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Variation by Gender in Abu Dhabi High School Students' Interests in Physics

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Abstract Abu Dhabi high school students' interest in physics in different contexts was investigated with a survey conducted in connection with the international project, The Relevance of Science Education (ROSE). The sample consisted of 2248 students in public and private schools. Means of most items that belong to the school physics context for both girls and boys were below the score of (3.0). The most interesting topics for both genders were connected with fantasy items. The least interesting items (particularly for girls) were connected with artifacts and technological processes. Girls assigned the highest scores for "why we dream" and "life and death." Boys assigned the highest scores for "inventions and discoveries" and "life outside of earth." The main message of the study is that new curricular approaches and textbooks can be developed through combining technological and human contexts. The implications for curriculum development, teacher professional development programs, and other education strategies in Abu Dhabi are discussed in light of the ROSE survey.

Keywords Interest in physics · ROSE · Science education · Abu Dhabi

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Introduction

Students' interests in science have become a major concern of science education researchers and policy makers (Christensen et al. 2014; Barmby et al. 2008; Trumper 2006). Studies in the science education literature emphasize that the development of a positive attitude toward science should be an important goal of the school curriculum. Students' interests are known to have a great impact on the course selection in school, the choices of majors and careers, and the lifelong engagement with science-related issues (Correl 2004). Many researchers have placed emphasis on a persistent decline in post-compulsory high school science enrollment over the last two decades, which has generated concern in many countries (Trumper 2006; Haubler 1987). These countries include the Caribbean countries (Ogunkola 2011), the UK (Smithers and Robinson 1988), Australia (Ainley et al. 2008; Dekkers and DeLaeter 2001), Canada (Bordt et al. 2001), India (Garg and Gupta 2003), Japan (Goto 2001), the USA (National Science Foundation 2002), and every country in the European Union (Commission of European Communities 2001). On a positive note, recent research shows that the proportion of high school graduates who will have taken at least one physics course prior to graduation continues to grow (American Institute of Physics 2014). The growth in enrollments continues to come from courses other than "regular" physics. A recent survey compiled by Cambridge Occupational Analysts (COA) also reported that the number of female students considering university courses in STEM subjects has seen a bigger increase over the last 7 years than for male students, according to new research (COA 2014).

There is a long tradition to the study of student interest, behavior, achievement, and attitudes toward physics

(Sjøberg 2000; Osborne et al. 2003; Bennett 2003). Research has shown that students will study and learn physics more effectively and choose physics courses in upper secondary school if they are interested in the subject. Interest-based motivation to learn has positive effects both on studying processes and on the quantity and quality of learning outcomes (Hidi et al. 2004). The development of positive attitudes toward science (physics), scientists, and learning science, which has always been an objective of science education, is increasingly a subject of concern (Christensen et al. 2014; Trumper 2006; Shroff and Vogel 2010).

Science Education in Abu Dhabi

In Abu Dhabi, physics, chemistry, and biology are separately taught at the lower secondary school stages, and the national curriculum, along with schoolbooks, emphasizes the basic concepts and physical laws, their (technical) applications, and the experimental nature of physics. In the national curriculum framework, the student learns the basic terms, principles, and laws and models that are applied to physical phenomena; can discuss features pertaining to the field and phenomena in physics; and can apply their knowledge of physics to the natural environment. The main contents of physics have been grouped into cognate themes: structures and systems, interactions, energy, processes, and method of scientific inquiry.

In Abu Dhabi, therefore, there are discrete syllabi for the three overarching science subjects: biology, chemistry, and physics. In addition, there is a general science curriculum. While technology is described in its own context, it is taught in many schools in an integrated manner with science or other subjects. Teachers have the discretion to make decisions about the type of teaching to be adopted and how the content is to be organized and sequenced. The content depicts science as a process developed through human activity, a way of describing and making our surroundings intelligible, and an important part of our cultural heritage, with an emphasis on the need for sustainable development.

The Relevance of Science Education (ROSE) project is an international comparative program of research that is a questionnaire-based study that explores the relevance of school science education from the perspective of the students themselves (Sjøberg 2002). The project rests on the assumption that knowledge of the views and perceptions of the students as learners is a necessary condition for effective science teaching. Because students' interest in physics learning is so important to future involvement in the subject, it is useful to know how the teaching of physics should be developed and the learning materials designed to increase their appeal and interest for students. In this paper, we review the literature of interest, and utilizing ROSE, we highlight aspects of interest in physics learning as it relates to students in Abu Dhabi high schools.

Review of Literature

Keeping Students Engaged in Science (Physics)

In general, keeping students engaged and interested in the classroom is an essential factor in successful teaching and learning (Hong and Lin-Siegler 2011); consequently, teaching engaged students becomes much easier (Lavonen et al. 2005). Many survey research studies were designed to track the interest and the engagement of students in topics and activities related to science, mathematics, and technology (Creagh and Parlevliet 2014). These types of study activities include, for example, carefully focusing on the instruction and applying adequate studying (learning) strategies for the topic.

Interest is usually content-specific, although influenced by context, associated with the interaction between a person and his or her environment. Moreover, interest is characterized by both cognitive and affective influences (Hidi et al. 2004). Traditionally, there have been two major points of view from which the topic of an individual's interest has been approached (Krapp 2002, 2003). One is interest as a characteristic of a person and the other is interest as a psychological state aroused by specific characteristics of the learning environment (Schiefele 1999; Schraw et al. 2001; Flowerday and Schraw 2000).

From the viewpoint of physics learning, the critical challenge of situational interest seems to be how to hold the student's interest long enough to positively affect the motivation to study and the associated positive study behaviors (Creagh and Parlevliet 2014). Ainley et al. (2002) have suggested that a student's affective response to teaching or learning material is the link between interest and learning. Interest can be seen as an integrated component of an interrelated network of psychical, social, and physical factors in a given learning situation (Volet and Järvelä 2001).

Physics is perceived as a difficult course for students in secondary schools (Rivard and Straw 2000; Olasimbo and Rotimi 2012). Lepper and Henderlong (2000) have emphasized that arousal of interest and intrinsic motivation is not possible if the student does not have a minimal level of competence. Thus, traditionally, studying physics has been motivating for gifted students who enjoy learning about natural phenomena, experimenting, and solving problems. On the other hand, students who experience physics as difficult do not even attempt to learn it, and they lose interest in the subject very quickly. It is unrealistic to believe that a student who fails to understand physics will develop an interest in it.

Students' originally positive attitudes toward science subjects markedly change in the upper grades, particularly in physics. Simpson and Oliver (1990) noted that a negative attitude toward a given subject leads to lack of interest, and when options are available for subjects to be selected, as in senior high school, many students will avoid the subject or the course. Furthermore, a positive attitude toward science "leads to a positive commitment to science that influences lifelong interest and learning in science" (Simpson and Oliver 1990). Major science education reform efforts have emphasized the improvement of students' attitudes. For instance, Project 2061, a multiple-year project in science education, suggests that "science education should contribute to… the development in young people of positive attitudes toward learning science" (American Association for the Advancement of Science 1990, p. 184).

In recent years, we have witnessed an increasing number of policy recommendations related to the need for a scientifically literate public (Ceci et al. 2014). The preparation of talented learners for future careers in science, mathematics, and technology has been subsumed within the broad vision of enhancing science literacy for all students (Christensen et al. 2014).

Physics education research has identified factors that interrelate with interest in physics learning: nationality, gender, perceived relevance for further studies or occupation, interest in the contents of physics, interest in a context where certain physics content or topics are met, interest and enjoyment in an activity type or the teaching methods used, perceived achievement, level of difficulty, and appreciation of the topic (Sadler et al. 2012; Simon 2000; Stokking 2000; Sjøberg 2000; Hendley et al. 1995).

The Context and Content of Physics

The role of context of physics has gained increasing attention (Volet and Järvelä 2001). In the framework of science education, context is particularly emphasized in context-based approaches (Lavonen et al. 2005). Contexts and applications of science are used as the starting point for the development of scientific ideas. In the context-based approaches, students may become familiar with the electromagnetic spectrum through learning about medical techniques for seeing inside the body or explore the views of different members of a community on the impact of locating a chemical industry nearby (Bennett 2003; Hodson 2003).

From the point of view of this research, astronomy can also be understood as a context for physics education. However, there is limited research about physics education in an astronomical context, although students' learning and attitudes toward astronomy have been researched (Bailey and Slater 2003). For example, astrobiology, the interdisciplinary study of life in the universe, has been recognized as a way to increase students' interest in astronomy and science (Zeilik et al. 2002).

According to Parker and Lepper (1992), meaningful and appealing fantasy contexts enhance interest and promote learning. Thus, some items in the questionnaire and used in this research are grouped and named "Fantasy context" inspired by the usage in the framework of computer game research. Based on this research, it is known that characteristics that make an (learning) activity or a game motivational and compelling include fantasy and curiosity (Lavonen et al. 2005; Asgari and Kaufman 2004, Uitto et al. 2006). Therefore, one way to make learning motivating is to present the material to students in either an imaginary context that is familiar to them, or in a fantasy context that is emotionally appealing for the learner.

The Gender Gap and Science Education

Factors affecting students' attitudes toward science in general include gender, personality traits, structural variables, and curriculum variables (Trumper 2006). One important goal in the development of physics education has been to bridge the gender gap in physics. Girls are often seen as an untapped resource (Bottiaa et al. 2015; Osborne and Collins 2001; Osborne et al. 2003). The most significant is gender, as Gardner (1975) stated. Many studies (Francis and Greer 1999; Jones et al. 2000; Menis 1983) have reported that males have more positive attitudes toward science than females. In principle, two possible approaches to take when aiming to increase the number of girls involved in physics have been suggested. The first is to change girls' attitudes, interests, or behaviors. An example of this would be to conduct a marketing campaign advertising the technology industry for increasing the perceived attractiveness of the field. The second approach is to change the content or context, the idea being that learning should be made more interesting (Biklen and Pollard 2001).

Some studies found no statistically significant gender differences (Sadler et al. 2012; Selim and Shrigley 1983). Kahle and Meece (1994) published a wide-ranging review of the gender issues related to students' attitudes toward science subjects. Ormerod and Duckworth (1975) indicated the importance of distinguishing between the physical and biological sciences with respect to gender differences in attitudes toward science. Gardner (1975) stated that there are "clear differences in the nature of boys' and girls' scientific interests, with boys expressing relatively greater interest in physical science activities, while girls bare interested in biological and social science topics" (p. 243). Osborne et al. (2003) showed "that there is still a bias against physical sciences held by girls, suggesting that at an individual level, the overwhelming majority of girls still choose to not do physical science as soon as they can" (p. 1064).

Many studies confirm that girls seem to be generally more negative to school science (Mattern and Schau 2002; Murphy and Beggs 2003; Reid and Skryabina 2003). It is not merely a question of science as a broad knowledge field or the discrete subjects being distasteful, but children also experience the content in different ways, and these experiences change because of societal development (Maltese and Tai 2011; Jones et al. 2000; Sjøberg 2000).

A study in the UK, Breakwell et al. (2003), shows that liking science is related to gender self-image and to gender stereotypes among adolescents. The results show that those girls who liked science less appeared to exclude the perceived in-group deviant from their gender in-group. Despite the so-called *masculine* image of science, these effects were not significantly stronger among girls than among boys.

In the present study, we focus on Abu Dhabi secondary school students' interests (median age 15) with regard to certain content and contexts in physics courses. The research question is as follows: Which are the physics contents and contexts that Abu Dhabi secondary school boys and girls find interesting?

Methods

Study Instrument and Analysis

In order to answer the research question, we organized a survey alongside the Abu Dhabi contribution to the international comparative research ROSE, aiming to shed light on factors of importance to the learning of science and technology in comprehensive schools (Schreiner and Sjøberg 2004). The ROSE questionnaire has been prepared through international cooperation so that the findings could help teachers and researchers to make science education and learning more engaging. However, in this study, only a small number of items from the original ROSE questionnaire were used to examine student interest in physics.

In the questionnaire, students were asked to state "How interested are you in learning about the following?" Students answered by ticking the appropriate box on a four-point Likert scale ("not interested," "somewhat not interested," "somewhat interested," and "very interested"). The responses were scored 1, 2, 3, and 4. Even if the scale is an ordinal one, it is easier to discern the findings when they are presented as means to each item.

Because there were many items connected to physics contents or contexts in the ROSE questionnaire, we used the same thematic grouping of the items reported in another similar study conducted in Finland (Lavonen et al. 2005), but with few modifications. Consequently, items are grouped into different content areas or contexts of physics. From the point of view of research questions, we decided to divide the items into four groups: (1) fantasy context, (2) astronomical context, (3) technology context, and (4) school physics context.

The study will show the descriptive statistics for items and groups. It will use the t-statistics to reveal the differences between boys and girls with regard to each item in each group. Further, if we concluded that there was a significant difference between girls and boys with regard to a certain item, we would need to calculate an effect size. For this purpose, Cohen's (d) will be calculated (Cohen 1988). The means of the boys' and girls' distributions have been compared using the independent-samples t test (two-tailed). Cohen's d measures the effect size for the difference between boys and girls: no effect at $d < 0.2$, small effect at $0.2 \leq d < 0.5$, moderate effect at $0.5 \leq d < 0.8$, and large effect at $d \geq 0.8$.

The items analyzed mainly measured students' interest in school physics, astronomy, and physics in an astronomical context, and technology and physics in a technological context. In the questionnaire, there were also some items exploring interests in phenomena not easily or not at all explained by school physics, such as those related to horoscopes, dreams, witchcraft, life and death, and mind reading (fantasy context).

The present grouping, to a large extent, reflects the Abu Dhabi curriculum framework and the research literature concerning interest. We should also mention that in certain cases, it is not clear to which group a certain item should be assigned. As noted by Lavonen et al. (2005), for example, the item "Electricity, how it is produced and used in the home" can be placed in the school physics context (first part of the sentence) or in technology (last part of the sentence).

Study Sample

In Abu Dhabi, the ROSE questionnaire was completed in June 2013 by 2248 high school students [1155 girls (51.4 %) and 1102 boys (48.6 %); mean age 15.97 years]. Students were invited to participate in the survey through a letter written by the Director General of ADEC. For Abu Dhabi as a whole, the percent of girls and boys in cycle 3 (grades 10–12) is 53.43 and 46.57 %, respectively. Compared to the percentages of the sample participants, it could be said that the sample is a reasonable representation of boys and girls in Abu Dhabi cycle three schools. The number of students answering the survey was 8.75 % of the whole age cohort. Thus, the external validity of the present research could be evaluated to be quite high, and the sample represents the population quite well.

All secondary schools were asked to participate in the study. Online (Arabic and English) questionnaires were designed for the study. The survey was conducted in the third semester in 2013. A letter was sent to all school principals with students identified as participants in the study, urging them to encourage their students to participate. The questionnaire was made available on the ADEC Web site. The national and international purposes of the survey were carefully explained in a cover sheet. Several reminders were sent to selected schools where the response rate was initially too low.

Results

To evaluate the internal consistency of the context scales, we calculated Cronbach's alpha (α) for each scale. Alphas were between 0.721 and 0.826, thus confirming that the context scales were internally consistent. The resulting Alpha coefficients for each scale are presented in the table headings of Tables 1, 2, 3, and 4. Tables 1, 2, 3, and 4 show the findings with the group of items that the students considered to be the most interesting being presented first and the one that they considered the least interesting last. Each table shows the mean (M) of the items and separate means for girls (M_g) and boys (M_b) as well as standard deviations (SD_g and SD_b). Within each group, the items have been arranged according to girls' preference rate.

With regard to students' interest in a fantasy context, results in Table 1 show that girls are more interested than boys. They score higher than boys with regard to all four items. Both genders provide a score higher than (3.0) to "Why we dream while we are sleeping, and what the dreams may mean." The t-statistic results show that girls and boys have significant differences in their interests with regard to all items in this category.

With regard to students' interest in an astronomical context, results show that there is a significant difference between the two genders to seven items. The most significant difference is with regard to the item that got the lowest mean interest: "The use of satellites for communication and other purposes." Both genders show high interests with regard to "Life outside of earth" and "How it feels to be weightless in space."

With regard to students' interest in a technology context, boys and girls show significant differences with regard to eight out of nine items. Both genders give the highest score to "Inventions and discoveries that have changed the world." With regard to mean interests, boys show higher scores with regard to all items. Boys also assign a high mean interest score to "How computers work" and to "How to use and repair everyday electrical and mechanical equipment."

With regard to students' interest in a school physics context, boys show more interest. Boys show high interest with regard to "How energy can be saved or used in a more effective way," "How the atom bomb functions," and "How a nuclear power plant functions." Girls assign scores of less than three to all items in this category. Boys and girls show significant interest differences with regard to all items in this category.

Among the four groups of items, the students, particularly girls, were most interested in fantasy context. Other topics such as astronomy, life outside of earth, and inventions that changed the world received high interests from girls. For boys, and among the sciences, students were most interested in topics related to astronomy and secondly in topics related to technology. Girls were least interested in topics related to the school physics context. Boys had at least some interest in the items in the school physics and technology context, but girls, as a group, had little interest.

Cohen's d indicated moderate effect size for only one item "How petrol and diesel engines work" ($M_b > M_g$). For all the other items, there was a small effect.

Discussion

Results of the present study identify a strategic question: What is the reason why students' interest in physics in high school is so low? What can be done to increase the interests of students, particularly girls, in physics, and later on, to encourage them to choose physics as their major field of study in higher education? As we have found in our study, most survey items received scores below the threshold of 3.0. Could anything be done to increase students' interest in physics by enriching their opinions about science classes in earlier years? In most countries, the evidence would indicate that children enter junior high school with a highly favorable attitude toward science and interest in science, both of which are eroded by their experience of school science, particularly for girls (Kahle and Lakes 1983).

According to Howes (2002), science education reforms basically ignore the very people they are intended to benefit. Physics as it is taught in the majority of physics courses does not seriously take into account students' interests. Adaptation of the curriculum by adding topics students are interested in could be a very effective means to solve some of the current problems of physics education.

Considering the results obtained in the present study in Abu Dhabi, we sought to identify the physics topics in which boys and girls were more interested. Results show

Table 1 Students' interest in a fantasy context

		Girls		Boys		t	Sig.	Cohen's size effect (d)
		Mean	SD_g	Mean	SD_b			
C13	Why we dream while we are sleeping, and what the dreams may mean	3.47	0.91	3.05	1.08	99.26	0.001	0.418
C11	Life and death and the human soul	3.29	1.03	3.02	1.07	36.48	0.001	0.255
C15	Thought transference, mind-reading, sixth sense, intuition, etc.	3.18	1.08	2.80	1.16	61.52	0.001	0.336
C14	Ghosts and witches, and whether they may exist	2.93	1.22	2.51	1.22	63.42	0.001	0.342
C9	Astrology and horoscopes, and whether the planets can influence human beings	2.70	1.21	2.47	1.18	19.46	0.001	0.191

$M = 2.942$, $M_g = 3.114$, $M_b = 2.770$, $\alpha = 0.731$

Table 2 Students' interest in an astronomical context

		Girls		Boys		t	Sig.	Cohen's size effect (d)
		Mean	SD_g	Mean	SD_b			
C8	Life outside of earth	3.26	1.06	3.10	1.09	12.20	0.001	0.1485
A34	How it feels to be weightless in space	3.04	1.13	3.08	1.07	0.695	0.404	
C10	Unsolved mysteries in outer space	3.01	1.16	3.00	1.11	0.075	0.786	
A35	How to find my way and navigate by the stars	2.94	1.17	2.80	1.11	7.991	0.001	0.1225
A22	Black holes, supernovas and other spectacular objects in outer space	2.91	1.16	3.01	1.10	4.525	0.031	−0.0879
A1	Stars, planets and the universe	2.83	1.10	2.83	1.08	0.020	0.886	
A23	How meteors, comets or asteroids may cause disasters on earth	2.83	1.16	2.93	1.09	4.330	0.033	−0.0888
C16	Why the stars twinkle and the sky is blue	2.82	1.14	2.72	1.10	4.089	0.044	0.0867
E29	The first landing on the moon and the history of space exploration	2.75	1.20	2.80	1.12	1.305	0.256	
A44	Rockets, satellites and space travel	2.69	1.12	2.81	1.11	26.29	0.001	−0.1073
A45	The use of satellites for communication and other purposes	2.48	1.11	2.66	1.06	59.97	0.001	−0.1647

$M = 2.877$, $M_g = 2.869$, $M_b = 2.885$, $\alpha = 0.826$

that boys and girls in Abu Dhabi high schools shared positive opinions toward science and technology with regard to many items. Results show that high interest scores were assigned by both boys and girls to items related to astronomical context. These items included "life outside of earth," "how it feels to be weightless in space," "unsolved mysteries of outer space," "black holes," and "how to find my way and navigate by the stars." Most of these topics relate to astronomy and astrophysics, a finding similar to that obtained by Sjøberg (2000) among 13-year-old students. It should be noted that astronomy is a subject included in the official Abu Dhabi curriculum, but it is not taught extensively in the schools in Abu Dhabi. Without this essential ingredient of relevance, sustaining interest becomes more difficult, if not impossible.

With regard to science and, in particular, physics, we also interviewed most school teachers teaching science in Abu Dhabi schools. They indicated that the curriculum had not changed for a long time. The time allocated to the science and technology classes was significantly lesser than the norm in other developed countries. Furthermore, science teachers made the observation that the professional developments offered by ADEC did not include subject-specific and subject-related content. They noted that many teachers lacked the training needed for teaching modern physics and interdisciplinary subjects. They also called for a new science and technology curriculum to be developed so that students became more science literate and became more interested in physics in order to address and eliminate these shortcomings.

Boys' and Girls' Interest in Contents and Contexts

Boys and girls also have different views of the topics that they would like to learn about (Dawson 2000; Jenkins and Nelson 2005; Sjǿberg and Schreiner 2005; Jones et al. 2000). Although the views expressed in a range of studies fall well short of uniformity, there is a degree of commonality, differentiated by gender.

Table 3 Students' interest in a STS context

		Girls		Boys		t	Sig.	Cohen's size effect (d)
		Mean	SD_g	Mean	SD_b			
E40	Inventions and discoveries that have changed the world	3.20	1.00	3.21	0.99	0.086	0.769	
C6	How mobile phones can send and receive messages	2.88	1.10	2.98	1.05	5.406	0.020	−0.0464
C7	How computers work	2.84	1.1	3.13	1.02	38.357	0.001	−0.2694
C4	How cassette tapes, CDs and DVDs store and play sound and music	2.45	1.15	2.63	1.11	13.604	0.001	−0.1589
C5	How things like radios and televisions work	2.62	1.14	2.86	1.07	25.780	0.001	−0.2164
E30	How electricity has affected the development of our society	2.69	1.10	2.91	1.03	21.549	0.001	−0.2059
C3	The use of lasers for technical purposes (CD-players, bar-code readers, etc.)	2.47	1.15	2.74	1.10	30.703	0.001	−0.2388
E28	How to use and repair everyday electrical and mechanical equipment	2.64	1.17	3.02	1.04	63.069	0.001	−0.3425
A47	How petrol and diesel engines work	2.25	1.14	2.86	1.09	162.086	0.001	−0.5442

$M = 2.798$, $M_g = 2.671$, $M_b = 2.926$, $\alpha = 0.820$

Table 4 Students' interest in a school physics context

		Girls		Boys		t	Sig.	Cohen's size effect (d)
		Mean	SD_g	Mean	SD_b			
E20	How energy can be saved or used in a more effective way	2.97	1.087	3.10	1.006	8.020	0.005	−0.1241
E2	How the sunset colors the sky	2.95	1.111	2.67	1.107	36.620	0.001	0.2524
C17	Why we can see rainbows	2.82	1.137	2.69	1.096	7.552	0.006	0.1157
E21	New sources of energy from the sun, wind, tides, waves, etc.	2.82	1.151	3.08	1.020	31.176	0.001	−0.2390
A30	How the atom bomb functions	2.81	1.203	3.09	1.107	32.660	0.001	−0.2422
E27	Electricity, how it is produced and used in the home	2.66	1.130	2.94	1.059	35.834	0.001	−0.2556
C2	Optical instruments and how they work (telescope, camera, microscope, etc.)	2.66	1.136	2.80	1.062	8.978	0.003	−0.1273
A21	How different musical instruments produce different sounds	2.65	1.200	2.47	1.148	13.906	0.001	0.1532
A19	Light around us that we cannot see (IR, UV)	2.63	1.150	2.79	1.077	11.264	0.001	−0.1436
A48	How a nuclear power plant functions	2.54	1.116	3.02	1.094	8.900	0.003	−0.4343

$M = 2.751$, $M_g = 2.865$, $M_b = 2.808$, $\alpha = 0.721$

Results showed that means of almost all items that belong to school physics context for girls (six items out of ten for boys) were under the score of 3.0. In general, girls' means were typically lower than boys. Hoffmann (2002) of the German survey emphasized that in grade 10, only 20 % of girls and 60 % of boys are interested in the topics discussed in physics lessons. On the other hand, the boys' and girls' group means suggest that they are also interested in the explanation of natural phenomena such as the twinkling of stars, why the sky is blue, and the changing colors of the sky during sunset.

Physics context and astronomy with regard to some items seem to carry no gender difference: No differences of moderate or large size were observed between girls and boys.

The boys' group means on indicate an interest toward the understanding and use of electrical and mechanical equipment such as satellites, petrol and diesel engines, lasers, radio, television, and computers. On the other hand, the less interesting things for girls in all tables were connected in some way to artifacts and technological processes: the use of satellites for communication and other purposes; how petrol and diesel engines work; and how a nuclear power plant functions. This is also similar to the findings of Hoffmann (2002) and Lavonen et al. (2005).

Girls were more interested than boys in phenomena not easily or not at all explained by school physics. It is clear that students' interests in the fantasy context belong to the feeling or affective related valences of interest and are associated with a topic, for instance, feelings of enjoyment and involvement (Schiefele 1991, 1999).

The most interesting things in all contexts were connected in some way to being human: How it feels to be weightless in space; inventions and discoveries that have changed the world; and why we can see rainbows. The results are in accordance with findings of ROSE in other countries (Uitto et al. 2005; Lavonen et al. 2005).

Results do not corroborate the hypothesis that technology context, applications-led, or science for all approaches were felt interesting by students. Most items scored <3.0, particularly among girls. Students were not so interested in understanding about skills where they may need to think and act scientifically as a member of the local, national, and global communities (How electricity has affected the development of our society; Electricity, how it is produced and used at home). This type of socially oriented context seems to be less interesting than contexts linked to the human experience.

The items with the lowest means cannot be understood to be what students want to learn about. For girls, these items are "Astrology and horoscopes, and whether the planets can influence human beings," "The use of satellites for communication and other purposes," "How petrol and diesel engines work," "The use of lasers for technical purposes (CD-players, bar-code readers, etc.)," and "How cassette tapes, CDs and DVDs store and play sound and music."

Challenges for Curriculum and Textbook Development

During the focus group discussions, there was a consensus that the findings could indicate several challenges for curriculum and textbook development in Abu Dhabi. Typically, it has been assumed that the context where science is discussed in situations of everyday life is interesting for students. Our survey indicates that phenomena that do not belong to everyday life are more interesting.

A further challenge is to clarify how astronomy content and physics in astronomy contexts can be increased in school physics. This is in parallel with findings of Osborne and Collins (2001). They also indicated that students would like to learn more about the solar system and the universe in physics. Lavonen et al. (2005) called for teaching physics in the astronomy context and to increasing teaching of pure astronomy. There is a wide spectrum of topics that could be approached in this context from kinematics to electromagnetic radiation and nuclear fusion. Discussion on satellites, space research, and, particularly, space exploration seems to be very exciting topics for students (Lavonen et al. 2005). Moreover, astrobiological topics such as extraterrestrial life seem to be interesting for students. This type of plan may be realistic in Abu Dhabi because the UAE recently announced that it will attempt to reach Mars by the year 2020; the new curriculum may assign additional time to science subjects of this nature.

An additional challenge is to increase the element of a humanity-related context, health education, and examples of life sciences to physics teaching. It is valuable if phenomena can be connected to real contexts students are interested in or that concerns directly themselves, e.g., human beings and, in particular, students themselves in everyday life, sports, or hobbies, animals such as pets they have, or plants they see in their surroundings.

Teaching technology presents yet another challenge. Boys like to know how technical applications work. This type of technical knowledge does not interest most girls. Considering youngsters' future, technical applications play a core role in further studies in schools of technology (vocational schools, polytechnics, or universities). Thus, it is important to find more versatile approaches to demonstrate for all students the intrinsic "interestingness" and importance of technical applications. It would be useful to make an intervention study on students' motivation and learning physics in the context where the technological context is combined with the human context or astronomical context.

For Abu Dhabi, the new curriculum framework has emphasized the use of technology in teaching. The goals and contents for technology teaching are described as a cross-curricular theme, and it will be taught by being integrated across several subjects such as math, physics, chemistry, biology, geology, and home economics. There is great potential to change the shape of technology teaching in schools in Abu Dhabi. Based on our survey, both genders are quite interested, for example, to know how energy can be saved or used in more effective ways or to know how inventions and discoveries have changed the world. These themes can be discussed, for example, through core contents of technology and mentioned in the curriculum. Further, students are competent to act in everyday life. Perhaps, students do not see what interest everyday situations could offer.

Students' experiences as well as their interest should be attended to in the construction of curricula, in the production of textbooks and other teaching materials, as well as in planning and delivering classroom activities. In doing these things, the larger gender differences in interests and values should be borne in mind. The teaching has to be motivating, meaningful, and engaging. It has, in some way, to link to the values and interest that the learner brings to the classroom.

Challenges for Teacher Education

A teacher can partly regulate the catch component of situational interest (interestingness), and students can also be encouraged to self-regulate interest (Krapp 2005; Sansone et al. 1999; Schraw et al. 2001). Teachers can promote the change in situational interest to personal interest by choosing the content, context, and teaching methods (Schraw et al. 2001). Therefore, it is important for a teacher to know what content and contexts interest students (Lavonen et al. 2005). In Abu Dhabi, the goal of teacher education is to prepare and develop a teacher as both researcher/innovator and autonomous developer of his/her work. In order to support this ambition, the outcomes of this study should be taken into consideration in planning teacher development/in-service education. In addition, all related information should be available to teachers. As an example, Hannula (2005) in her doctoral dissertation clarifies conditions for astronomy teaching. According to her thesis, the lower secondary school teachers' attitudes have been positive to astronomy teaching. However, the teachers have felt uncertainty about their competence, and they have worried about the lack of learning materials and the equipment available to them. It should be noted here that with regard to Abu Dhabi, there are great challenges for in-service and pre-service education of physics teachers as well as for the development of curricula and learning materials.

Generalizations and Further Challenges

On the basis of the findings of the present study for Abu Dhabi, teachers, policy makers, and school leaders need to be aware of the general differences between interests of groups of boys and girls. For Abu Dhabi, this research suggests developers of curricula and textbook authors, who have considerable freedom when reflecting on the most effective approaches and contexts.

It is important to understand that the findings of the survey are not absolute; they reflect present-day general trends among young people's perceptions and experiences. Results reflect the objects of interest of Abu Dhabi boys and girls and the world they experience in relation to science, as measured with the ROSE questionnaire. However, it should be noted that the situation in relatively wealthy developing countries (such as Abu Dhabi) seems to be different; in such settings, modern technologies seem to have much relevance as possible solvers of local problems, as indicated by the international ROSE survey (Schreiner and Sjøberg 2004).

On the other hand, surveys such as this yield information about the significance of studied phenomena. In the present research, the survey gave information about students' interest in different contents and contexts and helped to evaluate the degree of significance among the differences between boys' and girls' interests. There is clearly a need to explore in much more detail the effect on students following particular types of science courses using particular types of learning materials.

More detailed evaluation of the effects of specific components of context-based approaches and learning materials is needed. In these further studies, one interesting possibility is to follow suggestions of Schraw and Lehman (2001). Teachers should do the following: (1) offer meaningful choices to students, (2) use well-organized texts, (3) select texts that are vivid, (4) use texts that students know about, (5) encourage students to be active learners, and (6) provide relevance cues for students.

It should be noted that the ROSE questionnaire has the potential to measure students' interests with regard to science; however, it did not categorize the science subject components in a clearer manner (i.e., biology, mathematics, physics, geology, and technology).

Conclusion and Recommendations

The basic questions still remain: how to make students' attitude toward physics more favorable and how to increase their interest in physics? The present Abu Dhabi ROSE material may illuminate a range of important and topical discussions in the science education community, for example, issues such as the curricular content, and students' interests, cultural diversity, disenchantment with their science classes, and students' perceptions of science in the society. Results of the present study may also inform such discussions.

Based on the results of this study and discussions with various stakeholders, we came to the conclusion that several changes are needed for Abu Dhabi. Ormerod and Duckworth (1975) pointed out that interest in science appears to be aroused at an earlier age than interest in other curriculum areas, suggesting that primary science experiences are critical to future students' long-term interest in the subject. Abu Dhabi started its education reform journey in 2008 as a bottom-up approach starting from the KG levels and grade 1 going up one grade at a time. In 2015, the reform has reached grade 7. However, no major changes have occurred with regard to science and technology education. The curriculum should be evaluated as a system of inputs and outputs with causal relationships in mind. This should include preschool, KG, cycle 1, cycle 2, and cycle 3 systems. Physics subjects should be enhanced and integrated with technology and by adding topics that interest both girls and boys.

From the results of this study, it can be seen that students were interested in certain items related to physics education. If schools want to offer meaningful experiences to their students and to minimize alienation and indifference, students' preferences have to be considered carefully.

Thought should be given to students' choices and preferences in setting goals, content, and learning approaches. For Abu Dhabi, teachers should try to better understand which topics their students want to study in addition to the formal curriculum and should devote time to instruction in such topics. There is a need to concentrate on ways to develop students' affective response so that they find personal satisfaction in doing science and therefore want to continue with it.

Teachers who teach physics should have expert knowledge and high enthusiasm. Teachers should have the confidence and familiarity and stay away from didactic modes of teaching, which affect student learning negatively. We clearly need to make the curriculum as relevant and as exciting for students as possible, but as Woolnough (1994) has noted, without lively teachers, with the time and inclination to teach science in a stimulating manner, the number of students who "switch on" to science will not rise.

Teachers should be made more proficient in teaching physics and use constructive approaches to support girls to develop a more positive physics-related self-concept. This is consistent with same calls in other countries that experiences reform in the physics curriculum. There is also a need to allocate the appropriate time needed for the science and technology classes in high school. This is also proposed by other related studies (Trumper 2006; Seker 2005; Tai and Tuan 2005).

ROSE results may call for other studies to be scheduled. There are still many questions that remain unanswered or "un-understood." For example, to what extent, if at all, can the difference between girls and boys be attributed to school-based factors (i.e., the content of the science curriculum, the way science is taught and/or assessed, and the alleged difficulty in the physical sciences as subjects of study)? How important are other factors such as the influence exerted by parents, students' peer groups within and outside school, or career advisers, and what is the nature and extent of their interaction? How and why do students' attitudes toward, and interest in, science and technology change as they progress through compulsory schooling, and how are any changes related to success in these subjects at school and to the factors that influence that success? In addition, research methodologies that are more complex, qualitative, and sensitive than a questionnaire-based study are and thus required. They will need to allow the relevant issues to be tracked over time.

Results of the present study show that in effect, physics fails to attract a large proportion of students. The results suggest that particular attention should be given to curriculum development, teacher development, and use of other strategies to make students' experience more engaging. The task of making physics more relevant to students presents an interesting challenge to schools and ADEC strategy decision makers. For ADEC, the issue of which subject areas are of inherent interest to students, particularly girls, is worth exploring further. Such information has the potential to contribute to increasing an overall interest in physics and science in general.

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