Table 5: The mean scores of pupils' science attitudes with regard to the perception of self-achievement

Perception of self-achievement	Perception of subject		Perception of instruction		Perception of science	
	N (%)	M (SD)	N	M (SD)	N	M (SD)
Very successful	64 (12.9)	4.23* (0.95)	64	3.53* (0.80)	62	4.10* (0.73)
Successful	209 (42.1)	3.70 (0.97)	205	3.21 (0.85)	209	3.76 (0.79)
Average	217 (43.8)	3.26 (0.89)	211	3.01 (0.86)	216	3.61 (0.85)
Unsuccessful	6 (1.2)	3.30 (1.26)	6	2.87 (0.53)	6	3.46 (0.92)

* The highest scores in all of the sub-dimensions

Table 6: The mean scores of pupils' science attitudes with regard to the families' monthly income

Families' monthly income	Perception of subject		Perception of instruction		Perception of science	
	N	M (SD)	N	M (SD)	N	M (SD)
0-375 \$	150	3.42 (.97)	147	3.10 (.80)	149	3.57 (.82)
376-750 \$	195	3.56 (.95)	191	3.18 (.85)	193	3.79 (.81)
751-1500 \$	103	3.75 (1.03)	100	3.19 (.90)	103	3.87* (.81)
1501 \$ - and over	32	3.78* (1.13)	32	3.28* (.93)	32	3.65 (.95)

* The highest scores in all of the sub-dimensions

indicates using of traditional conception of teaching is not sufficient to gather the interests of pupils. The finding that the mean scores are higher than 3.00 demonstrates the pupils' attitudes are at the medium level in three-sub dimension.

Research Goal 2: Do the pupils' perception of subject; instruction and science differ with the pupil's personal information variables (*grades, attended school, gender*)?

The mean scores of pupil's attitudes differ with respect to their grade levels (Table 2). The attitudes of the pupils at grade 6 are significantly higher than the attitudes of the pupils at grades 7 and 8 in all three-sub dimensions. When the mean scores of the pupils' attitudes are compared, it is observed that the scores of sixth grade pupils are significantly higher than those of seventh and eighth grade pupils.

The mean scores of pupils' attitudes and standard deviations with regard to attended school at all grades are shown in Table 3. The pupils' attitudes change depending on the school they attend. The mean attitude score of the pupils attending 'School 3' are significantly higher than those attending other schools in all of sub-dimensions. The parents considered 'School 3', 'School 4' and 'School 5' to have high education quality among other basic schools in the city of Aydın. The pupils' attitudes towards science at all grades do not change significantly with regard to their gender.

Research Goal 3: Do the pupils' perception of subject; instruction and science differ with the pupil (*the favorite subject, perception of self-achievement, social self-perception*)?

The mean scores of pupils' attitudes and standard deviations with regard to the most favorite subject at all grades are shown in Table 4. The pupils' attitudes toward science change depending on their favorite subject. The pupils whose most favorite subject is science make the 14.2% of the all participants in this study. Their attitude scores are significantly higher than others in all three-sub dimensions.

The pupils' science attitudes change depending on their self-achievement perceptions (Table 5). The pupils who consider themselves to be 'very successful' in general have significantly higher science attitudes than those who consider themselves 'successful' and 'average' in three-sub dimensions. There are no significant differences between the pupils' science attitudes in all grades and their social self-perceptions.

Research Goal 4: Do the pupils' perception of subject; instruction and science differ with socioeconomic status of the family (*parents' educational background, parents' job, monthly income*)?

In this survey, parent's educational background indicates their basic education, secondary education and higher education degree. The results demonstrate that educational levels of the parents do not have significant influence on the pupils' science attitudes in any grades. There are not any significant differences in the pupils' science attitudes relating to their parents' job.

Table 6 shows the mean scores of pupils' science attitudes and standard deviations with regard to the monthly income of the family at grades 6 to 8. In terms of perception of subject and perception of science the attitudes of the children whose families' monthly income is 751-1500 \$ and over are significantly higher than those of 0-375 \$. In terms of the perception of instruction, the science attitudes of pupils are not significantly different. In terms of perception of instruction, the attitudes of the children whose families' monthly income is over 1500 \$ are more positive than the other monthly income categories (Table 6).

CONCLUSIONS

The sixth grade pupils' attitude scores are significantly higher than those of seventh and eighth grade pupils in three-sub dimensions. The pupils' attitudes towards science show significant differences at all grades with respect to the favorite subject, school attended and perception of self-achievement in three-sub dimensions and with respect to monthly income of the family in the perception of subject and perception of science. According to the *t*-test results, the pupils' attitudes towards science do not show differences in any sub-dimensions with regard to gender.

According to statistical analysis of Tukey test results:

- The pupils whose favorite subject was school science show higher attitudes towards science than the pupils whose most favorite subject were mathematics, Turkish or Social Sciences,
- The scores of the pupils' attitudes towards science was the highest at six grade in all sub-dimensions,
- The attitudes of pupils whose families' monthly income is 751-1500 \$ and over are significantly higher than those of 0-375 \$ in perception of subject and science sub-dimensions.

- The attitudes of pupils, whose perception of self-achievement is 'very successful', are more positive than the pupils who consider themselves to be 'successful' or 'average'.

DISCUSSION

The study revealed that the pupils have medium-level science attitude scores (higher than 3.00). This result may not be satisfactory. However, it makes us hopeful because 2.5% of the pupils have low-level attitudes scores (smaller than 2.70 in total of participants), which is not ominous at all. It is obvious that transforming the pupils' positive attitude scores to a higher level is easier than transforming the pupils' negative attitude scores to positive ones. If the convenient conditions are prepared for teaching science in schools, the pupils will enjoy those classes more. The attitudes of the pupils towards science are higher among those who say that they enjoy science classes.

The study indicated that the pupils' attitude scores exhibit remarkable differences based on the schools they attended. The attitudes of pupils attending 'School 3' are higher than other schools. Papanastasiou [24] stated that school ambience and features has a great affect on the pupils' attitude towards science. The qualified teachers, teaching methods, laboratory and other educational facilities, socio-economic status of families and number of pupils in the classroom may cause differences in the attitude scores of pupils.

The pupils' science attitude scores change with regard to their grades. In fact, attitude scores of 7th and 8th grades are similar in all of the sub-dimensions, but smaller than 6th grades. George [12], Pell and Jarvis [10], Stark and Gray [14] and Tal *et al.* [8] showed that as the level of education raises the students' science attitudes decline. The school science curriculum includes certain topics of Biology, Physics and Chemistry. While the 6th graders find Biology topics simple and comprehensible, Physics and Chemistry topics are considered to be relatively difficult at 7th and 8th grades because they include abstract concepts that require more mathematics skills. Among secondary school students, while the most preferred class they want to study is Biology [25]. On the other hand, Teppo [17] pointed out that Chemistry is the least popular school subject for all at nine graders. The findings of this study showed that the pupils' attitudes towards science do not change with regard to gender. Similar results were reported by Barrington and Hendricks [11], George [12] and Henry [13].

The parent's educational backgrounds do not have a significant effect on their children's science attitudes. Cukrowska *et al.* [26] stated that the students' attitudes toward chemistry did not change with regard to their parents' educational background. Papanastasiou's [23] study indicated that parents' educational background had the least amount of influence on the students' attitudes towards science among the factors such as family, social support and school ambience. The study showed that the attitudes of pupils change with regard to the monthly income of families. The families having higher monthly income may provide their children with more possibilities in terms of education. These families can afford children's special course or private lesson expenses and this may motivate their achievement in science.

The study pointed out that the pupils' science attitudes change with regard to the perception of self-achievement. The changing attitude scores depending on pupils' perception of self-achievement show that the level of pupils' self-consciousness is especially important. There is a correlation between the degree of self-achievement perceptions of pupils and their attitude scores. The self-evaluation of pupils' achievement is realistic and their attitude scores are correlated between their achievements. Cukrowska *et al.* [26] pointed out that successful student attitudes are much higher than the failed students' attitudes with comparison to their attitudes toward chemistry. Finally, our study also showed that the parent's job and the children's social self-perception do not make significant differences in the pupils' attitudes towards science.

RECOMMENDATION

Obviously human attitudes do not change easily in a short period of time; however, educational systems should always make an effort to improve the pupils' attitudes towards science. In achieving this, teachers also play an enormous role because they are great models for children. The more the pupils enjoy the school science, the higher the improvement in the pupils' attitudes towards science. Keeping this in mind, the pupils should be motivated and are elapsed alienation behaviors by science teachers. The science should be instructed by means of introducing the other alternative and effective teaching methods. The school atmosphere and features improve the pupils' attitudes. Today, by using films and the other training-teaching materials the pupils actively participate in learning in science laboratories in schools. The families of pupils have an effect on their science

attitudes. The school administrations and the teachers should give the information to parents about their children's attitude and behaviors at school. Obtaining information about children from their schools, bridges the gap of communication between the parents and their children. If teachers encourage the pupils in science class by giving them self-confidence, the pupils' attitudes toward science will increase. The positive attitudes that are formed in the early childhood and early school years should be continued in the next school years. Maintaining the level of positive attitude towards science in early years is easier than transforming the negative attitudes to positive in the following years. Instructing the school science as conveniently as possible in the basic education will bring enjoyment and improvement in pupils' science attitudes. The reasons for the decrease in science attitudes should be searched and the appropriate means should be applied to increase the attitudes towards positive. The syllabus at seventh and eighth grades should be changed, if necessary.

REFERENCES

1. Webster, B.J. and D.L. Fisher, 2000. Accounting for variation in science and mathematics achievement: a multilevel analysis of Australian data Third International Mathematics and Science Study (TIMSS). *School Effectiveness and School Improvement*, 11: 339-360.
2. Oliver, J.S. and R.D. Simpson, 1988. Influences of attitude towards science, achievement motivation and science self-concept on achievement in science: A longitudinal study. *Science Education*, 72: 143-155.
3. Salta, K. and C. Tzougraki, 2004 Attitudes towards chemistry among 11th grade students in high school in Greece. *Science Education*, 88: 535-547.
4. Ramsden, J.M., 1998. Mission impossible?: Can anything be done about attitudes to science? *International Journal of Science Education*, 20: 125-137.
5. Weinburg, M., 1995. Gender differences in student attitudes toward science: A meta-analysis of the literature from 1970-1991. *Journal of Research in Science Teaching*, 32: 387-398.
6. Simpson, R.D. and J.S. Oliver, 1985 Attitude toward science and achievement motivation profiles of male and female science students in grades six through ten. *Science Education*, 69 (4): 511-526.
7. Greenfield, T.A., 1996. Gender, ethnicity, science achievement and attitudes. *Journal of Research in Science Teaching*, 33: 901-933.
8. Tal, T., R. Geier and J. Krajcik, 2000. Urban Students' Beliefs about Science in Inquiry-based Classrooms. Paper Presented at AERA Conference, New Orleans, April 1-30.
9. Ahu, T., 1995. Pupils' opinions about the factors that affect teaching and learning of junior science in Lesotho. *School Science Review*, 77: 107-111.
10. Pell, T. and T. Jarvis, 2001. Developing attitude to science scales for use with children of ages from five to eleven years. *International Journal of Science Education*, 23: 847-862.
11. Barrington, B.L. and B. Hendricks, 1988. Attitudes toward science and science knowledge of intellectually gifted and average students in third, seventh and eleventh grades. *Journal of Research in Science Teaching*. 25: 679-687.
12. George, R., 2000. Measuring change in students' attitudes toward science over time: An application of latent variable growth modeling. *Journal of Science Education and Technology*, 9: 213-225.
13. Henry, G.H., 1996. A study investigating student and teacher attitudes toward science and science education. Unpublished Ph.D. thesis, Dayton.
14. Stark, R. and D. Gray, 1999. Gender preferences in learning science. *International Science Education*, 21: 633-643.
15. Colley, A., C. Comber and D.J. Hargreaves, 1994. Gender effects in school subject preferences: A research note. *Educational Studies*, 20: 13-18.
16. Hendley, D., J. Parkinson, A. Stables and H. Tanner, 1995. Gender differences in pupil attitudes to the national curriculum foundation subjects of English, mathematics, science and technology in Key Stage 3 in South Wales. *Educational Studies*, 21: 85-97.
17. Teppo, M., 2004. Grade nine students' opinions relating to the relevance of science education, M.Sc. Thesis, Tartu.
18. Talton, E. and R.D. Simpson, 1987. Relationship of attitude toward classroom environment with attitude toward and achievement in science among tenth grade biology students. *Journal of Research in Science Teaching*, 24: 507-525.
19. Sjøberg, S. and C. Schreiner, 2002. "ROSE Handbook". Introduction, guidelines and underlying ideas.

20. Holbrook, J., 2003. The way forward. *Science Education International*, 14: 5-13.
21. Tobias, S., 1994. Interest, prior knowledge and learning. *Review of Educational Research*, 64: 37-49.
22. Bryman, A., 2004. *Social Research Methods*. Oxford University Press.
23. Green, S.B., J.S. Neil and T.M. Akey, 2000. *Using SPSS for windows: Analyzing and Understanding Data*. New Jersey: Prentice Hall.
24. Papanastasiou, C., 2002. School teaching and family influence on student attitudes toward science: based on TIMMS (The Third International Mathematics and Science Study) data for Cyprus. *Studies in Educational Evaluation*, 28: 71-76.
25. Lannes, D., V.M. Rumjanek, A. Velloso and L. De Meis, 2002. Brazilian schools: comparing students' interest with what is being taught. *Educational Research*, 44: 157-179.
26. Cukrowska, E., M.G. Staskun and H.S. Schoeman, 1999. Attitudes Towards Chemistry and Their Relationships to Student Achievement in Introductory Chemistry Courses, 52(1): 8-14.