Uncovering Gender Differences in Science Achievement and Attitudes towards Science for Jordanian Primary Pupils

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Abstract

Much of the literature concerning the relative performance of girls and boys in science indicates that boys outperform girls in most areas of the science curriculum, and that it is rare to identify areas of the science curriculum in which girls out perform boys. Student's attitudes towards science have been found in some studies to be linked to performance in the subject, and have been found to be influenced by different teaching approaches. In the study reported here, it was hypothesised that pupils performance in science and attitudes towards science in Jordanian primary schools would be enhanced by the adoption of different teaching methods. It is argued that, in of the context the Ministry of Education inspired shift of emphasis away from frontal teaching and towards more student centred approaches, it is desirable that the effects of such changes on the performance of pupils as a whole and different sub groups within primary schools needs to be understood. In comparing traditional (mixed) approaches to teaching science with co-operative (group) learning methods and demonstration methods, a straightforward evidence emerged which would lead to one approach being recommended over another. However, it was startling to find that, across all approaches to teaching, and across three age groups, girls had more positive attitudes towards science than boys and they outperformed boys in the end of the unit test.

Introduction

Over the past two decades there has been much activity across many countries in reconceptualising and reforming science education. An understanding of the nature of science has come to be seen as necessary for all citizens both because scientific literacy is seen as necessary in democracy, and because modern economic development depends on scientifically educated workforce (Gogolin and Swartz, 1992; Yager, 1993). Fensham (1988) documented the wide variety of countries, which were invested in curriculum development projects in science education. In The UK the Secondary Science Curriculum Review was introduced. In the US the National Science Foundation undertook a massive review of science curricula. In 1984 UNESCO was asked to make 'Science for All' a priority in it's regional office for Asia and the Pacific. Fensham gives a number of other examples. However, the important point is that in the 1980's and 1990's the level of interest in developing science education which would achieve the dual purposes of developing a scientifically literate citizenry and a scientifically educated workforce was high. The aim then is to ensure access to science education for all pupils and to secure high quality science education for future workers who will contribute to the economic well being of the country. This means that equality of opportunity is essential. Any changes in approach to science education at a national or local level need to be based on an understanding of the extent to which equality of access is achieved for different sub-groups, so that the effects of shifts can be monitored and evaluated.

In Jordan, as in many other developing countries over recent years, there has been a major centrally-driven, shift in the curriculum in a number of areas including science. This has involved the revision of the science curriculum. This shift has been undertaken in order to enhance science education in the country for all students. Since 1987 educational reform has taken place in Jordan to improve the different inputs of the whole educational system and many changes have happened especially in the field of teaching and learning. A new science curriculum was introduced in Jordan in 1989. The main objectives of this curriculum were stated as being to develop critical thinking, problem-solving and collaborative and co-operative work among pupils to build positive attitudes of pupils

towards science and schooling and to encourage independence among pupils. Having established the aims of science education and developed a curriculum intended to meet these aims, the next stage was the production of new science textbooks for all grades. These textbooks were produced by teams of science educators who translated the science curriculum into what they felt were suitable texts for students. All the textbooks for the primary and secondary stage were ready by the scholastic year 1996/1997. In-service training programmes were started as the new textbooks were published. The main purpose of these programmes was to introduce and discuss the content of the textbooks in order to build a shared understanding of this content among all teachers. During 1996, another type of training programme was introduced; this programme concentrated on the application of different teaching and learning methods and on attempts to improve the established methods.

It was stated that:

> The new science textbooks were built and organized to give students the main role in learning, while the teacher's role should be as a coordinator and facilitator for students' learning. So, the students should have an active role to reach this goal.
>
> (Ministry of Education-Jordan, 1992, P. 7)

Jones, Howe and Rua (2000) found that males reported more extracurricular experiences in manipulating different laboratory tools. Females showed to have more experiences with bread-making, sewing and planting seeds. Males students showed more interests in science and scientists' jobs than females.

Explanatory factors for gender differences in science performance were explored. Large advantages for boys on the subject of physical science and a modest advantage for girls in life science were noticed. According to these finding, increasing experimental and hands- on learning activities, especially in physical science, should be given more emphasis particularly for girls (Lee and Burkam, 1996). Students attitude and particularly in science and how they might vary by gender were studied. Results showed that boys and girls expressed similar opinions about science, but girls were less likely to view science as a male- stereotyped

field. Attitudes towards science among youngster students were more positive compared with older students. Girls participated actively in science compared with boys (Greenfield, 1997). As a result of looking at gender issues in science and dealing with it in science education, different opinions appeared. Gender in science education should be directed to biological sex not to other things of thinking or abilities. Males and females have similar opportunities and skills which are important to be directed to improve the learning of science. Gender and science education is a vital issue; gender interacts in significant ways with other social variables and must be taken into consideration (Rennie, 1998; Atwater, 2000; Rennie, 2000). A range of beliefs and experiences along the intersection of professional and personal identities, views of the nature of science, beliefs related to student' experiences in science education, and kinds of curricula and instructional strategies were used to promote access and equity for all students. Bias against minorities and women is still a problem in science education, and it needs more work to be improved (Bianchini; Cavazos; and Helms, 2000).

The situation in Jordan

The curriculum in Jordan has undergone marked changes over the last few years. There is an attempt by the central government to change the approaches adopted by teachers from the didactic frontal teaching which is most common to more student-centred approaches. However, this is a slow process, partly because of the extremely prescribed curriculum, which is based on textbooks developed centrally for the teachers to deliver. The timing, content and, to an extent, method of delivery are all prescribed. However, the assessment of pupils at the end of each topic, and at the end of each year is left to the teachers. They devise their own tests. University entrance is decided on the basis of centrally-devised tests and on examinations devised and implemented by the different universities. There is no National collection of assessment data which might give an indication of any differences in performance between different sub-groups of students, such as boys and girls in each subject area of the curriculum.

Science is given a high priority in Jordanian Educational System as it is taught through all primary and secondary school grades. In Jordan, pupils are taught in single sex schools throughout the primary and

secondary phases. The primary phase lasts up to grade 10 (age 16). In this phase, students are taught in mixed-ability groups by teachers using the prescribed textbooks. Both boys and girls study science to the end of primary education. The science textbooks are organised into topics; each of which focuses on a specific area of science. In the secondary school, students have to study science as a compulsory subject in the academic education stream. The science topics taught in this stream are physics, chemistry, biology and earth science. Students may choose two or three science subjects. While in the vocational or applied secondary education, students have to take general science as part of the vocational syllabus. Boys are taught by male teachers and girls by female teachers throughout their schooling.

In a developing country, changes in the curriculum and the associated training of teachers which this should involve are expensive to implement. Informed decisions about the possible effect of such changes on the students in schools need to be made. International evidence provides insights into the possible effects of changes on particular groups of the population. In this paper, I intend to focus on the possible effects on girls and boys when moving from a curriculum which is more focused more on knowledge acquisition using teaching strategies which involve whole class teaching with little involvement of the learner to the more student-centred investigative approaches.

Teaching *and* Learning and gender

Differences with respect to subject studied

Many studies looking at gender differences have focused on differences in performance related to the different science subjects. A number of studies have found that boys achievement in science is significantly better than that of girls (e.g. Fleming and Malone, 1983). Levin, Sabar and Libman (1991) found that the achievement of boys in all subject area of their study (earth science, biology, chemistry and physics) was significantly better than the achievement of the girls. Young and Fraser (1994) in a study of Australian secondary school students also concluded that boys' achievement in biology, physics and chemistry was significantly better than girls. In England and Wales, the Assessment of

Performance Unit (APU) data for thirteen year old pupils indicated that boys outperformed girls in the use of graphs tables and charts, using apparatus and measuring instruments, interpretation of data and application of physics and chemistry concepts; whereas there was no difference in the performance in the application of biology concepts, (Murphy and Qualter 1990). However, results from APU surveys of eleven year olds indicated few large differences between boys and girls (Harlen 1993) although the age eleven surveys included very few questions relating specifically to the application of physics, chemistry or biology concepts.

Although, as described above, there are many studies which identify differences in performance between boys and girls, others are less conclusive. Erickson and Erickson (1984)noted that differences were not consistent across all grades and that a typical pattern of differences was that boys perform better in physical sciences, while their advantage becomes relatively small in biological sciences. Houtz (1995), for example, reported that there were no significant differences in performance between girls and boys in the seventh and eighth grades in midwest USA. This lack of difference could not be explained by the areas of science being studied as grade seven had studied life science, while grade eight had studied physical science. Other studies have also documented no significant differences between boys and girls' performance in science (Ajewole, 1991; Catsambis, 1995; Greenfield, 1996). In two of these studies (Ajewole and Greenfield), the authors also reported no significant differences between boys and girls in their attitudes towards science. Catsambis found males had a more positive attitudes than females, but that no differences in science achievement were noted. These latter studies are fairly recent, and the lack of difference between boys and girls may be related to different approaches being taken to teaching science which results in more positive attitudes towards the subject by pupils, particularly girls. One suggestion which has been put forward is that students attitudes towards science could have an effect on their subsequent performance in the subject.

Differences in respect to attitude

Rennie and Punch (1991) concluded that the causal direction of the relationship between achievement and attitudes towards science is not

clearly established. However, Bloom (1976) stated that there is a positive correlation between attitude to science and achievement which is greater than that found in other curriculum subjects. In a meta-analysis of studies dealing with gender and attitude towards science, Weinburgh (1995) found that in studies undertaken between 1970 and 1991 boys were reported to have a more positive attitude towards science than girls. These studies also indicated that there was a strong positive relationship between attitude towards science and achievement in science. However, the relationship was stronger for girls than for boys. Although few studies examined the correlation between attitude towards science and achievement in science by gender (Schibeci and Riley, 1986; Cannon and Simpson 1985).

Head (1985) suggested that there is a decline in pupils' attitudes towards science starting in the primary phase and continuing through to undergraduate studies. In particular, amongst both boys and girls there is a decline in interest in physics and chemistry, but far less in biology. In a similar study, Simpson and Oliver (1985) revealed that attitude toward science among students declined sharply from the beginning of the year to the middle of the year and more gradually from the middle of the year to the end. In addition, attitude steadily declined from grade six to grade eight. However, the sharpest decline was observed from grade seven to grade eight. Males presented significantly more positive attitudes toward science than females across the grades studied. Similar conclusions were drawn by Yager and Penick (1986). Again, James and Smith (1985) found that the sharpest decrease in positive attitudes towards science occurred between the sixth and seventh grades and the most significant decrease was amongst girls. This study also found a positive relationship between attitude to science and attainment.

Although the evidence to link attitude towards science to attainment in science is not conclusive, it does likely seem that attitude towards science influences performance. Girls, less positive attitude towards science may explain the lower attainment levels recorded for girls in many studies. In an example from the Jordanian context, Hasan (1985) reported that the main variable affecting students' attitudes towards science was their perception of their own ability in science. Furthermore, female students' attitude towards science was more positively influenced than was their male counterparts when they perceived their science teacher to be interesting and

motivating. It would seem possible that students attitude towards science is linked to their performance, and that the attitudes of girls to science may be influenced in different ways than are those of boys. It is therefore possible that any changes in the curriculum could have a differential effect on boys and girls.

Differences related to different curricular

One way in which many science curricula have changed over recent years is to introduce more practical investigative work for pupils themselves to undertake. Sidney (1989) designed a ten-week study to assess the effect of inquiry science on critical thinking skills, achievement and attitude toward science among fifth -grade students. At the end of the study, it was found that there were no significant differences between the level of critical thinking skills, achievement and attitude toward science among the two groups treated by inquiry science and traditional chalk-and -talk methods of instruction. Furthermore, there was no gender effect or interaction between gender and method of instruction on critical thinking skills, science achievement, or attitude toward science.

Killermann (1996) carried out a study to test the effect of different teaching methods on both cognitive and affective performance in biology. Kellerman considered practical work in implementing laboratory activities in which students carried out the experiments themselves comparing this with the demonstration of the experiments to students by their teachers; while the presentation of the content by the teacher without any experiment was used as the control method. The results of this study showed that in the fifth grade, the students in the two experimental groups achieved significantly more than the control group in their understanding of biology content. The effect of gender was noticeable in the fifth grade in the experimental groups, where girls achieved more than boys in the demonstration group. In the seventh grade, the demonstration group achieved significantly better than the other two groups. However, grade seven boys achieved better scores than girls in all groups. The content of the grade-seven topic was mainly concerned with the water balance in plants as a part of the biology curriculum.

Okebukola (1985) reported that girls have a negative attitude towards laboratory work. This study was designed to explore the effects of

cooperative learning on the attitude of students towards laboratory work. The two main targets of this design were that students work together to accomplish shared learning goals and to maximize their own and their classmates' achievement. Okebukola (1986) found that students in the cooperative group had significantly more favourable attitudes toward group work in comparison with students in the control group who did not experience a structured cooperative learning environment. It was also found that boys were more favourable towards laboratory work than girls as result of cooperative group work. It seems, then, that through the use of cooperative group work techniques the attitudes of both boys and girls towards laboratory work is enhanced. For girls a negative attitude may be changed; while for boys a positive attitude might become even more positive. This is, however, speculation as the data arises from two separate studies.

The evidence to suggest that different curriculum materials and different approaches to teaching science might influence any gender differences in attitudes towards science or attainment in science is far from conclusive. Although it does seem that, as far as attitudes towards science are concerned, girls are likely to be more influenced by the teaching approach adopted by their teacher and by the level of interest they have in the subject rather than are boys (Duncan, 1989; Eshiwani, 1988). However, it is clear that any changes in curriculum approach or content structure are likely to affect student's performance in science. It is also likely that the affects may be different on different sub-groups such as boys and girls.

The study

Aims and questions of the Study

The purpose of the study reported here was to compare the effects of three types of learning approaches on students' achievement and attitudes towards science in primary schools in Jordan. At a time when there is a move towards more student-centred approaches to science teaching and with the new curriculum materials in place, it was felt to be important that the effect which might arise from teachers adopting particular styles should be understood. This study was designed to examine if there are effects of cooperative (group) and demonstration approaches versus the more traditional (mixed) teaching approaches adopted by most teachers in Jordan

on students' achievements in and attitudes towards science? As part of the study the effect of gender and the effect of the interactions between methods of teaching and gender on primary students' science achievement and attitudes towards science were measured.

Methodology

The study began at a time when the Ministry of Education was beginning to make training available to teachers to support them with the introduction of the new curriculum for science. For the purposes of the study reported here a small sample of teachers were offered training in delivering certain units of the curriculum in two different ways according to the two experimental approaches (cooperative (group) learning and demonstration). The content of the textbooks had been translated by the researcher with the support of other science educators in Jordan into a suitable form for each of the two experimental approaches. Other teachers taking part in the study as the control group simply taught the content of the textbooks without additional training. In general, and as implied in the textbooks, this involved mainly frontal teaching, with lecturing by the teacher to passive learners.

The methodology and measurement instruments adopted in the study were selected on the basis of the general hypothesis that cooperative (group) teaching methods would result in superior performance to that produced as a result of demonstration approaches which would in turn produce better performance than students taught by the traditional (mixed) methods. In addition, it was hypothesised that students attitude towards science would be enhanced as a result of cooperative teaching methods. As suggested above, it was also considered possible that boys and girls would react differently to different teaching approaches. The efficacy of the teaching methods was tested quantitatively using a written attitude questionnaire and end of unit achievement tests, and qualitatively using observations and interviews with students, teachers, Head Teachers and parents and these results were reported elsewhere. This study concentrated on both research techniques for exploring the efficiency of the experimental (cooperative and demonstration) and control science teaching methods. Grades 5, 7 and 9 (11, 13 and 15 year olds) from the primary stage of the educational system were selected at the beginning of the

2000/2001 academic year. Each sample of males and females was divided into three groups, two experimental (cooperative and demonstration) and one control group. Each group of students was taught using different methods of learning for a period of ten weeks.

Sample of the Study

The schools selected in this study were random and socially mixed. Pre-achievement was determined on the basis of school based end of year test results. The topics for the study were general science topics. In the light of the literature discussed above it might be expected that performance would be equal between boys and girls in relation to these subjects (Scholfield et al 1989; Ajewole, 1991; Catsambis, 1995; Greenfield, 1996). It is also possible that girls might achieve better performance in biological sciences than boys (Lee and Burkham 1996) although there are fewer studies suggesting this. The main findings of this study will be reported elsewhere. Here we intend to report on the gender differences in attitudes to and attainment in science between boys and girls arising out of the different approaches to teaching the same science content.

The topics, which were covered during the experimental period (ten weeks), were general science in content for all grades. In grade 5, the content was about living organisms and the matter. In grade 7, the content was about useful materials and human body. While in grade 9 it was about living things and human system.

Instruments of the Study

Attitudes towards science were measured by administering an Attitude Questionnaire which was originally designed by Towse in 1983 to measure the attitudes towards science among Lesotho students. The questionnaire was then translated and validated for use in Jordan by Zeitone in 1994 (Appendix 2). Prior to the experiment pupils were asked to complete the questionnaire. The questionnaire did not emphasise biological issues. It included questions such as "I want to learn a lot more about science", "Science is rather difficult", "I would like a career which involves science", "I look forward to our science lesson" and "I like our science teacher". The same questionnaire was administered after the experimental period.

Achievement in science was judged initially using the results of test administered by the schools at the end of the previous academic year. As stated previously, although the curriculum in Jordan is tightly prescribed, teachers themselves devise the end of unit and end of year tests. The final achievement test for the units implemented during the experimental period was devised by the researcher in negotiation with the teachers involved in the study (Appendix 1). The same test was used for each class within a grade, so that direct comparisons could be made.

Findings

Attitude Towards Science

Table 1 shows the attitude scores of pupils before and after the experiment. Initially no significant differences were found between pupils in grades seven and nine, but females in two of the grade five classes had more positive attitudes towards science than males in the same grade. Because the same questionnaire was administered to all students these findings suggest support for the argument that there is a deterioration in attitude towards science with age.

After the experimental period, the same attitude questionnaire was administered. For the purposes of the main study any differences existing between pupils prior to their studying the units were controlled for using an analysis of variance. As table 1 shows no differences emerged between pupils in grade five classes (see Appendix 3, table 3). This suggests that no changes in attitude towards science had occurred as a result of the approach to teaching adopted. This is the case for both males and females. Although females in grade five classes had more positive attitudes towards science than males before the experiment this difference was statistically controlled by using analysis of covariance technique to test the effects of different learning approaches used in the study on students attitudes towards science. For grade seven students the situation is less clear. Although none of the differences are statistically significant, grade

Table 1

Means and standard deviations on attitude toward science before and after the experiment (max. mark=165) of students in experimental and control groups of grades 5,7, and 9

Grade	Group	Male		Female	
		Mean	S.D.	Mean	S.D.
5/Pre	G1	127.30	8.44	124.48	9.49
	G2	117.10	15.36	125.42	10.85
	G3	116.50	17.40	118.50	10.45
Post	G1	127.18	11.77	126.80	15.00
	G2	118.18	13.33	122.84	15.33
	G3	117.00	13.22	120.00	10.25
7/ pre	G1	114.26	13.64	117.81	11.61
	G2	112.56	11.90	119.12	9.19
	G3	113.94	9.99	118.12	10.13
Post	G1	120.89	18.28	115.88	11.95
	G2	111.88	10.71	118.98	11.44
	G3	113.36	10.40	117.88	9.84
9/pre	G1	112.55	17.34	117.50	10.40
	G2	111.33	15.35	112.14	9.38
	G3	115.41	11.63	119.18	8.83
Post	G1	114.57	20.14	117.88	13.13
	G2	105.00	17.85	113.60	10.10
	G3	117.50	11.82	120.18	7.95

G1 = Cooperative (group)/ Experimental

G2 = Demonstration / Experimental

G3 = Traditional / Control

Pre = Pre- attitude

Post = Post - attitude

seven females in the experimental groups had more positive attitudes towards science after the experiment than males who were taught either by the demonstration approach or through the more traditional methods (See Appendix 3, table 4). Again in grade nine there were no statistically significant differences between groups and between males and females, but all females in the different treatment groups exhibited more positive attitudes towards science than males (See Appendix 3, table 5).

It is noteworthy that initially Jordanian student's attitudes towards science were very positive. Other studies undertaken in western countries

did not find such positive attitudes towards science prior to undertaking their studies (e.g. Ajewole, 1991; Catsambis, 1995; Greenfield, 1996). It is likely then, that, having started off with such positive attitudes towards science, particularly given the limited length of the study described here, there would be little observable enhancement of attitudes to science. Indeed, figures presented in table 1 suggest that the approach taken to teaching students is not the main influence on student's attitude towards science. It is interesting to note that for this group of Jordanian students no significant differences were found between boys and girls in their attitudes towards science before or after the experimental period. This is contrary to much of the evidence in the literature which indicates that boys have a more positive attitude towards science than girls (Weinburgh, 1995), while it may provide some support for the findings of Hasan (1985) who reported that the main variable influencing Jordanian students' attitudes towards science was their perception of their own ability.

Attainment (Achievement in Science)

Table 2 indicates that there are differences in the attainment of pupils in the different treatment groups. These differences do not follow a simple pattern. Table 2 shows the achievement of students in the experimental and control groups of 5th, 7th, and 9th grade after finishing the experiment. It reveals that there are differences between the means and standard deviations of the groups. In grade five the female demonstration group achieved the highest score (See Appendix 4, table 6). In grades seven and nine the female cooperative group achieved the highest scores, although, in grade nine the female control group achieved higher scores compared with the demonstration group (See Appendix 4, tables 7&8).

Table 2

Means and standard deviations on achievement before and after the experiment (max. mark =100) of students in experimental and control groups of grades 5, 7, and 9

Grade	Group	Male		Female	
		Mean	S.D.	Mean	S.D.
5/pre	G1	66.10	15.68	66.88	14.88
	G2	65.78	14.11	66.93	18.29
	G3	66.16	17.50	66.75	16.30

Post	G1	48.66	26.23	68.28	14.55
	G2	50.32	14.37	74.41	20.66
	G3	35.00	26.44	64.92	10.11
7/pre	G1	62.44	16.40	62.84	16.82
	G2	62.66	12.89	62.99	16.80
	G3	62.97	9.00	62.93	18.15
Post	G1	26.22	18.18	52.81	20.00
	G2	32.19	16.00	46.55	19.00
	G3	24.37	10.22	41.00	14.44
9/pre	G1	60.94	14.41	60.72	16.33
	G2	62.05	18.13	62.17	14.81
	G3	60.57	18.00	60.93	10.83
Post	G1	52.33	18.19	64.55	20.55
	G2	47.00	18.81	50.11	18.55
	G3	44.60	20.88	58.00	16.44

G1 = Cooperative (group)/ Experimental

G2 = Demonstration / Experimental

G3 = Traditional / Control

Pre = Pre- attitude

Post = Post - attitude

The striking finding in these data is that for all grades studied and for all treatment groups girls outperformed boys. The evidence collected from this quantitative study does not suggest that there is a strong differential effect on the performance of boys and girls of different approaches to teaching science topics. However, an unexpected finding was that girls outperformed boys across all three approaches to teaching the topics and across all three age groups involved.

Discussion

The aim of the study as a whole was to explore the effects on attitudes to science and performance in science of different approaches to teaching science topics. The methodology employed was therefore designed to address this issue. However, it was also considered possible that males and females might react differently to the different approaches (Okebukola, 1986; Odubunmi and Balogun, 1991; Young and Fraser, 1994). The

findings of this study indicate that there is no simple relationship between the approach adopted to teaching the science topics and student's performance in tests taken at the end of the topic. There is however, other qualitative data not reported here, which suggests that over a longer period of time students might gain skills and achievements which are not at present measured by end of topic tests developed by teachers. This data is reported elsewhere.

Much of the literature concerned with attitudes towards science indicates that boys hold more positive attitudes towards science, and that although attitudes towards science decline for both girls and boys during adolescence they decline more rapidly for girls than for boys (Head, 1985; Oakes, 1990). The data presented in this study does not support these findings. Girls exhibited at least as positive an attitude towards science as boys, with some grade 5 girls being more positive than boys. It might be suggested that this finding could be due to the biological nature of the topics covered in the present study. However, the attitude questionnaire did not focus on biological issues and was administered at the beginning of the school year before any teaching had taken place. Indeed the finding by Hasan (1985) that the attitudes to science of Jordanian girls were more influenced by their teacher than boys might have been used to explain some of the differences, but again, as this was a new academic year often with different classmates and with a different teacher, this is unlikely.

Overall, the fact that girls' performance on tests at the end of the experimental period was consistently higher than that of boys for all three grades involved and for each of the three experimental groups suggests that, at least in the science concept areas covered, girls in Jordan are performing better than boys. The data provided by schools; arising from tests devised by teachers but based on the content of the prescribed curriculum, did not indicate any differences in performance between boys and girls. Boys and girls are taught in separate schools, boys by male teachers, girls by females. There is therefore no exchange of teachers between schools for boys and schools for girls, and therefore little opportunity for teachers to compare standards in the different schools. There is no moderation of tests between schools; therefore there is no evidence to support the assumption that standards of performance in science are the same in boys and girls schools. It is therefore possible that

the findings arising from the present study simply reflect higher levels of performance in science by girls across the grade range included in the study. Another possibility is that the subjects being studied might produce better performance by girls than other topics would. Few studies have been reported where girls performance on biological topics is significantly better than that of boys, although a number have reported no significant differences for biological topics while there were differences in topics related to physical science. What is clear in the case of Jordan is that there is no evidence other than that reported here which could inform judgements about the relative performance of boys and girls in science.

The changes currently being introduced in science education in Jordan are predicated on the belief that students understanding of and attitudes towards science can be enhanced by a move towards more student centred teaching. It is hoped that this will lead to a more scientifically literate society and provide a work force which is better able to engage with scientific ideas. How will the effect of these changes be evaluated? There are no national data showing levels of performance in science for students or sub groups of students. Although students at the end of secondary schooling take examinations set by the Ministry of Education, we know of no available information which allows for comparisons of performance in science between sub groups of pupils, such as between boys and girls. Unless such information is available it is difficult to see how far equality of opportunity is being achieved between boys and girls, and it will be impossible to evaluate any long term effects resulting from the changes now being instituted in Jordan. The study reported here simply gives a suggestion that the situation in Jordan with respect to boys and girls performance in science may not reflect the situation in other countries. It would be wise to explore this possibility as decisions about policy changes in relation to the science curriculum need to be informed.

The findings of this study could lead to a number of suggestions for further research which would help to uncover gender differences in performance in science. However, one fairly straightforward study could be quickly undertaken. Students at the end of the secondary stage undertake examinations set by the Ministry of Education, data arising from these examinations should be scrutinised for gender differences in performance in physics, chemistry, earth sciences and biology. Although students are

streamed in the secondary school, and have a certain amount of choice of subjects for study, this data could provide a valuable starting point for further research.

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Appendices

Appendix 1

Final Achievement tests

The Final Achievement test/ Grade five
(Science)

Name: Section:

Part One **(30 Marks}**

Directions: Write in the proper answer space the letter of the choice that best completes each statement.

-----1. If you have a material composed of oxygen and another element, this means that this material is an example of:

a. bases b. acids c. oxides d. salts

-----2. In general, base includes many elements, but it must include two main elements which are

a. oxygen and iron b. oxygen and hydrogen
c. hydrogen and copper d. sodium and oxygen

-----3. Adding lemon juice to calcium carbonate produces a gas which is

a. carbon dioxide b. oxygen

c. hydrogen d. water vapour

-----4. The best separation method used to purify raw petroleum oil components is

a. vaporization b. extraction

c. precipitation d. distillation

-----5. Which of the following is an example of the micro organisms?

a. Ant b. Paramecium c. Mosquito d. Housefly

-----6. Bacteria cause many diseases to humans. One of the following disease is n2t caused by bacteria which is

a. cholera b. tuberculosis c. brucellosis d. malaria

-----7. The green layer which covers lakes and pools, is mainly composed of

a. algae b. fungi

c. Protozoa d. green plants

8. The movement organs of Euglena are

a. cilia b. flagella

c. pseudopodia d. sliding organs

9. Normally, immunisation against polio is repeated times.

a. four b. one c. three d. two

10. The most convenient method for preserving the traditional white cheese is to

a. put it in a sugar solution b. put it in a salt solution

c. make it dry d. sterilize it by heat

Part Two (20 Marks)

Directions: Answer the following short-answer questions in the space provided.

1. Acids solutions convert the blue litmus paper to ------- colour one.

(2 Marks)

2. 2. The main uses of calcium oxide are

a.

b.

(2 Marks)

3. It is <u>not</u> allowed to touch or taste acid, that is because it is --(2 Marks)

4. Complete the following chemical equation

Sodium Hydroxide + Hydrochloric Acid ---> + Water +
(2 Marks)

5. By classification concept, we mean: --- (2 Marks)

6. What is the importance of microscope in studying microbiology?
(2 Marks)

7. Is there any similarity between bacteria and green plants in the way of nutrition? State this similarity if it is found. (2 Marks)

8. To which group of micro organisms the yeast belongs?

What is the benefit of the yeast to human? (2 Marks)

9. It is danger to eat expired canned food. Why? (2 Marks)

10. What is the role of the white blood cells in the human body?
(2 Marks)

The Final Achievement Test/ Grade Seven (Science)

Name: Section:

<u>Part one (26 Marks)</u>

Directions: Write in the proper space the letter of the choice that best completes each statement

1. During a detection activity of food sample, smashed potato; egg albumen; grape juice and olive oil were put id four different test tubes. A

red colour appeared in one of the four test tubes. This result may means that this sample is

a. fat b. starch
c. protein d. glucose

2. The mineral that helps in blood clotting and prevents haemorrhage is

a. iron b. phosphorus c. iodine d. calcium

3. Which of the following is a balanced meal?

a. Chicken, yoghurt, apple and brown bread.
b. Eggs, cheese, cucumber and grapes.
c. Fish, potato, orange juice and beans.
d. Lean meat, white bread, broad beans and milk.

4. As a result of the chemical digestion, one of the following conversions happen:

a. starch to glycerol b. protein to fatty acids and water c. oils to fatty acids and glycerol d. minerals to ions

5. The absorption of some vitamins and minerals takes place in

a. small intestine b. colon
c. duodenum d. stomach

6. The main factor which causes the tooth decay is

a. eating much sugars
b. shortage of minerals in the food
c. bad brushing and cleaning
d. conversion of sugar to lactic acid

7. One of the following may be a reason of fatness

a. eating fruits and vegetables daily
b. irregularity of thyroid gland function
c. not practising physical activities
d. hyperactivity of digestive system

8. Water has many uses in the body, one use it does not have is to

a. supply energy b. acts as a solvent
c. cool the body d. help excrete wastes

9. The largest number of calories is supplied by one gram of

a. cake b. potato c. lean beef d. butter

10. In normal nutrition, most of the body's energy needs are supplied by

a. proteins and amino acids
b. proteins and fats

c. carbohydrates and fats
d. carbohydrates and roughage
11. For the average healthy person, the best source of vitamins is
a. a balanced diet
b. a vegetarian diet
c. supplementary vitamins pills
d. enriched canned fruit juices
12. The process of digestion prepares
a. the body for using food materials
b. nutrients for oxidation and assimilation
c. body membranes for the passage of food materials
d. food materials for passage through body membranes
13. Emulsification of fats means that fats are
a. made soluble by the emulsifier
b. digested by the bile from the liver
c. broken up into small globules
d. insoluble and therefore indigestible

Part two (24 Marks)

Directions: Answer the following short-answer questions in the space provided

1. What is the main difference between the chemical components of carbohydrates and proteins? (2 Marks)

2. Why we need food? (2 Marks)

3. It is necessary for the pregnant woman to eat enough proteins. Why?

(2 Marks)

4. In Jordan, by law the factories of table salt have to add iodine to their products. What are the reasons for this decision? (2 Marks)

5. As a medical advice, it is important to eat some vegetables without cooking (fresh) .Could you explain why? (2 Marks)

6. Movement and drinking enough water could prevent the formation of stones in the kidney. Explain how? (1 mark)

7. It is not recommended for the person with a removed gall bladder to eat much fatty foods. Is this a true advice or not? Why? (2 Marks)

8. What is the best way for the person to protect him/herself from stomach ulcer? (2 Marks)

9. Could you expect what is going to happen if the secretion of hydrochloric acid stops from the stomach during the digestion process? (3 Marks)

10. Through which way are digested fats absorbed from the digestive canal and passed to the circulatory system? (2 Marks)

11. Name the organ that produces pepsin. (2 Marks)

12. Which helps in speeding up the absorption of nutrients in the small intestine? (2 Marks)

The Final Achievement Test/ Grade Nine (Science)

Name: Section:

Part one (26 Marks)

Directions: Write in the proper space the letter of the choice that best completes each statement.

1. In the same species, the chromosome number of a zygote and gamete are in the ratio of

a. 4:1 b. 2:1 c. 1:1 d. 1:2

2. As a result of mitosis, each new cell has

a. half as many chromosomes as its mother cell

b. twice as many chromosomes as its mother cell c. quite as many chromosomes as its mother cell

d. just as many chromosomes as its mother cell

3. An important function of the sperm is to supply the egg with

a. additional food

b. needed cytoplasm

c. an extra supply of ATP

d. an extra quantity of DNA

4. Fraternal twins develop from

a. two fertilized eggs b. one fertilized egg

c. one egg fertilized by two sperms d. two eggs fertilized by one sperm

5. An important function of the cornea in the eye is to

a. reflect the extra light b. absorb the strong light

c. protect the frontal parts of the eye d. cover the inner parts of the eye

6. During night study, it is important to put the light source

a. in front of you b. backward to your head

c. over your head d. anywhere in the room

7. One of the following ear parts keeps the body equilibrium, which is

a. semicircular canals b. vestibule c. cochlea d. malleus

8. Distribution of taste buds for bitter taste on the human tongue are mostly located on the

a. front b. sides c. middle d. back

9. The stimulus which we can not receive by the sensory receptors of the skin is

a. pressure b. sound c. touch d. heat

10. Irregularity of the testosterone hormone secretion in man resulted in

a. disorder of the hair growth

b. sterility in the late life stages

c. abolishing of the sex urge

d. producing abnormal sperms

11. The following figure is for a cell in one division stage, this stage is

a. anaphase b. prophase

c. metaphase d. telophase

12. Crossing-over which ends in exchanging some of the chromatids' parts during meiosis happens in - stage.

a. prophase b. metaphase c. telophase d. anaphase

13. The main function of the umbilical cord is

a. fixing the embryo inside the uterus

b. protecting the embryo from external collisions

c. regulating the nutrition of the embryo

d. keeping the temperature of the embryo

Part two (24 Marks}

Directions: Answer the following short-answer questions in the space provided

1. Which organ carries the coded information to guide the development of daughter cell? (2 Marks)

2. What do we mean by fertilization concept? (1 Mark)

3. The pregnant mother is recommended not to have X-rays treatment during the pregnancy stage. Could you explain why? (2 Marks)

4. It is a misconception to say that the ear is the hearing organ. *So,* what is the scientific truth for this? (2 Marks)

5. How could we solve the farsighted eye (hyperopia) problem? (2 Marks)

6. It is advisable to chew gum while travelling from a high mountain to a valley area and the opposite. Is there any medical reason for this advice? State. (2 Marks)

7. Describe the smelling mechanism of the food smell. (3 Marks)

8. During the common cold disease we can not taste the real taste of food. Why? (2 Marks)

9. What is the role of the cilia in the female oviduct? (2 Marks)

10. Differentiate between menstruation and abortion. (2 Marks)

11. State three factors cause sterility case in human. (2 Marks)

12. What is the best way to decrease the percentage of sexual diseases among human society according to what you studied in the textbook? (2 Marks)

Appendix 2

The Attitudes Questionnaire

Name: Class: Section:

Dear student

Please, check the answer that most agree with how you feel about science at this school. Answer how you feel and not how you think you should feel. Then, select the choice which best reflects your response towards the following statements by putting (X) in the space provided for each statement.

Key: SA (Strongly agree) A (Agree) U(Uncertain)
D(Disagree) SD(Strongly disagree)

No.	Statements	Responses				
		SA	A	U	D	SD
1.	I am usually interested in science.					
2.	I usually do quite well at science.					
3.	The teacher does not give us much help.					
4.	Science will help me to get a job when I leave school.					
5.	I want to learn a lot more about science.					
6.	The teacher makes the subject lively and interesting.					
7.	Science helps me to work thing out properly.					
8.	Science is not as interesting as other subjects.					

9. If we give the wrong answer the teacher is generally careful to discuss it with us.

10.Science makes it easier to understand many of the worlds' problems.

11.1 do not like reading books on science.

12.Science has helped to improve our standard of living.

13.The teacher is usually so busy that I do not like to ask him/ her questions at the end of the lesson.

14.1 would like to spend more time on science even if it means there is less time for other subjects.

15.Science is rather difficult.

16.0ur teacher enjoys the subject. 17.Science shows us how we might solve some of the problems in Jordan.

18.1 have difficulty understanding the words and expressions used in science.

19.The teacher passes on US his/ her enthusiasm for science.

20.Science teaches you to question ideas and opinions

21.1 would like a career which involves science.

22.The teacher encourages us to take a greater interest in science.

23.Science makes us think about what is happening in the world.

24.1 find it difficult when I am asked to use what I have learned to solve new problems.

25.1 like science less than I used to.

26.The teacher always tries to relate science to our everyday life.

27.1 can not see the point of many of the experiments.

28.1 am not sure what I am doing half the time.

29.1 look forward to our science lesson.

30.The teacher tries to get round the whole class during practical work.

31.1 often find the teacher's instructions difficult to follow.

32.1 like our science teacher.

33.Science is easier than it used to be.

Appendix 3

Final Attitude Toward Science

Grade Five

Table 3

Analysis of covariance of attitude toward science (post) according to covariate (attit. -pre), treatment, sex, and interaction between sex and treatment of students in experimental and control groups of 5th grade class

Source of variation	SS	df	MS	F	Sig. F
Covariate(attit.pre)	6775.934	1	6775.934	55.256	.000*
Treatment	486.964	2	243.482	1.986	.140
Sex	51.855	1	51.855	.423	.516
Treat.x Sex	6.4441	2	3.222	.026	.974
Residual	21950.414	179	122.628		
Total	31313.532	185	169.262		

*=Significant

Grade Seven

Table 4

Analysis of covariance of attitude toward science (post) according to covariate (attit.pre), Treatment, Sex, and interaction between treatment and sex of the students in experimental and control groups of grade 7 class

Source Of Variation	SS	df	MS	F	Sig.of F
Covariate(attit.pre)	9964.200	1	9964.200	122.395	.000*
Treatment	355.457	2	177.729	2.183	.115
Sex	89.282	1	89.282	1.097	.296
Treat.x Sex	1016.893	2	508.447	6.245	.002*
Residual	17096.125	210	81.410		
Total	29007.410	216	134.294		

* = Significant

Grade Nine

Table 5

Analysis of covariance of attitude toward science (post) according to covariate (attitude-pre), Treatment, Sex, and interaction between treatment and sex of students in experimental and control groups of 9th grade class

Source of variation	SS	df	MS	F	Sig.of F
Covariate(attit.pre)	12868.262	1	12868.262	111.861	.000*
Treatment	1268.914	2	634.457	5.515	.005*
Sex	180.404	1	180.404	1.568	.212
Treat x Sex	463.222	2	231.611	2.013	.136
Residual	22547.408	196	115.038		
Total	40100.887	202	198.519		

* = Significant

Appendix 4

Final Achievement

Grade Five

Table 6

Analysis of covariance of achievement (post) according to covariate (pre-achievement), Treatment, Sex, and interaction between sex and treatment of students in experimental and control groups of 5th grade class

Source of Variation	SS	df	MS	F	Sig. F
Covariat (pre-ach)	9468.817	1	9468.817	184.765	.000*
Treatment	1113.287	2	556.640	10.862	.000*
Sex	6868.379	1	6868.379	134.023	.000*
Treat.x Sex	233.449	2	116.725	2.278	.105
Residual	9173.363	179	51.248		

Total	**26880.414**	**185**	**145.300**

* = Significant

Grade Seven

Table 7

Analysis of covariance of achievement (post) according to covariate (pre-achievement), treatment, sex, and interaction between sex and treatment of students in experimental and control groups of 7th grade class

Source of variation	**SS**	**df**	**MS**	**F**	**Sig. F**
Covariate (Pre-Achiev)	**6566.728**	**1**	**6566.728**	**199.851**	**.000***
Treatment	**661.309**	**2**	**330.655**	**10.063**	**.000***
Sex	**4855.987**	**1**	**4855.987**	**147.787**	**.000***
Treat.x Sex	**458.649**	**2**	**229.325**	**6.979**	**.001***
Residual	**6900.195**	**210**	**32.858**		
Total	**19600.627**	**216**	**90.744**		

* = Significant

Grade Nine

Table 8

Analysis of covariance of achievement (post) according to covariate (pre-achievement), treatment, sex, and interaction between sex and treatment of students in experimental and control groups of 9th grade class

Source of Variation	**SS**	**df**	**MS**	**F**	**Sig.of F**
Covariate (pre-achiev)	**8806.594**	**1**	**8806.594**	**170.233**	**.000***
Treatment	**1113.390**	**2**	**556.695**	**10.761**	**.000***
Sex	**1198.965**	**1**	**1198.965**	**23.176**	**.000***
Treat.X Sex	**233.243**	**2**	**116.621**	**2.254**	**.108**
Residual	**10139.572**	**196**	**51.733**		
Total	**21433.852**	**202**	**106.108**		

* = Significant

Recevied: 28/9/2003.