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What Makes Children Like Learning Science? An Examination of the Attitudes of Primary School Students towards Science Lessons

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Abstract

This study examines attitudes to school science classes amongst primary school children, based on the assumption that these will influence their attitudes and choices later in life. 1298 primary school students in grades 4-6 were given a Likert-type questionnaire and asked to provide verbal explanations for their agreement/disagreement with each item. The items were divided into three "clusters," representing three central influences on student attitudes: "motivational factors", "locus of control" and "relevance of science."

Our results support the findings of previous research in elements such as students' enthusiasm for experiments, and reveal some interesting discrepancies in the way boys and girls assess the relevance of science they learn in school. While the questionnaire shows that most of the students saw discussion in science class as a source of interest, students' explanations and their answers to the open-ended questions also indicate that the most common model of a science lesson they see is readings from the textbook, accompanied by the teacher's explanations. Only about one half of the students claim to take an active part in lessons, answering questions asked by the teacher in class, taking part in class discussions, and expressing their opinions. The teacher is perceived as a significant part of the learning process. The students' explanations indicate that they see the teacher as a primary source of information and authority.

Keywords: motivational factors, locus of control, relevance of science, self-efficacy

1. Introduction

Despite the ever-growing importance of science in our daily lives, recent research shows a continuous decline in the number of students who choose to study scientific subjects in high school and to later pursue scientific careers (Osborne, Simon & Collins, 2003; OECD, 2007). While to date only a relatively small body of work has been devoted to assessing the attitudes of primary school students towards the learning of science (Neathery, 1997, Pell & Jarvis, 2001, Tymms, 1997), as early as three decades ago researchers showed that age 8-13 is a crucial period in the development of attitudes towards science (Ormerod & Duckworth, 1975 in Pell & Jarvis, 2001). Further research showed that a positive attitude towards science significantly impacts motivation to learn it, both in school and in other educational frameworks, and that attitudes developed in primary school influence the choices of students later in their life (Osborne, Simon & Collins, 2003). This study therefore assesses the attitudes of primary school students towards learning science, attempting both to characterize their science-education experience, and to identify the central components that influence their perception of it. One element it examines in this context is gender, and the manner and extent to which it may influence students' experience of science, even at such an early age.

1.1 Motivation and Attitudes towards Learning Science in Primary School

Attitudes and motivation have been the subject of educational research for several decades (Ormerod & Duckworth, 1975 in Pell & Jarvis, 2001, Roeser et al., 1996, Singh, 2002, Yager & Penick, 1986, Palmer, 2005, Brophy, 2004, Osborne, 2003). Despite the rather limited amount of studies conducted into the attitudes of primary school students towards science (Yager & Penick, 1986, Murphy & Beggs, 2001, Pell & Jarvis, 2001) a number of patterns have nevertheless been identified. These include the significance of the teacher's role, the recognition of science as important, the perception of science class as a positive, "fun" experience (Yager & Penick, 1986, Murphy & Beggs, 2001), a distinct gender difference in students' attitudes (Jarman, 1993, Reiss,

2004) and a general keenness about conducting experiments (Reiss, 2004).

Research has shown a correlation between teacher conduct, class atmosphere, and pupils' attitudes in different ages. Children have indicated teacher conduct in science class as an influential factor in developing their attitudes and their views about science in school and science in general (Haladyna, Olsen & Shaughessy, 1982). Moreover, studies of children's level of satisfaction with their science classes found that the satisfaction children derive from science class, as well as their motivation for learning science, are influenced by the way they are taught (Brok, Fisher & Scott, 2005). Good teachers have been described as those who are fond of what they are teaching, who link topics learned in class to everyday life and who teach in an orderly way. Using diverse ways of teaching and involving pupils in active learning has also been pointed out by the children as positively influencing their attitude to science in school and in general (Osborne & Collins, 2001). Pupils with positive attitudes towards science tend to develop a more positive approach towards topics learned in school and toward science class as a whole (Atwater, Wiggings & Gardner, 1995).

The interaction of students with their teachers and with the study material involves yet another very important and widely studied feature in attitude and motivation research - self-efficacy. The belief in one's capacity to successfully perform a particular task is one of the most powerful motivational predictors of how well a person will perform at almost any endeavor. A person's self-efficacy is a strong determinant of their effort, persistence, and strategizing, as well as their learning and further performance. Studies have shown that students' self-concept of their ability in science has a continuous and crucial influence in the development of their attitude towards science classes and science in general (Haladyna, Olsen & Shaughnessy, 1982; George, 2000). A high rate of self-efficacy towards a certain task leads to a stronger determination to persist in performance, as well as making the task seem more important and enjoyable (Schunk, 1991).

Teachers' conduct can provide students with verbal and non-verbal indications about their progress, which they use to build up their self-efficacy. While this has been found to be true of high-school students, primary school pupils have been found to have a relatively high (3 of 5) and stable notion of self-efficacy in science that was *not* dependent on external variables, such as their general attitude to school or their academic achievement in other subjects (Tymms, 1997; Pell & Jarvis, 2001). Furthermore, some studies showed that younger children showed more self-efficacy than older ones (Yager & Penick, 1986).

An additional factor influencing motivation and attitudes towards science is the very recognition of science as something important and worthwhile. Studies show that primary school pupils see science as important, helpful and useful for future life (OECD, 2007; Neathery, 1997; Yager & Penick, 1986). Recent decades, however, show that interest in science at school is in a distinct state of decline, which starts in junior high and becomes even stronger in high school (Sorge, 2006; Reiss, 2004). Furthermore, Osborne, Simon & Collins (2003) have found that despite the general recognition of the importance of science studies, students relate to science more as a technical tool for success, rather than as something interesting worth indulging in. On a personal level, many students described science as a prestigious subject, and students who succeed in science are seen as "smarter". At the same time, however, students did not mention that science was interesting, and even pointed out that some science topics were completely unnecessary in their opinion.

Unlike older students, primary school students have been shown to see science as highly important and valuable, even as an end unto itself (Neathery, 1997). A high percentage of primary school pupils spoke about science in terms of interest, though its practical value is by no means overlooked: about 90% of primary school pupils agreed that science would help them in their future career, and more than 70% of them described science as relevant and useful in everyday life (Yaher & Penick, 1986).

1.2 Gender Differences in Primary School Attitudes and Motivation

There are, however, certain variables that continuously influence the attitudes of students in all age groups, and one of these is gender. Gender issues in education, including academic preferences and motivation, have already been studied for a number of years (Baird, Lazarowitz & Allman, 1984; Kahle & Rennie, 1993; Weinburgh, 1995; Jones et al., 2000). Though the significance of differences has been shown to increase with age, studies of primary school children revealed that distinct gender differences were already present, with boys tending to like physics and chemistry related topics, while girls gravitate toward topics related to the human body, healthy lifestyle, and communication between animals (Baird, Lazarowitz & Allman, 1984; Jones et al., 2000).

The recognition of science as important and relevant also changes between genders with age. In primary school, boys and girls alike report a high level of awareness that learning science is important and relevant to their lives, but as students grow older, this conviction decreases markedly, especially in girls. In high school the number of girls voicing strong support of the importance and relevance of science is much smaller than that of boys (Kahle

& Rennie, 1993). Decreasing interest in science amongst girls was discovered in extracurricular activities as well. An extensive survey of questions sent by pupils and students to a popular Ask-A-Scientist site held over 10 years showed that around the world girls tended to send in fewer questions as they grew older (Baram-Tsabari et al., 2008).

On the other hand, despite their less positive attitude towards science, girls have usually boasted higher academic achievement than boys (Weinburgh, 1995, Ander et al., 1999). However, lower achievement notwithstanding, boys have nevertheless reported higher self-efficacy than girls, a difference that also increased as they grew older (Kale & Rennie, 1993, Mecee & Jones, 1996). In addition, it was found that science and science related careers are seen by students as "more suitable for boys" (Weinburgh, 1995, Jones et al., 2000, Osborne, Simon & Collins, 2003).

Primary school pupils, boys and girls alike, report an all embracing support for conducting experiments in science classes. Despite the fact that pupils sometimes describe science as "dangerous and destructive" (Jones et al., 2000) most of them relate to experiments as the most interesting and the enjoyable part of the science lesson (Murphy & Beggs, 2001, Reiss, 2004, Yager & Penick, 1986). In discussing science classes with students, studies suggest that in general primary school pupils expect science class to be "a bit different", involving more creative and practical hands-on activities than other classes (Pell & Jarvis, 2001), and see science as "exciting, magic, important and understandable" (Yager & Penick, 1986, Murphy & Beggs, 2001).

1.3 Science Education in Israeli Primary Schools

Primary education in Israel is an integral part of the state's compulsory education system. It is divided into grades 1 through 6, for children between the ages of six and twelve. The science curriculum employed today is based on the STS approach, which holds that science and technology are an essential part of proper modern education, necessary for any person striving to become an active contributing citizen. It includes topics from different scientific fields (life-science, material science, earth science and technology) which reflect interactions between science, technology and human society, such as environmental issues, energy production (power stations etc.), human body and medicine, and the plants and animals dwelling in children's immediate environment.

Topics included in the primary school science curriculum deal with a number of fundamental scientific concepts and terms, such as the definition of matter and state of matter, power and energy, the definition of "system" etc. Pupils learn to solve hypothetical problems and practical assignments related to environmental issues, animals and their habitat, energy production and sources of energy in everyday life, basics of electrical engineering (electric circuit, conduction, insulating etc), human body and diseases.

2. Research Goals and Questions

This study aims to characterize the attitudes of primary school students towards learning science. Our research questions address three of the factors identified in Osborne (2003) as particularly influential in defining students' attitudes. We therefore ask the following: a) Which motivational factors are manifested in the attitudes of primary school students towards learning science? b) How do locus of control issues figure in and influence the attitudes of primary school students' towards learning science? c) How do primary school students assess the relevance of the science they learn in school?

3. Research method

3.1 Sample

The study was conducted among primary school students ranging from grade 4 to grade 6, selected from twenty primary schools throughout Israel to represent different socio-economic backgrounds and various types of population points (town, village, agricultural residential area). The sample included 1298 participants (575 boys (44.3% of the sample) and 723 girls (55.7% of the sample), a size sufficient to allow us to identify internal sub-groups in the sample and check their prospective interrelationship.

3.2 Research Tools

The questionnaire we used (see Appendix) was developed especially for this study. We based the development of the items on previous research (see Jarman, 1993; Awater et al., 1995; Crawley & Coe, 1990; Osborne, 2003; Schreiner & Sjoberg, 2004; Tuan et al., 2005; Pell & Jarvis, 2001; Caleon & Subramanian, 2008). Most of that research focused on high school students, so we carried out a preliminary test, interviewing 5 primary school students to get feedback and adjust the items we developed for use in primary school.

Quantitative data collected from Likert-type items, however, is not sufficient for forming an understanding of the reasons underlying a phenomenon. While it is an efficient tool for *identifying the nature* of a phenomenon, quantitative research provides very little information for the purpose of *understanding* it (i.e., it can indicate that a phenomenon has occurred, but it cannot explain how or why). For these reasons our study combined the use of a Likert type questionnaire with open-ended questions, in which the participants were asked to explain the extent to which they agree with the questionnaire statements. Using qualitative and quantitative data together in this way lent greater credibility to the findings by triangulating the data through both source types (Creswell & Tashakkori, 2007).

3.3 Data Analysis

Since our research tools combined quantitative and qualitative techniques, data analysis involved statistical tests as well as the categorization of text. The explanations the children wrote for each Likert item and their answers to the open-ended questions were analyzed based on the interpretative methods of qualitative research (Strauss & Corbin 1990) and according to the following steps:

1) Finding the main idea of every explanation – each was summarized into a short sentence representing its main point.

2) Division into categories – categorization was carried out concurrently with the interview analysis to ensure the identification of categories that are as precisely representative as possible. This process was evaluated and validated throughout by the researcher's advisor to further ensure its accuracy.

Categories were numbered separately for each Likert item, as well as for every item from the second part of the questionnaire. This allowed us to perform statistical tests in order to identify internal patterns within the explanations.

The quantitative analysis was carried out using SPSS 15.0 software. A reliability test was performed (Alpha Cronbach) over the total research sample with the result of 0.77, indicating high reliability. Confirmatory factor analysis showed three "clusters" of items, corresponding to the three factors described in the research questions. In order to check the significance of the differences between the clusters, One-way Repeated Measures Anova was performed for the three factors found in the factor analysis. The test showed a significance of $F(2,1296)=8.28$, Wilks' $\Lambda=0.987$, $p<0.001$. Further t-tests for each pair of clusters showed a significant difference between Clusters #1 and #2 ($t[1297]=4.02$, $p<0.001$), and between Cluster #1 and #3 ($t[1297]=2.33$, $p=0.02$).

Table 1. Factor analysis findings (N=1298)

Item / Factor loading	Cluster 1 **Motivation factors in learning science**	Cluster 2 **Locus of control in learning science**	Cluster 3 **Relevance of science**
1. I enjoy science classes because we have interesting discussions on science topics	**0.723**	0.184	0.127
2. I enjoy science classes because the teacher and students do experiments	**0.541**	0.153	0.120
3. I'm not really interested in the science we learn in class	**0.675**	0.258	0.159
4. I do not enjoy science classes, because I don't like class discussions	**0.637**	0.252	0.152
5. Science topics we learn in class are usually very interesting to me	**0.676**	0.241	0.146

6. If I don't understand a science concept, I'll turn to the teacher for explanation	0.167	**0.387**	0.152
7. I feel that I have a good command and understanding of science topics we learn	0.104	**0.715**	0.025
8. I take an active part in science classes and answer the teacher's questions orally	0.091	**0.780**	0.011
9. I take part in class discussions and express my opinion	0.147	**0.748**	0.079
10. Science topics that I learn in school are important, because they help me understand different phenomena in the world around me	0.340	0.148	**0.433**
11. During science classes we deal with topics from everyday life	0.051	0.064	**0. 801**
12. Science topics we learn in class are not related to real life	0.059	0.048	**0.784**
Eigenvalue	3.691	1.338	1.221
Percent difference	28.396	10.294	9.392

4. Results

On the whole, the attitude of our study population towards science was found to be positive. Data analysis showed that, when asked in the questionnaire to name their favorite subject, the overall population of the study named science third most popular at 11.6%, while the most popular was sports (46.3%) and the second most popular was mathematics (12.3%). The analysis also showed minor gender differences in the popularity of science: boys graded science their second most popular subject with 11.3% support, while girls graded it third most popular with 11.9%. The mean value at each one of three clusters found by the factor analysis was above 2.4 (Table 2), which suggests that the general attitude of the primary school students tends toward the favorable.

Table 2. Analysis of gender differences

Cluster	Gender	Mean value	Standard deviation	F(1,1298)	p-value
Motivation factors	Male	2.38	0.50		
	Female	2.44	0.49	5.38	0.02
Locus of control in learning science	Male	2.48	0.44		
	Female	2.47	0.44	0.142	0.71
Relevance of science	Male	2.39	0.54		
	Female	2.50	0.47	16.24	<0.001

The results presented here, which address the factors contributing to this favorable attitude, are divided into three "clusters." These correspond to the three influential factors addressed in the research questions, and reflect elements that have already been marked as important in the literature. Our analysis showed significant differences between the three clusters, implying that the influence of motivational factors and relevance issues on attitudes is stronger than that of locus of control.

4.1 Cluster #1: Motivational Factors and Their Influence on Student Attitudes

Data for this cluster was drawn from items 1 through 5 in the questionnaire. Analysis showed that children listed class discussions, lab experiments and interest in the topics being learned as motivational factors for learning science. As Table 3 indicates, a high percentage of the participants, girls and boys alike, chose the "not sure" option (a phenomenon that recurs in Clusters 2 and 3 below).

Table 3. Cluster 1- Motivation factors in learning science

Item	**Gender**	**Degree of agreement**			**Mean**	**SD**	**t**	**Degrees of freedom**	**p- value**
		3-Agree	**2- Not sure**	**1- Disagree**					
1*	Male	%48.2	%36.3	%15.5	2.33	0.73	1.12	1296	0.26
	Female	%51	%35.1	%13.8	2.37	0.72			
2*	Male	%50.3	%25.9	%23.8	2.26	0.82	2.13	1296	*0.03
	Female	%55.2	%25.6	%19.2	2.36	0.79			
3*	Male	%13.9	%32.7	%53.4	1.61	0.72	1.59	1296	0.11
	Female	%11.9	%30.4	%57.7	1.54	0.70			
4*	Male	%12.2	%28	%59.8	1.52	0.70	1.54	1296	0.12
	Female	%11.8	%22.8	%65.4	1.46	0.70			
5*	Male	%57.4	%29	%13.6	2.44	0.72	1.47	1292	0.14
	Female	%62.2	%25	%12.8	2.50	0.72			

1* I enjoy science classes because we have interesting discussions about science-related topics.

2* I enjoy science classes because the teacher and students do experiments

3* I'm not really interested in the science we learn in class

4* I do not enjoy science classes, because I don't like class discussions

5* Science topics we learn in class are usually very interesting to me

Nevertheless, the results showed that most students see class discussion as interesting (49.8% agreed with statement 1). The most common explanation for this was “because it is a funner way to study science.” Nevertheless, it is worth noting that only 5.5% of the students cited discussion as the source of interest in class, and only 9.6% see it as a good and efficient way of conducting a science class. The most common model arising from students' explanations (Table 4) is highly teacher-oriented. Thus 39.3% of students reported that usually science class is based on discussion of scientific topics conducted by the teacher, and 37.8% reported that reading in the textbook combined with teacher's explanation are the main components of the science lesson. Interest in the study topics is a key part of students' motivation to learn science, as shown by their extensive disagreement with statement 3 (55.8%). This is also supported by such explanations as “this year we learned many interesting things.”

While many of the items in the questionnaire did not show a significant difference between boys and girls, this cluster did reveal some gender differences in the students’ approach to experiments. 55.2% of girls stated that they like science classes because of experiments, while only 50.3% of boys supported this statement. This was further supported by the analysis of the students’ explanations for the Likert items in this cluster, which showed that 40.7% of girls vs. 37.2% of boys listed experiments as a main source of enjoyment in class: "I love experiments", "I like experiments, they are re-e-e-e-ally interesting!", "We perform lab experiments and they are one of the main things I like about science classes". On the other hand, however, analysis of the answers to the items from the second part of the questionnaire suggests that boys are more dissatisfied with the small quantity of lab experiments in the class: 59.8% of the boys vs. 56.2% of the girls state that an interesting science class must include experiments, and 75% of the boys vs. 70% of the girls would like the class to be taught through experiments only. Interestingly, the number of boys and girls who asked for more experiments to be added to the regular science class was almost identical at 54.6% and 55% respectively. The seemingly contradictory evidence presented here suggests that, despite the apparent significance of the differences shown here, the question of gender-based attitudes to experiments in science class requires further inquiry.

4.2 Cluster #2: Locus of Control Issues and Their Influence on Student Attitudes

This cluster was addressed in items 6 through 9. Previous studies (Osborne, Simon & Collins, 2003; Chang &Ho, 2009; Jang et al, 2010) show that mastery of the learning process is an important factor in generating meaningful learning. In our study, most of the students indicated that they did feel a mastery and an understanding of the material they learned class (52.7 agreement with item 7). 40.8% of the students said that they take an active part in lessons and answer questions posed by the teacher in class (item 8), and 52.6% claimed to participate in discussions and express their ideas in class (item 9). Their explanations suggest that the main motive defining students' mastery of the subject is self-efficacy, consisting of statements like: "I know and I understand, I've got excellent perception!"; "I feel that I know it well"; "I know I've got a lot to contribute to the discussion and that's why I always answer and speak out"; "Yes, because I understand and I'm ready to answer questions orally"; "I participate a lot, because the material is easy for me," as well as statements indicating a lack of self-efficacy, such as: "I'm not a big shot in science." It is worth noting that on the whole students did not see testing as a primary indicator of academic success, with only 3.8% mentioning tests in their explanations for item 7.

The students' explanations also indicate that they see active participation as a way to learn. 13% of them saw discussion and expressing opinions as an effective learning strategy, providing explanations like: "yes, in order to understand the material I ask" and "I keep trying all the time". The explanations also mention other methods of studying, such as: "I listen in class and learn," "yes, because I study at home."

Aside from self-efficacy, the teacher is portrayed as a significant figure in the learning process. 79.8% agreed with item 6, that they would not hesitate in approaching their teacher if they do not understand something. Explanations show that students perceive the teacher as a source of knowledge and authority: "yes, because he knows how to help with difficulties!"; "yes, because she understands it best and can help me"; "because when the teacher explains, I understand the material."

While analysis of the Likert items in this cluster revealed that more boys than girls declared their mastery of the subject (see Table 4, item 7*), the current study revealed no statistically significant gender differences in the ramification of locus of control issues for the students' attitudes towards learning science. The dispersal of the students' agreement with these statements is presented in Table 4 below.

Table 4. Science class components as seen by the students

Item #7. How would you prefer you science class to be conducted? Choose an alternative below:			
Category	**General population %**	**Male %**	**Female %**
The teacher runs a discussion and a conversation about science topics	9.6	9.7	9.5
Students conduct experiments	72.4	75	70.4
Students read a textbook and afterwards the teacher explains the subject	6	6.6	5.5
Students learn a new topic by doing research projects	11.5	8.2	14.1
Item #8. How are science classes conducted in your school? (choose an alternative from Question 7 above)			
Category	**General population %**	**Male %**	**Female %**
The teacher runs a discussion and a conversation about science topics	39.9	39.7	39
Students conduct experiments	8.8	8.5	9
Students read a textbook and afterwards the teacher explains the subject	37.8	35.7	39.4
Students learn a new topic by doing research projects	7.7	7.5	7.9

4.3 Cluster #3: The Relevance of Science and Its Influence on Student Attitudes

This cluster was addressed by questionnaire items 10 through 12. The dispersal of the students' agreement with these statements is presented in Table 5 below. Studies have shown that primary school children find the material learned in science more relevant than older students do (Osborne, Simon & Collins, 2003). Our population found them highly relevant (77.4% agreement with item 10). Explanations show the importance of science as a central component in the students' interest (26.9%). "It's fun to learn important things"; "they help me understand important things." Another recurring factor in the students' explanations was curiosity (at 11.7%, the third most prominent explanation for item 10): "science lessons help me understand phenomena that I've wanted to understand for a long time." Interestingly, these two reasons showed a certain difference of emphasis here between boys and girls, with boys placing more emphasis on the *importance* of science (21.6% of the boys vs. 19.2% of the girls), while more girls based their need to learn on interest and curiosity (46.3% of girls vs. 39% of boys). A third relevant component for the students was the benefit/value of learning science. This topic came up in the explanations for all of the items in this cluster, but only in those for item 10 did it find a significant percentage of support (17.8%).

Gender differences found in this cluster were statistically significant in each one of the three Likert items, as shown in Fig. 8. 50.2% of the girls vs. 43.6% of the boys stated that in science classes they deal with issues from everyday life (item 11*). Moreover, in item 12*, 57.7% of the girls vs. 51.2% of the boys confirmed (inversely, by denying the negative) that the science topics they learn in class are related to real life, a point that is also stressed in the explanations children wrote for those items, including: "We deal with problems from real life, like heart and health", "Science is related to all people", "Science is related to real life, like power stations." The girls were also more positive in affirming (item 10*) that science they learn in class helps them understand the world around them (80.8% vs. 73.2% respectively), while the explanations for this item showed that one of the main factors of influence here is interest and curiosity: "Things in the world are so interesting to me", "It's fun to learn new things."

Table 5. Cluster 2 - Locus of control in learning science

Item	Gender	Degree of agreement			Mean	SD	t	Degrees of freedom	p- value
		3-Agree	2- Not sure	1- Disagree					
6*	Male	%80.1	%15.7	%4.2	2.76	0.516	0.2	1295	0.743
	Female	%79.5	%16.3	%4.1	2.75	0.519			
7*	Male	%55	%38.1	%7	2.48	0.624	1.252	1295	0.912
	Female	%50.8	%42	%7.2	2.44	0.625			
8*	Male	%41.1	%46.2	%12.7	2.28	0.677	0.054	1292	0.733
	Female	%40.6	%47.1	%12.4	2.28	0.671			
9*	Male	%52.3	%34.7	%13.1	2.39	0.707	-0.281	1294	0.822
	Female	%52.9	%34.5	%12.6	2.40	0.702			

6* If I don't understand a science concept, I'll turn to the teacher for an explanation

7* I feel that I have a good command and understanding of the science topics we learn

8* I take an active part in science classes and answer the teacher's questions orally

9* I take part in class discussions and express my opinion

Table 6. Cluster 3 - Relevance of science

Item	Gender	Degree of agreement			Mean value	SD	t	Degrees of freedom	p-value
		3-Agree	2- Not sure	1- Disagree					
10*	Male	%73.2	%22.4	%4.3	2.69	0.55	3.09	1296	**0.002
	Female	%80.8	%16.2	%3	2.78	0.48			
11*	Male	%43.6	%29.5	%26.9	2.17	0.82	3.33	1280	**0.001
	Female	%50.2	%31.2	%18.6	2.32	0.77			
12*	Male	%20.6	%27.3	%52.1	1.31	0.79	2.34	1289	*0.02
	Female	%16.1	%26.1	%57.7	1.42	0.75			

10* Science topics that I learn in school are important because they help me understand different phenomena in the world around me

11* During science classes we deal with topics from everyday life

12* Science topics we learn in class are not related to real life

5. Discussion

The primary conclusions that may be drawn from the results of our study are:

a) Most of the students saw discussion in science class as a source of interest, but their explanations and the answers to the open-ended questions indicate that the most common model of a science lesson they see is readings from the textbook, accompanied by the teacher's explanations.

b) The central source of the students' interest is experiments.

c) Most of the students find the topics studied in science class interesting.

d) Only about one half of the students claim to take an active part in lessons, answering questions asked by the teacher in class, taking part in class discussions, and expressing their opinions.

e) The teacher is perceived as a significant part of the learning process. Most of the students claimed that they would not hesitate to ask their teacher to explain something they do not understand. The students' explanations indicate that they see the teacher as a primary source of information and authority.

5.1 Motivational Factors

The motivational factors raised by the students in this study included class discussion and experiments. A large percentage of the students described class discussion as both interesting and enjoyable. Nearly half of the students saw it as a tool to make science class more fun, but only a small percentage mentioned it as an effective and interesting way to learn. This contradiction most likely arises from the fact that students see discussion as a tool for independent thought, which allows them a certain amount of freedom and raises their involvement in the learning process (Hanrahan, 1998; Reiss, 2005), whereas in practice their experience is of class discussions governed by the teacher's closed questions, which do not encourage independent thought, but require the memorization of details and facts (Newton et al, 1999).

Indeed, the students' answers show that the most common model of a science class they see is a lesson based on reading from the textbook, explanations from the teacher and discussion which the teacher controls – a result in keeping with findings in other literature (Naylor et al, 2007; Newton et al, 1999). Despite the importance of discussion to creating a meaningful learning process, teachers are minimal in their use of it (Southerland et al, 2005). Reasons for this cited in the literature include the pressure of being unsure of the material, the lack of training for teachers in running an effective discussion, and teachers' psychological difficulty in changing the teaching style to which they have been accustomed (Naylor et al, 2007; Newton et al, 1999). Our results suggest that providing teachers with the proper training and gradually introducing discussion into classroom routine would constitute a positive step (Driver et al, 2000).

In addition to class discussion, experiments and lab work in science class have for several decades been a point of interest in science education research (Hofsten & Lunetta, 2004; Murphy & Beggs, 2001). Our study supports previous literature in showing that more than half of the students see experiments as a significant point of interest in lessons, claiming that science class becomes much more interesting when it includes experiments (Yager & Penick, 1986; Jarman, 1993; Murphy & Beggs, 2001; Reiss, 2004). Furthermore, the students' explanations indicate their belief that there are not enough experiments currently included in their science studies. Nearly two thirds of our students claimed that the main thing they would like added to the science classes in their school is experiments. A similar percentage maintain that for a science class to be "truly interesting", it must include an experiment. Other researchers have raised similar results (Murphy & Beggs, 2001; Pell & Jarvis, 2001).

Interestingly, while the percentage of girls in this study who cited experiments as a particular source of their enjoyment of science classes was higher than that of the boys, more boys than girls complained that the amount of lab experiments in science lessons was insufficient, and more boys wanted science classes to be taught mainly by means of experiments. This discrepancy may possibly be explained by the different definition girls and boys have for the term "experiment". Most of the experiments in classes are done as demonstrations performed by the teacher only, while the class watched, and this may not have been enough for boys. Boys see science as something "dangerous, destructive, exciting" (Neathery, 1997, Jones et al., 2000) and engage in more out-of-class activities involving technical or scientific equipment, such as electrical or optical devices (Kahle & Rennie, 1993; Jones et al., 2000). These findings suggest that boys may be unsatisfied with the number of "hands-on" experiments included in science classes. Some researchers (Kahle & Rennie, 1993; Adamson et al., 1998) have mentioned that girls' attitude to experiments is also influenced by their previous experience with science. Perhaps in primary school girls have not yet accumulated any negative science experience and they still see it as enjoyable. Moreover, biology and chemistry are considered "girl-oriented" and a lot of the science curriculum is therefore "girl-favored" (Kahle & Rennie, 1993), since it includes less physics or technology experiments. These factors may explain why boys might feel deprived and express a desire for more experiments.

Research has shown that primary school children expect science class to be more "practical and creative" than their other classes (Pell & Jarvis, 2001). They see science as something "exciting" (Neathery, 1997). A lack of response on the part of teachers and curriculum to this expectation could significantly diminish students' motivation towards science (Yager & Penick, 1986; Reiss, 2004). We must therefore address this, designing primary school science lessons that include a greater number of experiments render science class more interesting and challenging for the students.

5.2 Locus of Control in the Learning Process

Approximately half of the students participating in this study claimed that they are active in lessons, answer the teacher's questions, participate in discussions and express their opinions in class. Their explanations indicate that the principle motivation behind this is self-efficacy. Other studies support this correlation, and suggest that the connection is mutual – some show active participation to enhance students' self efficacy (Richter & Tjosvold, 1980), while others also argue that students with high self efficacy tend to participate more often (Zimmerman, 2000). Tobin (1990) has also found that students' level of self efficacy determines their learning methods, so that the higher their self efficacy, the more active their class participation becomes.

It is interesting to note that in studies into the correlation between active participation and self efficacy, results indicated that the conduct of the teacher can influence these mutual relations (Patrick, Ryan, & Kaplan, 2007; Furrer & Skinner, 2003). The question of the teacher's role in the learning process arose in our study as well. Our students perceived teachers as a significant part of the learning process, seeing them as a source of information and authority. The students in our study voiced a great deal of trust in their teachers, proclaiming their readiness to approach them with questions about material they did not understand.

This echoes the results of other studies into the figure of the primary school teacher (Yager & Penick, 1986, Speering & Rennie, 1996). The primary school science teacher is perceived by most students as someone who loves what they teach, is ready to answer questions, and provides personal attention and leadership (Brok, Fisher & Scott, 2000; Yager & Penick, 1986). As mentioned, teacher conduct and self efficacy may be connected, with students drawing upon their teacher for indications of their progress, and using these in their own assessment of their ability for continued learning (Furrer & Skinner, 2003; Hamre & Pianta, 2005; Briner & Pajares, 2006).

Our findings suggest that despite the relatively high level of self efficacy displayed by these students and their active participation in class, the science teacher nevertheless has a significant role in creating effective learning processes in the lesson. An in-depth understanding of the mutual interactions between the elements comprising the locus of control in science studies will allow teachers to make proper, informed choices when deciding upon courses of action.

5.3 Relevance of Science Studies

The relevance of learning science has been at the center of research education for several years. In light of the declining tendency of youthful interest in science, researchers have been trying to identify those elements that affect students' perception of the topic's relevance (Schreiner & Sjøberg, 2004; Osborne, Simon & Collins, 2003; Murphy & Beggs, 2001; Neathery, 1997). Our study found that curiosity is what serves as a significant basis for students' decision that what they learn in class is relevant. Our data showed a substantial amount of curiosity towards the material on the part of the students. Other studies have similarly found that close to sixty percent of students of primary school age claim that science classes arouse their curiosity (Yager & Penick, 1986). Another element that influenced the students' perception of science's relevance in this study was their awareness of the importance of studying science. The students' explanations indicate that they were interested in the material they learned because they considered it important. This phenomenon too has already been remarked upon in the research literature (Reiss, 2004; Osborne, Simon & Collins, 2003; Caleon & Subramanian, 2008).

While our findings in this area correlate to those of other studies, which also indicate that primary school students see what they learn is science class to as relevant to their lives (Yager & Penick, 1986; Murphy & Beggs, 2001), our study nevertheless revealed a measure of ambiguity amongst our students. This was manifested as a gap between the percentage of students who agreed with the Likert items on the topic of relevance, and those who also expressed similar sentiments in their explanations. The ambivalence suggested here may be the result of teaching methods that do not encourage students' natural curiosity, such as teachers' complete control over activity in class, a lack of independent work and requiring students to do an overlarge amount of reading and writing (Jarman, 1993; Murphy & Beggs, 2001). Another possible explanation is the disparate messages students get from their environment: on the one hand, the educational system stresses the importance of studying science and succeeding academically, while on the other, students' close environment does not always define being a scientists as the highest form of self-actualization and success.

The reason underlying the necessity of learning science was one source of gender difference found in this study. A comprehensive overview of the various available studies suggests on the whole that at primary school ages the two genders' enthusiasm for the subject of science is nearly identical (Sorge, 2007). In our study girls explained that we need to learn science because of curiosity and desire to learn more about the surrounding world, while the boys explained that learning science is necessary because science is important for human society. This difference may be the result of social expectations, since boys more than girls are expected to succeed in science-related disciplines and go on to science related careers (Andre et al., 1999, Jones et al., 2000). However, further inquiry is yet to be made into what exactly boys mean by the term "important".

Girls and boys in our study also showed different perceptions of the relevance of science to their lives. More girls confirmed that the science they learned in class was relevant, which is consistent with findings in literature that girls tend to see science as something related directly to people and close environment (Brtiner & Pajares, 2001). The primary school science curriculum does indeed include many topics dealing with practical everyday issues and the immediate environment of humans. This seems to increase the emotional involvement of girls, and subsequently to increase their perception of learning science as immediately relevant (Reiss, 2005).

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Appendix

The questionnaire is used for research in science education. Thank you for participating!

The questionnaire is intended for both males and females

Grade: ________ Gender: **male/female** (circle the appropriate)

Indicate the extent of your agreement by checking the appropriate box

№	Item	Disagree	Not sure	Agree
1	I enjoy science classes because we have interesting discussions on science topics Explain:			
2	I enjoy science classes, because the teacher and students do experiments Explain:			
3	I'm not really interested in the science we learn in class Explain:			
4	I do not enjoy science classes, because I don't like class discussions Explain:			
5	Science topics we learn in class are usually very interesting to me Explain:			
6	If I don't understand a science concept, I'll turn to the teacher for explanation Explain:			
7	I feel that I have a good command and understanding of science topics we learn Explain:			
8	I take an active part in science classes and answer the teacher's questions orally Explain:			
9	I take part in class discussions and express my opinion Explain:			
10	Science topics that I learn in school are important, because they help me understand different phenomena in the world around me Explain:			
11	During science classes we deal with topics from everyday life Explain:			
12	Science topics we learn in class are not related to real life Explain:			

Please answer the following questions in detail. The questionnaire is anonymous.

1. What is your favorite subject in school? Why?

____

____

2. What would you like to change (or to add) in the science class in your school?

____

____

3. In your opinion, why should one learn science?

____

____

4. What would make a science class really interesting?

____

____

5. What do you find difficult in science classes?

____

____

6. What do you find boring in science classes?

____

____

7. Would you like to take an out-of-school science course? Explain your answer.

____

____

8. How would you prefer your science class to be conducted? Choose an alternative below:

a) The teacher conducts a discussion on a science topic.

b) The students do experiments.

c) The students read the textbook and afterwards the teacher explains.

d) The students learn a new topic by doing research projects

Explain why?

____

____

9. How science classes conducted in your school? (choose an alternative from Question 8 above and give example)

____

____