Faculty of Humanities
Science and Mathematics Education Centre

Science and Physics for Saudi Girls: Their Perceptions, Motivations and Career Perspectives

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This Thesis is presented for the Degree of
Doctor of Philosophy
of
Curtin University

April 2017

DECLARATION

To the best of my knowledge and belief, this thesis contains no material previously published by any other person except where due acknowledgment has been made.

This thesis contains no material which has been accepted for the award of any other degree or diploma in any university.

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ABSTRACT

The research reported in this thesis examined how Saudi girls' perceptions, motivations and career perspectives influenced their attraction towards the study of science and physics. The study used a mixed methods research design involving 800 Saudi girl students in Year levels 9, 10 and 11 from eight intermediate and high schools in Jeddah, Saudi Arabia. The quantitative data comprised 11 items with 5-point Likert type questions adopted from five instruments and later modified to suit the Saudi context. The qualitative data were derived from semi-structured interviews with 35 Saudi girls using a questionnaire containing 16 questions.

Results from both the quantitative and qualitative data analyses indicated that Saudi girls are attracted to science disciplines that have personal relevance, aligned with their stereotypic views and motivations engendered by some biology topics especially those related to medicine. In contrast, Saudi girls feel bored in physics class and most see no benefit of studying physics. Saudi girls' interest in science often declines after elementary school level. There is a positive correlation between students' interest in science and their understanding. Moreover, from the motivation perspective, there were four factors of motivation. Those factors can be divided into intrinsic and extrinsic motivations. The intrinsic motivations are Confidence, Enjoyment and Interest and Liking for science. In contrast, extrinsic motivation includes the impact of examinations and concerns about the other students' progress. Motivation improvement could help Saudi girls' understanding of the stereotype of a girl science student. Therefore, from a stereotype perspective, Saudi girls believe that those who choose science to study are smart, ambitious, motivated, beautiful, empathetic but not lonely, not pompous, not stubborn, and have good learning experiences.

Saudi girls receive enough support from their families to study any chosen science discipline and believe that the teacher and her teaching skills are one of the most important contributing factors to attract students towards the study of science. Moreover, many Saudi girl participants believed that their desire to study science disciplines and engineering was due to peer influence.

Furthermore, more than half of the interviewed participants planned to work in intermingling jobs such as medicine and law. On the other hand, participants believed

that studying science subjects in school can impact on their future careers by helping them gain knowledge in different learning strategies such as practical work and showing links of science subjects to their real life. The most favourite profession is a medical doctor followed by a profession in education as a teacher or educator. Also, more than half of the interviewed participants preferred a job related to science. Therefore, many of these Saudi girls planned to study STEM courses.

ACKNOWLEDGEMENTS

I would like to acknowledge the direct and indirect help and support of many people for the production of this thesis. I would like to express my sincere gratitude to my supervisor, Professor David Treagust, for his patience, guidance and belief in my abilities which kept me constantly motivated and truly helped me in completing this task.

I would also like to thank my co-supervisors, Dr Mihye Won and Dr Venkat Vishnumolakala, for motivating me and providing me with invaluable suggestions for writing this thesis.

I would also like to acknowledge the Saudi Arabian government for the King Abdullah Scholarship and Taif University for supporting me and my family's financial needs during my research.

I would also like to express my appreciation to all my postgraduate colleagues for the formal discussions we had regarding our projects. I would especially like to extend my heartfelt appreciation to a very special friend, who prefers to remain anonymous due to personal reasons, for helping me many times to get back on track.

I would like to thank my mum for the unconditional love and inspiration she has provided me, despite being far away. She never lets me realise that she is living on the other side of the world.

I would like to thank my brothers and sisters, Ateeq, Hamoud, Abdullah, Ramzi, Rajha, Samha, Aisha and Monerah for their support during my study away from home.

Lastly, I would like to thank my beloved husband, Dr Ahmed AlGhamdi, for his endless patience and everlasting support. I also wish to express my gratitude to our children, Juri, Hala, Fajer and Abdullah, for their love and being a source of everyday inspiration for all the work I have put into this thesis.

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INTRODUCTION

1.1 Statement of the Problem

It has been stated that if you want to find out the impact of education on an individual, you should do an intense observation of the ways of well-educated people and then compare them with those of illiterate people (Heussner, 2013). The difference between educated and illiterate people is that educated people are more able to improve themselves than are illiterate people (Fasheh, 2002). Teaching and education can be the basis for building a society at both the personal individual level and at the community level. Teaching and education are the prime influences in the development of civilizations and are the main reasons for the evolution of communities and nations (AlHuthaifi, 2009). Furthermore, there is no doubt about the importance of scientific and technological knowledge for an individual to be successful in the modern age (AlHuthaifi, 2009).

For Saudi Arabia, as an Islamic country whose citizens believe that the first word in the Quran is "اقرأ" or "Read", education is viewed as an important characteristic for its people (Mandhouj & Huguelet, 2016). This view is evidenced by the establishment of the Directorate of Education in 1925, even before the Kingdom of Saudi Arabia was established in 1932 by King Abdulaziz Ibn Abdurrahman Al Saud. The Directorate of Education was later changed in 1953 to the Ministry of Education (Rugh, 2002).

Moreover, women's education in Saudi Arabia is an area that has made significant progress since a formal learning system was enacted in 1955 to increase girls' attendance in education and to reduce the education gap between Saudi men and women at different academic levels (Geel, 2016; Hamdan, 2005). Consequently, girls' and women's education has led to a number of major social developments, for example, a decrease in the rates of fertility and mortality, an improvement in health and an increase in female participation in the workforce (Hamdan, 2005). The purpose of girls' education has been to make women "good wives and mothers and to prepare them for 'acceptable' jobs such as teaching and nursing that were believed to suit their nature" (Hamdan, 2009, p. 96). However, progress has gone beyond this view and recently, the Saudi Council of Engineers established a section for women engineers

(Saudi Council of Engineers, 2016). Moreover, the Chief of Engineers in the Ministry of Finance announced that there are women engineers who are members of committees for the development of the masjid al-haram in Mecca (Abdullah, 2016), which is regarded as the most important Islamic mosque in the entire world.

Nevertheless, despite an increase in the number of women in science and engineering in Western countries, in Saudi Arabia the participation of the female population in these disciplines remain under-represented (Hill, Corbett, & St Rose, 2010; Kessels & Hannover, 2008). The impact of fewer girls studying science and physics may lead to a shortage of scientifically educated women in Saudi Arabia. The decline in a scientifically educated workforce can negatively affect the national economy (Hill et al., 2010). Specifically, this may lead to a lack of important skills and knowledge including that of future teachers who may not have the desired qualifications and background needed to encourage the next generation of potential students in science, especially in physical science. The lack of qualified teachers may further accelerate the decline of the scientific workforce and affect national economy (Cottaar, 2012; Murphy & Whitelegg, 2006).

Research in Western countries has shown that girls tend not to choose physics as a major subject in school (Hannover & Kessels, 2004; Kessels & Hannover, 2008; Murphy & Whitelegg, 2006; Taconis & Kessels, 2009). Research has also reported reasons for girls not choosing physics, for example, girls perceive they are not good at science (Hannover & Kessels, 2004; Kessels & Hannover, 2008; Mitrevski & Treagust, 2011; Taconis & Kessels, 2009), science is seen as being more difficult than other subjects (Kessels, 2005; Mitrevski & Treagust, 2011) and girls are unable to see themselves as scientists (Kessels, 2005; Mitrevski & Treagust, 2011). Therefore, understanding the social, cultural, educational and career issues faced by young women in Saudi Arabia to enter science and engineering fields can help to determine the possible solutions.

1.2 Context of the Study

Saudi Arabia's geographical location is in the middle of Arabic and Muslim countries. Many issues for women in Saudi Arabia are different from those faced by women in other countries. From an educational perspective in Western countries, there are wide

discussions about using single-sex schooling as a way to enhance the girls' participation in science education (Hazari, Sonnert, Sadler, & Shanahan, 2010; Kessels & Hannover, 2008). However, it has been emphasised that, the impact of single-sex schooling and grouping does not necessarily "enhance girls' interest or motivation to study physics" (Murphy & Whitelegg, 2006, p. 29). Nevertheless, research on "girls from single-sex physics classes has reported a better physics-related self-concept of ability than girls from coeducational classes" (Kessels & Hannover, 2008, p. 273). So this finding begs the question and forms the basis of this study about girls' learning and motivation for studying physics in Saudi Arabia which has single-sex schools.

Family traditions, customs and religious conformity are the strongest factors in the Saudi family (Almutairi, 2012). One of these traditions and religious conformity is to distinguish between the education of boys and girls in schools. In the Saudi Arabian education system, single-sex education is compulsory from Year 1 to higher education. Moreover, all members of girls' schools, the principal, the teachers and the students, are female. Hamdan (2010, p. 380) argued that "there are advantages and disadvantages with both co-educational and all girls schools". Also, as a student in Saudi Arabia, she considered that "sciences such as physics and mathematics not to be taught exclusively for males" (Hamdan, 2010, p. 380).

This research was design with the goal to help Saudi girls transcend the social and tradition obstacles to study physics and science. To observe these obstacles, qualitative and quantitative questions were administered to Saudi girls in Jeddah from Year 9 to Year 11. Qualitative and quantitative questions can help to find out the weak points in the education system for girls to study science and physics so as to avoid these issues in the future.

1.3 Rationale

In many countries, the social and environmental factors can be important determinants of sex differences in education (Benbow & Minor, 1986; Cobern, 1996). From a constructivist perspective, "students in different cultures will have somewhat different perspectives on science" (Cobern, 1996, p. 295). In Saudi Arabia a woman's place is said is be her home (Hamdan, 2005) though, as discussed above, in recent years

women are engaged in work outside the home and participate in institutions of civil society, such as teaching, medicine and business. Moreover, "the government of Saudi Arabia has adopted a clear vision for the empowerment of women as reflected in recent development plans that show a clear shift in the orientation of planning efforts towards the development of women's roles instead of focusing on women's right to education and employment" (Al-Ahmadi, 2011, p. 49). This is an important development because according to Metcalf (2011), Islam has afforded women rights, but the tradition and cultural practices in Saudi Arabia have impacted negatively upon women's economic and social advancement. Nevertheless many authors in Saudi Arabia believe that "women's education will allow them to be actively involved in their society, both at home and in the civil society" (Hamdan, 2005, p. 54). It is argued that because children learn religion and manners at home, the future generations will benefit through mothers who have received better schooling and advanced education (Hamdan, 2005; Schultz, 1993).

In many Western countries, research has shown that physics lessons are unpopular for high school students; this has been of great concern over the last decade, For example, in the Netherlands, there was a lack of engineers, teachers and scientists, because physics remained an unpopular subject among high school students (Cottaar, 2012). Moreover, there are many reasons why science, especially physics, is out of favour for girls (Murphy & Whitelegg, 2006). Physics is one of the subjects that is labelled unfeminine (Betz & Sekaquaptewa, 2012; Kessels, 2005). In contrast, studying in a single-sex education system, like Saudi Arabia (Hamdan, 2010) does not alone help to enhance girls in their study of physics (Murphy & Whitelegg, 2006). On the other hand, "girls from single-sex physics classes reported a better physics-related self-concept of ability than girls from co-educational classes" (Kessels & Hannover, 2008, p. 273). Therefore, the single-sex school argument may not offer the whole solution to identify whether or not it will have a positive or no-effect on girls' preference towards the study of physics.

According to Blanco (2000), women entering male-centred occupations do face a great deal of difficulties such as low support from colleagues and superiors. Occupations defined as male-oriented, often provide an inhospitable context for women. To overcome such professional challenges and to gain better jobs, women need higher achievement in education (Heath & Mobarak, 2011; Uz & Eryılmaz, 1999). Studying

physics is not only to be a physical scientist or engineer; a knowledge of physics enables interaction with other scientists such as those in biology or medicine (Hobbie & Roth, 2007). An excellent example of the relationship between physics and medicine is medical imaging which depends on an understanding of signals and waves which have to be related with medical knowledge (Webb, 2010).

1.4 Purpose of the study and research questions

This research was aimed to determine whether or not Saudi girl students are attracted to science in Year 9 and to physics in Year 10 and 11, and how their perceptions, motivations and career perspectives impact upon their subject selections. Consequently, this study sought to answer the following research questions:

Research Question 1: What are Saudi girls' perceptions of science and physics?

Research Question 2: What are Saudi girls' motivations for learning science?

Research Question 3: Does physics match Saudi girls' stereotype of a scientist or physicist?

Research Question 4: How does Saudi culture impact on the girls choosing science?

Research Question 5: How does choosing science subjects impact on Saudi girls' future careers?

1.5 Methodology

This research used a mixed methods design with quantitative and qualitative data. The combination of quantitative and qualitative data provides a better understanding of the research problem (Creswell, 2013).

Quantitative data were collected by a questionnaire designed to examine students' interests in science in Year 9 and their interest in physics in Year 10 and 11, students' views of science, students' experience of science in school, student thinking about a good teacher (Hollins, Murphy, Ponchaud, & Whitelegg, 2006), students' stereotype of a scientist or physicist (Hannover & Kessels, 2004), identity (Taconis & Kessels, 2009) and their motivation (Glynn, Taasoobshirazi, & Brickman, 2009).

Qualitative data were collected by interviews containing comprehension questions to discuss students' current science and physics courses, past science and experiences in physics and behaviour inside and outside of the school, such as:

> hobbies and activities; peer and family expectations and actions related to science and physics involvement; perceptions of science/physics and scientists; sense of self learning and doing science; influence of gender and ethnicity on their lives, particularly as related to science/physics and scientists opportunities; and their dreams and plans for the future.
>
> (Aschbacher, Li, & Roth, 2010, p. 568).

1.5.1 Participants

The quantitative data were obtained from 800 intermediate and high school students from different girls' high and intermediate schools in the city of Jeddah in the Mecca region (Saudi Arabia). For these groups, data were collected from questionnaire instruments translated into Arabic.

The qualitative data were obtained from the interviews with 35 girls from the same intermediate and high school in the city of Jeddah in the Mecca region (Saudi Arabia).

1.5.2 Data collection and analysis

The quantitative data were analysed after respondents completed answering the questions. Statistical analysis was computed for the responses to all of the items in the questionnaire after they were coded. Statistical analysis was conducted using the Statistical Package for Social Sciences (SPSS) (Pallant, 2013).

The qualitative data were analysed after the interviews were recorded in writing in the researcher's notebook. This process involved transcribing the interviews from Arabic to English, summarising the interviews, making a matrix, coding and categorising the information collected from the interviews. Data relationships were identified within and across instructions for feasible relationships between "science identity and performance, demographics and school/academy attended" (Aschbacher et al., 2010, p. 569). Finally, group summaries were compared.

1.6 Significance of the Study

The research is significant for several reasons: Firstly, Saudi Arabia is a unique country, where single-sex education is compulsory. Understanding of girl students' thinking of science/physics in school could help to improve the education system in Saudi Arabia. Secondly, the outcome of the study may help to improve the concept of physics among high school girl students. Thirdly, the research may help to improve the learning outcomes because female teachers and girl students have a better understanding of the science and physics concepts in the curriculum. Fourthly, the study may offer an understanding of reasons for the decline in the number of girl students in Saudi society studying science. Finally, the outcomes of the study may help to find the reasons in support of girls studying science in high school.

1.7 Limitations of the Study

The main limitations in this research are: 1) This study was carried in a limited number of schools in the Mecca region; 2) The research participants are from urban-school settings, therefore their views may not be comparable to those from small country towns. Both the first and second limitations were caused by lack of budget to travel to many schools. 3) Some interview questions were avoided because there may be a scope for misunderstanding by the girls, schools and families; for example, questions on Islamic values especially intermingling between women and men were intentionally avoided. 4) The responses from most of the participants were very short and did not have enough details, most likely because the interviewees were not used to talking with a researcher or a person from outside the school and maybe they were afraid of making mistakes. Saudi traditions urge people to respect older people, therefore, most of the respondents gave short answers. Also, the participants might have been fearful that making a mistake could cause problems for them and this might have led to cautious short answers to the interview questions. 3) Schools refused to allow the researcher to record (tape record) interviews with students because of the restrictive administrative procedures of the education department.

1.8 Overview of the Study

After discussing the background, purpose of the study, rationale and contextual significance of the study in Chapter 1, the next chapters are:

- **Chapter 2** presents a review of the literature related to education in Saudi Arabia, science education, physics education, perceptions, motivations, self-image, Saudi culture, Saudi girls' careers and the relation between Saudi girls' careers, STEM; and also because this research is on education, the main learning theories are discussed.
- **Chapter 3** provides a more detailed description of the methodology used to explore Saudi girls' perceptions, motivations, self-image, culture and science career perspectives. This procedure involved a qualitative and quantitative approach to analyse the data among the intermediate and high school girl students in Saudi Arabia.
- **Chapter 4** describes the pilot study that was utilized to determine the reliability and validity of the instruments.
- **Chapter 5** includes the presentation of data which were interpreted and analysed on the basis of the issues arising from the responses to the questionnaire items. Those items discuss Saudi girls' perceptions of science and physics, motivations for learning science, favourite subjects and analysis of the stereotype of a scientist or physicist.
- **Chapter 6** presents the qualitative data results and their analyses.
- **Chapter 7** includes the discussion of the results from data analyses.
- **Chapter 8** contains a summary, conclusions and recommendations.

Chapter 2
LITERATURE REVIEW

2.1 Introduction

This chapter reviews the literature relevant to Saudi girls' perceptions of science and physics, motivations for learning and science and physics, self-image about studying science and physics and science career perspectives. This chapter is divided into an introduction, nine content-related sections and a summary of the chapter; each section is linked to the objectives of the research. Understanding the education system in Saudi Arabia is essential to this study; and therefore, knowing about the segregation levels and gender relations within Saudi Arabian education system is very relevant to the research objectives as shown in Section 2.2. Section 2.3 discusses science education in Saudi Arabia and other countries, whereas physics education worldwide is discussed in Section 2.4. To understand the learning issues in this study, the main learning theories are reviewed in Section 2.5.

Because of the importance of perceptions, motivations and self-image of Saudi girls in this research, Section 2.6 systematically illustrates the arguments about perception, students' perceptions of science/physics, girls' perceptions of science/physics and Saudi girls' perceptions of science/physics. Similarly, Section 2.7 illustrates students' motivations towards learning of science/physics, girls' motivations for learning science/physics and more specifically, Saudi girls' motivations for learning science/physics. Section 2.8 presents arguments relating to: students' self-image, girls' self-image, Saudi girls' self-image and Saudi girls' self-image and study of science/physics.

Also, the way that Saudi culture impacts upon girls' selection of science/physics is discussed in Section 2.9 and the literature on how Saudi girls' career impacts on their choice of science/physics is presented in Section 2.10. The relation between Saudi girls' career and STEM (Science, Technology, Engineering and Mathematics) areas is presented in Section 2.11. The chapter summary is included as Section 2.12.

2.2 Education in Saudi Arabia

A review of the quality of education in Saudi Arabia has shown improvement at all school levels (Dagher & BouJaoude, 2011; Mansour & Al-Shamrani, 2015). The latest improvement in education was made at the beginning of 2015, when King Salman, as King of Saudi Arabia, ordered the merger of the Ministries of Education and Higher Education to become The Education Ministry (Jain, 2015). This improvement was designed to help integrate all plans for education in Saudi Arabia. Education improvement in Saudi Arabia is not only for boys, but girls' education has been given equal attention because the Saudi women are an essential part of Saudi Arabian society. Therefore, over the past 50 years, women's education in Saudi Arabia is an area that has made significant progress in increasing girls' access to education and reducing the gender gap at different educational levels (Rugh, 2002). Figure **2.1** shows the milestones in women's education in Saudi Arabia (Al Rashedi et al., 2015; Royal Embassy of Saudi Arabia, 2014).

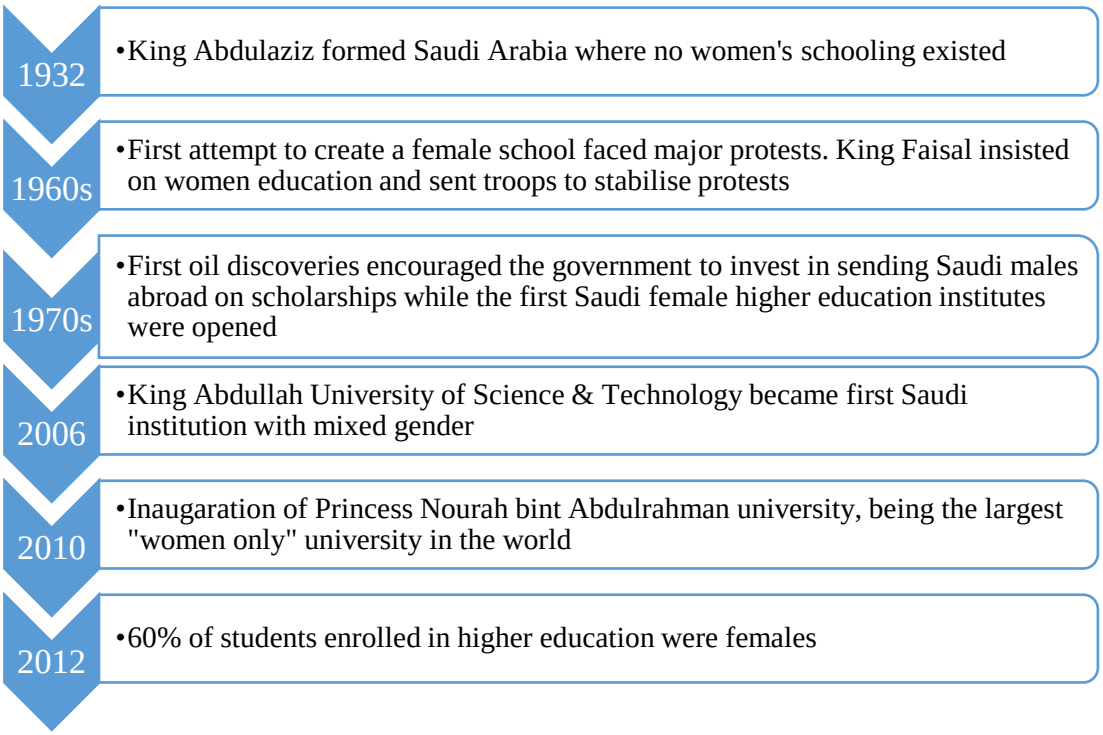

Figure 2.1: Milestones in women's education in Saudi Arabia

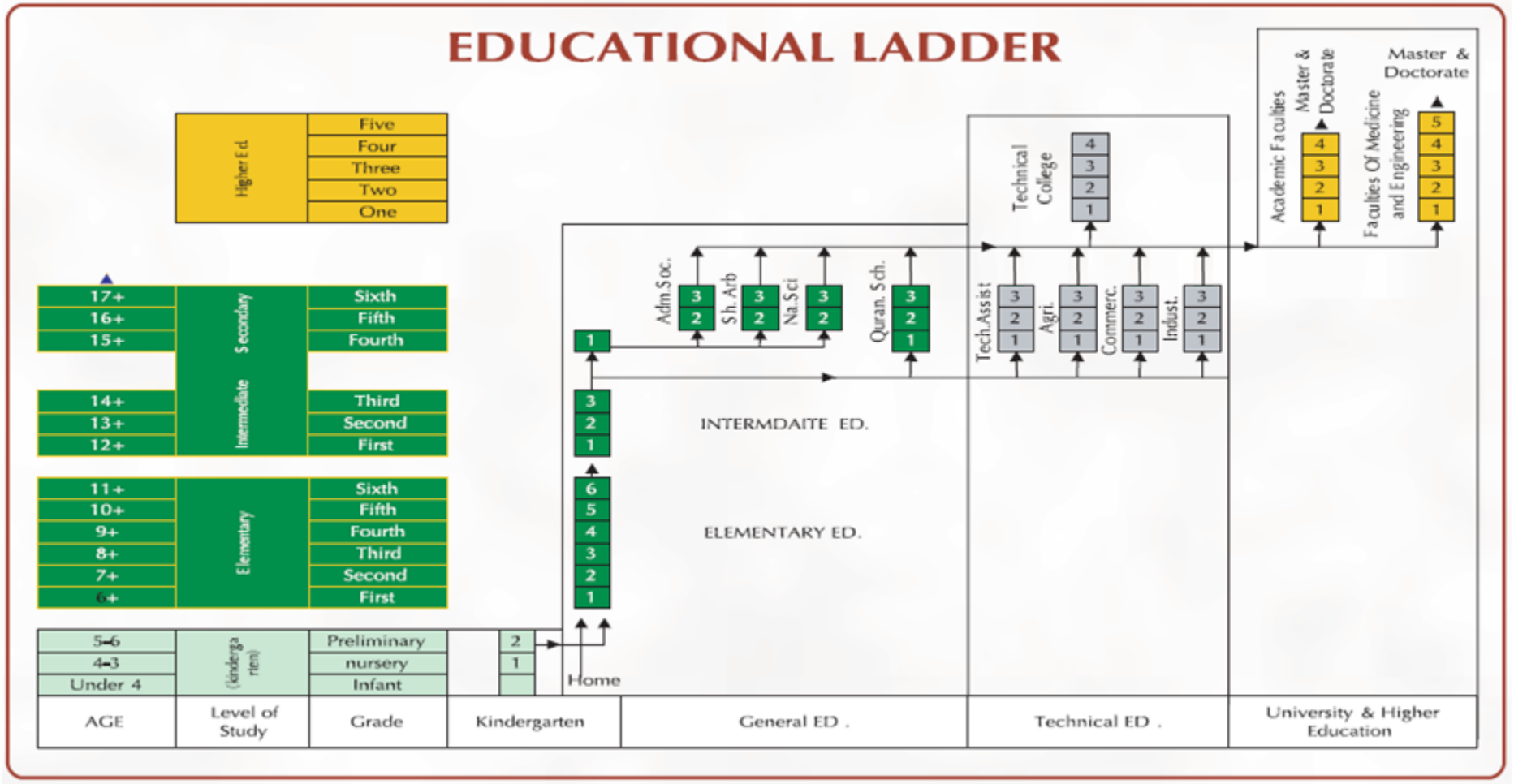

Figure 2.2: Education in Saudi Arabia taken from *(Educational system in Saudi Arabia, 2006)*

As shown in Figure **2.2**, the main structure of the educational system in the Kingdom of Saudi Arabia for both genders in single-sex schools consists of the following levels (*Educational system in Saudi Arabia*, 2006):

Pre-Primary Level: Similar to many other countries, the pre-primary level in Saudi Arabia prepares boys and girls ready for primary education. The children at this stage stay for a period of two years. Children at the age of four are enrolled in the kindergarten level and at age of five are enrolled in the pre-primary level.

Primary Level: Primary level schooling is obligatory and is considered as "an essential foundation for the development of an overall educational program" (*Educational system in Saudi Arabia*, 2006, p. 3). Children at the age of six are enrolled and study for six years at the primary level. In each school year, students study for two semesters, spanning 15 weeks of classes in each semester at least; students study six classes and the duration of each is 45 minutes. Students who are in primary schools are assessed by their teachers. Boys and girls study in a single-sex education system.

Intermediate Level: After completing the elementary levels, students between the age of 12 and 14 years continue their education at the intermediate level (the equivalent of grades 7-9 in the Australian education system). Similar to the primary level, the school year at this level comprises two semesters; each semester has 15 studying weeks and two examination weeks. There are 33 class periods per week with 45 minutes for each class. English as a subject becomes a requirement in intermediate school. "Passing an examination is necessary to receive the Intermediate School Certificate, which is a prerequisite for entering secondary school" (*Educational system in Saudi Arabia*, 2006, p. 3).

Secondary Level: High school education or secondary level education spans three years and generally serves students in the age group of 15 to 17 years. "Students in regular High schools study a general curriculum for the first year and additionally for the remaining two years students choose one of the following majors: Administrative & Social Sciences or Natural Science or Shariah & Arabic Studies" (*Educational system in Saudi Arabia*, 2006, p. 4). Students who maintain a high grade-point average at Year 10 grade level are motivated to enroll in the science program. Similarly to the primary and intermediate levels, the high school level consists of two semesters; each

semester has 15-studying weeks and two examination weeks. Class periods are 45 minutes long and the total scheduled classes for each week vary between 26 and 33. In order to earn the Secondary School Certificate, students are expected to attain a minimum of fifty percent in individual subject examinations.

University level: The higher academic education year in Saudi Arabia is similar to that in the USA, with a two-semester year and an optional summer semester (Clark, 2014; Ministry of education, 2015). Students can study for two years to gain associate degrees or four years to gain Bachelor degrees. If a student wishes to study for a Master's degree, he or she can spend two years after the Bachelor degree (Clark, 2014; Ministry of education, 2015).

In Saudi Arabia there are different types of higher education institutions: universities and technical colleges. There are 36 universities, 26 of which are public and the remaining are private. Princess Nourah Bint Abdulrahman University and Effat University are women's universities. Also, there are more than 50 technical colleges, 17 of which are for women (Clark, 2014; Ministry of education, 2015; Technical and Vocational Training Corporation, 2015).

2.3 Science Education

According to Harris (2007), "students choose to study science for a variety of reasons and will take their qualifications into a variety of work places. The challenge for universities is to ensure we do all we can to support this" (p. 7). Students' views of science education have an impact on their interest and motivation to learn science and on their selection of science-related careers. For example, the number of Australian students studying science in grades 11 and 12 has steadily declined since 1976 because of several factors like students' ability, teaching methods, lack of motivation and interest (Hassan, 2008). As a result, it is argued that the reduction of students' enrolment in sciences has impacted upon Australia's economy (Hassan, 2008).

From a teaching and learning perspective, there are two main reasons to enhance students' participation in science (Masu, 1989): Firstly, a natural instinct to grow and learn so that students succeed in life. Secondly, the future work of the students may be affected by their attitude towards learning of science. Furthermore, students'

perceptions towards science lessons are related to their achievement and beliefs in science (Fraser, 1998; Roberts & Ommundsen, 1996). Therefore, the school plays a vital role in encouraging students to enroll and work in science-related fields (Gibson & Chase, 2002; Masu, 1989) because students start building their life experience from school (Dickson & Mitchell, 2014). Teacher guidance is an essential part of the students' development as much as self-development (Duit, 1995). Also, the teacher is a very essential part of an education system irrespective of his or her approaches to teaching, using technology or not (Albirini, 2006; Entwistle, 2013), and has a very important responsibility to facilitate students' understanding, attitudes and experiences to scientific values (Yager, Tamir, & Kellerman, 1994). For example, the teacher passes his or her attitudes towards students (Alhammad, 2015; Masu, 1989). Therefore, many teacher education researchers work to improve teachers' skills and their ways of teaching (Albirini, 2006; Entwistle, 2013).

Saudi Arabia, as an example of the gulf countries, needs to improve its education system (Alhammad, 2015) as shown by the results of the Trends in International Mathematics and Science Study (TIMSS) conducted in 2003 and 2011, which indicated that students from Saudi Arabia scored lower than the international average (Dagher & BouJaoude, 2011; Mullis, Martin, Foy, & Arora, 2012). Likewise, one of the issues facing education in Saudi Arabia is the limited quality of Saudi Arabian science learning, which is impacting negatively on students' attitude towards the study of science subjects (Almazroa & Al-Shamrani, 2015). Alnahdi (2013) suggested that education in Saudi Arabia needs to have gradual improvement, periodical evaluation of improvements for quality assurance and to increase the competition between the teachers. Therefore, there is a need for Saudi Arabia Education Ministry's policy-makers to make especial attention to develop high quality teachers, especially science teachers (Almazroa & Al-Shamrani, 2015).

To generate student interest, the teacher should use society, culture, and the environment as a platform for class lessons (Katan, 2014). Culture is "more than an idea to think with. It influences how people act and make sense of their world" (Waldrip, Rodie, & Sutopo, 2014, p. 172). Students need to be linked to their society and culture to make sense of what they are learning in school and especially in science because they cannot learn science concepts by themselves (Driver, 1995; Osborne, 1996). Therefore, teachers should use examples in order to link students' culture with

scientific phenomena in their classroom learning environment (Ladson-Billings, 1995). Also, teachers have to develop relevant pedagogical tools for teaching a certain topic in order to achieve a well-formulated goal needed to care about the society and culture as well as to consider the age and ability of the students (Eilam & Gilbert, 2014). Moreover, there is an argument that students' learning is impacted by their own background, culture and society (Devlin, 2013). In brief, teachers should create a link between the school, students and families and display a respect for students' culture (Waldrip et al., 2014).

Science has many disciplines such as chemistry, biology and physics (Menis, 1988). According to Breslyn and McGinnis (2012), each discipline needs a special curriculum, structure and classroom context. Therefore, there are differences between physics and other disciplines. Subsection 2.4 illustrates the literature in relation to physics education.

2.4 Physics Education

Physics is one of the disciplines of science and has a different context compared to other science disciplines. The main difference between physics and other science disciplines is that the linkage between mathematics and science is more obvious than with other sciences with an understanding of one enabling an understanding of the other (Barker, 2012; Hestenes, 2013). Hestenes (2013) stated that, "cognitive processes for understanding physics and math are intimately linked and fundamentally the same" (p. 14). During the nineteenth century, the mathematics profession was separated from physics because approximately 80% of mathematicians were ignorant of science and vice versa (Barker, 2012). Consequently, cognitive learning for both mathematics and physics has been equally impacted (Hestenes, 2013) especially when students cannot make links between physics rules and physics concepts, as a result of which, their conceptual retention rates do not exceed 40%; and consequently, they lose the rules subconsciously (Coven, Gibbon, & Wright, 2014; Hestenes, Wells, & Swackhamer, 1992; McDermott, 1993).

To overcome the low rate of success in physics, constructivist teaching techniques have been introduced (Coven et al., 2014; Hestenes et al., 1992). Using these techniques, students conduct experiments without formulae or textbook and further

link them to their experiences by discussing their findings with each other in class. As a group, students summarize their findings and try to apply them to new experiments and predict results. The constructivist techniques to teaching and learning make the students build their experience before using formulae. Consequently, while preparing for examinations, students do not need to remember the formulae because they can study the experimental findings and the kinds of problems. The experimental findings can lead to the development of the formula needed. According to the literature, this technique, when used at Arizona State University in the USA, has increased the rate of students studying physics by 60-80% (Coven et al., 2014; Hestenes et al., 1992). Constructivist theory is not the only theory used to inform science and physics learning. Several other learning theories that support science and physics are discussed in the next section.

2.5 Learning theories

Understanding how the students learn the science and physics concepts is very important in this research. One of best ways to understand how the student learn science and physics is by studying learning theories. There are numerous theories and perspectives relating to the teaching and learning of science such as Behaviourism, Constructivism, Social Constructivism, the Learning Cycle, the Generative Learning Model and Visual Learning (Ballard, 2011; Siemens, 2005). Each of those theories, with the exception of Behaviourism, was evident in the responses of the students to the questionnaire in the survey and interviews in that those students were explaining ideas about science that made sense to them both in class and outside school.

Behaviourism, which is one of the four main learning theories, was initiated in the early 1900s and turned into a main learning theory in early 20th century by Watson and Skinner (Kim, 2001; Leonard, 2002; UNESCO, 2015). Behaviourism started with animals and transferred to humans (O'Donohue & Kitchener, 1998). For a behaviourist, learned behaviour becomes a habit as a result of reinforcement (Case & Bereiter, 1984) and deals with the behaviour's consequences using reward or punishment (Bandura, 1974). In the middle of the previous century, behaviourism was the main learning theory in education, at least in the USA (Duit & Treagust, 1998).

Constructivism is a result of post-positivist views of science which consider science as a social process. Students engage and construct knowledge actively by not just receiving it from the teacher (Geelan & Fan, 2014). According to Bybee (1997, p. 176), "Constructivism is a dynamic and interactive model of how humans learn". The constructivism model explains "how learning takes place" (Cobern, 1993, p. 105). Furthermore, constructivist theory claims that if a science topic is relevant and connected to familiar things, students are more likely to find it interesting and worthy of study (Harrison & Coll, 2008). Constructivist approaches can be Driver's (1995) Constructivist Teaching Sequence, Concept Substitution, Contrastive Teaching, the Conceptual Change Model, Concept Attainment and Cognitive Development Theory (Treagust, Duit, & Fraser, 1996).

Constructivism comes from the idea that knowledge is constructed, both individually and socially, by the learner (Hein, 1991). Therefore, construction cannot occur without the experience and thinking (Jonassen, 1999). Also, students can help each other by sharing their experiences with each other rather than just receiving contribution of the teacher (Slavich & Zimbardo, 2012). According to constructivist theory in such a constructivist classroom, "the teacher provides students with experiences that allow them to hypothesize, predict, manipulate objects, pose questions, research, investigate, imagine, and invent" (Ballard, 2011, p. 25; Slavich & Zimbardo, 2012).

In constructivism, students construct their knowledge (Brickhouse, 1990). Therefore, according to (Cunningham & Duffy, 1996), students will pass by these stages: applying their existing knowledge and real world experience, learning to hypothesize, testing their theories, trying things that don't work, asking questions, sharing with each other and constructing on their experiences. Constructivist teaching and learning processes are designed to help students acquire more knowledge and especially their enjoyment of learning. Also, they focus on problem solving, critical thinking and deep understanding, rather than memorization. Teaching based in constructivism provides activities, opportunities, tools and environments, which encourage metacognition, self-regulation and self-reflection for students (Fosnot, 2013).

Social Constructivism is built "on the foundation of constructivism, extending into how interacting with others impacts and influences the learning process" (Hill 2012, p. 272). Science education has received more attention from social constructivists

whose perspectives are that culture and environment are very important in the learning process (Duit & Treagust, 1998; Kim, 2001). Social constructivism is a meaningful learning process through human activity and student interaction with others and the environment to create knowledge and social engagement.

The Learning Cycle approach was established following Bruner's theoretical framework and a Piagetian perspective. According to (Adams, 2007), the theoretical framework of Bruner is a constructivist theory which has "an active process in which learners construct new ideas or concepts based upon their current/past knowledge" (p. 73). On the other hand, the Piagetian perspective is a theory about development of children's intelligence which has three phases: Exploration, Concept Introduction and Concept Application (Ballard, 2011). Later on, this approach underwent many modifications such as the 5E Model (Bybee, 1997; Bybee et al., 2006; Hackling, Peers, & Prain, 2007; Tanner, 2010) containing five phases: Engagement (engage the students in a new concept by using short activities), Exploration (generate new ideas by using previous knowledge), Explanation (students explain their new concept), Elaboration (challenge and extend the concept understanding of students) and Evaluation (assess students' understanding and whether or not they meet the educational objectives for achievement).

The Generative Learning Model is "a model of teaching of comprehension and the learning of the types of relations that learners must construct between stored knowledge, memories of experience and new information for comprehension to occur" (Wittrock, 1991, p. 170). Also, this learning model provides a linkage between new and old knowledge and is regarded as essential for young students and unmotivated learners of science (Flick, 1996). Furthermore, according to Lee, Lim, and Grabowski (2008) the Generative Learning Model contains four parts—generation, motivation, learning and knowledge creation—that have been illustrated in a concept map as shown in Figure **2.3**.

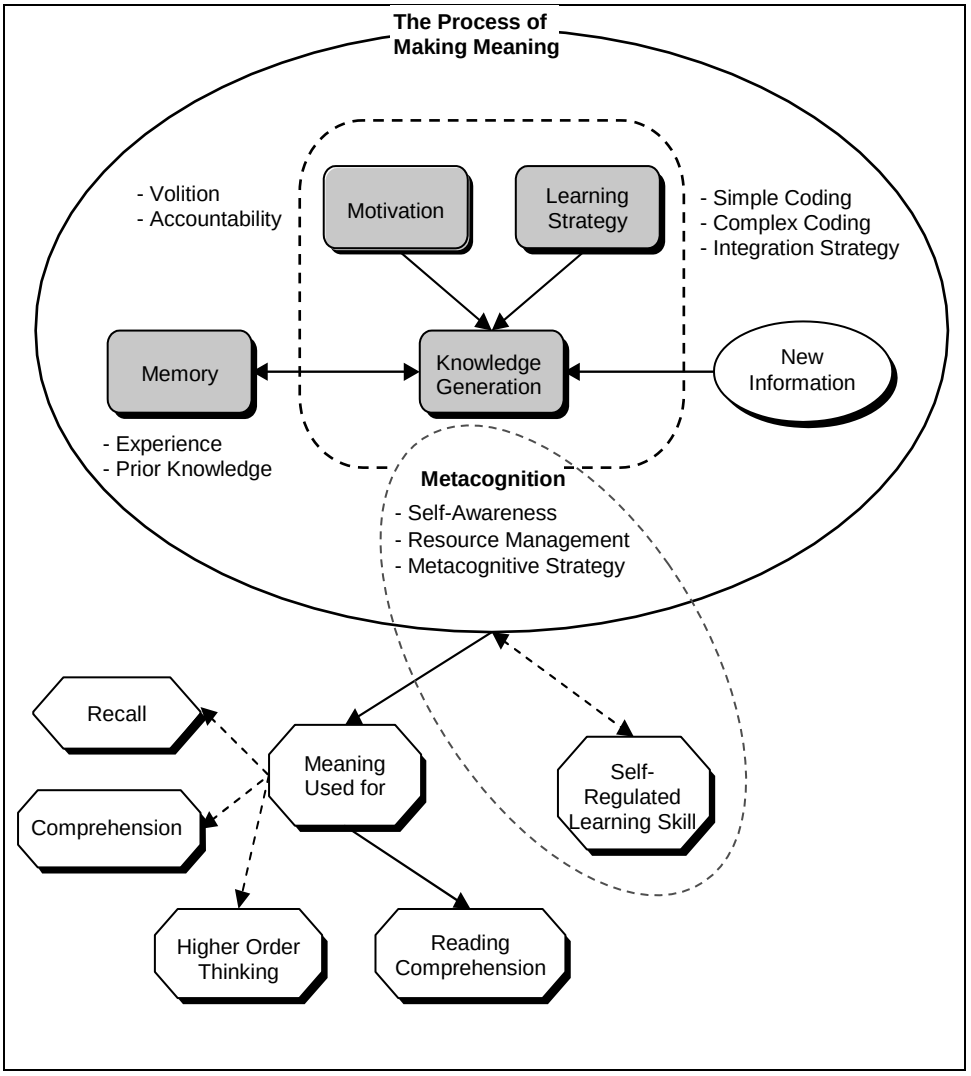

Figure 2.3: Conceptual understanding of generative learning (Lee et al., 2008, p. 113)

Visual Learning is considered one of the best methods for "teaching students of all ages how to think and how to learn" (Harding & Terrell, 2006, p. 3) because visual images make students understand relationships and patterns easily (Gilbert, 2008). Technology development helps to improve the visual learning. A combination of visual learning technique and technology makes students develop more clear views, critical thinking and better information processing (Gilbert, 2008). Moreover, it has been considered that using advanced technology in the class can help improve the students' visual and audio learning experience (Gilbert, 2008).

Learning theories aimed at motivating students' perceptions depend on their stereotype (Lunetta, Hofstein, & Clough, 2010). In the next sections, perceptions, motivation and stereotype will be discussed.

2.6 Perceptions

Perception is “the process by which organisms interpret and organize sensation to produce a meaningful experience of the world” (Dayour, Yendaw, & Jasaw, 2015, p. 2188; Lindsay & Norman, 1977). Another definition of perception is “organization, identification, and interpretation of sensory information in order to represent and understand the environment” (Schacter, Gilbert, & Wegner, 2010, p. 138; Shuaib & Enoch, 2012). These definitions contain five main verbs: *organize, interpret, sense, produce and understand* (Morreale, Spitzberg, & Barge, 2007). Acquired knowledge is gained when passing through these five stages. When applied to the context of learning, acquisition of knowledge involves, first, organizing by concept map, then, interpreting sensations, and finally, producing understandable information (Berionni & Baldón, 2006; Bruner, 2009; Hamlym, 1994). According to Murphy and Whitelegg (2006), “perceptions of relevance are closely linked to and influence what students find interesting and motivating” (p. 21). Self-perception, school connectedness and learning and attitudes are three factors that may have an impact on science achievement (Tighezza, 2014). Also, students’ conceptual learning may be impacted by culture, tradition and practice (Alhammad, 2015; Snively & Corsiglia, 1998).

Perceptions can be presented as a concept map. Indeed, many researchers have built their thoughts as a concept map. From the perspective of generative learning, the student is the controller of information learned (Grabowski, 2004). Because Lee et al. (2008) believe that understanding students’ perceptions of concepts is the main key for improving students’ learning, they designed their conceptual understanding of generative learning as shown in Figure 2.3, where the main idea was initiated by Wittrock (Grabowski, 2004). As depicted in Figure 2.3, knowledge generated from new information needs to create a relationship with memory. Then, students need to utilize different learning strategies, such as a coding to generate the learning process. Also, knowledge generation needs motivation to stimulate the learning process through volition and accountability (Lee et al., 2008). Understanding the concept and knowledge generation can enhance students’ interest (Lee et al., 2008; Wittrock, 1991). Three generative learning processes are related to the regulation of metacognition, which, according to Livingston (1997, p. 1) is “higher order thinking which involves active control over the cognitive process engaged in learning”.

Metacognition is a self-regulated learning skill consisting of self-awareness, student resources management and their learning strategies (see Figure 2.3).

Students' perceptions can be impacted by changing the learning environment. According to Ferguson and Fraser (1998), changing the learning environment from general to specialist subject learning is one of the results of moving to secondary school or in the case of research in this study to higher grades in the secondary school. This change in the learning environment in secondary school can make students feel that science subjects are not similar to the science subjects they studied previously in primary school (Ferguson & Fraser, 1998). In this research, the learning environment is different especially between Year 9 and 10 because Year 9 is the last grade of intermediate school and Year 10 is the first grade in high school (*Educational system in Saudi Arabia*, 2006).

2.6.1 Perceptions of Science and Physics

According to the Scottish Executive Education Department (1999),

> *All young people, not just those intending to follow careers in science, must be scientifically literate. They need to have a good knowledge and understanding of science and scientific ways of thinking in order to function effectively in a global and evolving technological society.....As responsible citizens they will need to be able to evaluate the benefits and risks associated with developments in science and their applications (p. 2).*

A similar situation can be applied to young people in Saudi Arabian schools. According to (Darandari & Murphy, 2013), it is expected that Saudi students need to develop:

> *(1) knowledge, which involves the ability to recall, understand, and present information, including knowledge of specific facts, concepts, principles theories; (2) cognitive skills, which include the ability to apply conceptual understanding; (3) interpersonal skills and responsibility, including the ability to take responsibility for their own learning and continuing personal and professional development; (4) communication, information technology, and numerical skills; and (5) psychomotor skills (pp. 67-68).*

In the context of learning science and physics, there is a proportional relationship between perception and achievement (Cavallo & Laubach, 2001; Harwell, 2000; Kessels, 2005). Moreover, "students' perceptions of their personal ability to achieve or self-concept of ability in science has been described as the attitude of students towards science and self-concept of ability was significantly and positively related to science achievement" (Cavallo & Laubach, 2001, p. 1031). According to Fraser (2012), there are many research findings that proved the relation between "students' cognitive and affective learning outcomes and their perceptions of psychosocial characteristics of their classrooms" (p. 1218). Exploration of students' perceptions helps the teacher to improve the students' achievement (Eilam & Gilbert, 2014). For example, a strategy of physics teaching named, *perceptional approach* was initially used in the Department of Physics at the University of Helsinki, Finland (Kurki-Suonio, 2011). The strategy of perceptional approach in teaching of physics was intended to realise students' own perceptions as a contributor to their practical understanding as an initial point for learning (Kurki-Suonio, 2011). Moreover, physics as a practical science establishes a natural relationship with technology and culture, and thereby has an impact on students' cognitive development (Kurki-Suonio, 2011). Science teaching can be described as a triangle consisting of three corners: Science, phenomenon and the concepts (Tseitlin & Galili, 2005).

2.6.2 Girls' perceptions of science and physics

Several studies have found that even though girls enjoy and are involved in science classes and do outperform boys on different academic tasks, girls' perceptions of their ability in the subject are lower than boys (Brotman & Moore, 2008; Majere, Role, & Makewa, 2012; Spinath, Eckert, & Steinmayr, 2014; Tyler-Wood, Ellison, Lim, & Periathiruvadi, 2012). Moreover, "evidence from both large-scale and small-scale in-depth studies show that gender differences in what students consider personally relevant affect their perceptions of the areas of their competency. These perceptions influence what and the extent to which they choose to engage in learning and assessment situations. The evidence indicates that what boys, more than girls, pay attention to and engage in is generally valued and judged relevant in physics" (Murphy & Whitelegg, 2006, p. 15). Also, the decline in students' participation, especially for

girls, is linked to their perceptions of the relevance of physics to them (Murphy & Whitelegg, 2006).

Research has identified several factors that influence girls' choices of science subjects, namely, "parental support, previous science experiences, teachers, and course selection processes" (Brotman & Moore, 2008, p. 978). Moreover, Hadjar, Krolak-Schwerdt, Priem, and Glock (2014) and Cambridge Primary Review, Alexander, and Armstrong (2010) argued that gender identity and gender-related social perceptions play essential roles in restricting girls' engagement in learning science. Moreover, according to Tyler-Wood et al. (2012), observing the gender stereotype from society helps form girls' perceptions of science. Also, some studies (Betz & Sekaquaptewa, 2012; Howe, Jones, & Rua, 2000; Kessels, 2005; Miller, Blessing, & Schwartz, 2006) have highlighted the need to stop describing science as being difficult, unattractive or unfeminine. According to Al-Ahmadi (2008), there are two reasons behind this: firstly, physics is a subject which appeals more to boys; secondly, the introduction of physics described as a science subject is also more appealing to boys. Moreover, girls understand physics concepts better when they are exposed to a broader world-view (Al-Ahmadi 2008; Stadler, Duit, & Benke, 2000).

In contrast to boys, girls like other science subjects such as biology; they are attracted to those topics that involve helping others (Baker & Leary, 1995; Howe et al., 2000; Miller et al., 2006). Overall, several findings related to gender differences in students' choices and perceptions of science subjects show that girls prefer and choose the biological sciences, whereas boys like and choose the physical sciences (Christidou, 2006; Dawson, 2000; Howe et al., 2000; Miller et al., 2006). Multiple studies (Howe et al., 2000; Kessels, 2005) have shown that students, both boys and girls, have stereotypical views about physical sciences being more suitable for boys and biological sciences being more suitable for girls. And despite girls preferring practical experiments in science (Dawson, 2000; Harwell, 2000), researchers have reported consistently that boys have more extracurricular science experiences than girls, especially in the physical sciences (Christidou, 2006; Howe et al., 2000). Therefore, it was pointed out that girls in particular should benefit from technology-based learning to improve extracurricular science experiences (Cavallo & Laubach, 2001; Heard, Divall, & Johnson, 2000). As mentioned earlier in Chapter 1, "girls' interest in science often declines after elementary school" (Brotman & Moore, 2008, p. 979). Also,

Majere et al. (2012) pointed out that the brain divisions (hemispheres) make serious impact of selecting science for girls because women have a large size of Wernicke's area (major language comprehension centre in the brain). As illustrated by many research studies, the combination of these points is worthy to understand issues that are concerned with gender access to science (Murphy & Whitelegg, 2006; Reid & Skryabina, 2003; Woodward & Woodward, 1998).

In contrast to that view, Skryabina (2000) reported that physics can be more attractive to girls if the content of physics lessons reflects the interests of girls. When a similar disciplinary content was delivered, Skryabina (2000) found that boys and girls had equal levels of interest in topics relating to physics but their interests did not always coincide. If the physics curriculum is designed mainly by men, then it is highly likely that the themes and illustrations would arise from male-orientated interests (Reid & Skryabina, 2002). Moreover, linking the girls students' learning to social settings will help them improve their opportunity to learn mathematics (Tanko & Atweh, 2012).

Both boys and girls are affected by the change in the science learning environment but differences between boys and girls need special attention (Lahelma, 2014). For example, girls and boys who selected to study science at high school had similar cognitive favourites; however, girls who were suggested to take science subjects, but decided not to, had different cognitive favourites, whereas the boys who were recommended did not (Malone & Cavanagh, 1997). Moreover, other studies that investigated gender differences in learning found some differences in students' interests in specific science topics (Baram-Tsabari, Sethi, Bry, & Yarden, 2006; Baram-Tsabari & Yarden, 2005; Christidou, 2006). For example, Christidou (2006) noted that "there were certain gender differences in Greek students, but also there were many areas that appealed equally to girls and boys, including astronomy, light, sound, plants and animals. Both of these studies argued that the current science curriculum does not adequately address the interests of most students, boys and girls and thus proposed curricular changes to address this problem" (Brotman & Moore, 2008, p. 983).

According to Rosser (1989), there are two factors that could discourage girls to study physics, mathematics and engineering. The first factor is isolation. "Because of the current small number of women in science and the *lock-step* sequencing of the courses,

females may be relatively isolated from other women and excluded from informal male networks" (p. 373). The second reason is competition. Mostly, the girls learn very easily with "a cooperative pedagogical method" rather than "a competitive pedagogical method" because girls prefer everyone to win. In a co-educational environment, "it is essential that females be paired with females as laboratory partners because male-female partnership frequently results in the male working with the equipment while the female writes down the observations (she has gained no more experience for her next science course)" (Rosser, 1989, p. 366). However, isolation and competition in the single-sex education, such as the Saudi Arabian education system, is very limited which makes a reasonable reason for girls having high achievement in science and other subjects (Gneezy, Niederle, & Rustichini, 2003; Lee & Bryk, 1986).

2.6.3 Saudi girls' perceptions of science and physics

Saudi Arabia has a special case of education and normal life. Women do not have the same rights as men. Majere et al. (2012), in a study in Kenya where women do have the same rights as men, reported that girls show mostly no significant difference in self-conception (perception) compared to boys. In Saudi Arabia, similar to other nations, boys select science subjects more than girls who still favour the arts subjects. On the other hand, Raven Matrices testing of innate abilities showed that Saudi girls achievement was higher than Saudi boys in science subjects of grades 10 and above (Aljabri & Alahmadi, 2012; Raven, Raven, & Court, 1998).

In Saudi Arabia, education is not yet approaching the government's target (Almazroa & Al-Shamrani, 2015). Science education in Saudi Arabia uses traditional teaching methods mainly based on teachers and textbooks (Alhammad, 2015; Hamdan, 2006). The teacher's way of teaching and learning makes the student expect that the teacher will do everything for him or her (Alhammad, 2015; Litvin, 2010). Moreover, according to Hamdan (2006), both teachers and students believe teaching and learning is mainly for passing examinations in all subjects. Encouraging students to be involved and develop critical thinking is rarely available (Hamdan, 2006). On the other hand, education in Saudi Arabia, like other gulf countries, has single-sex schools in which girls have higher achievement than those in co-educational schools (Wiseman & Anderson, 2015).

2.7 Motivation

Motivation generally is defined as the reason why and what people do (Wentzel & Brophy, 2014). Also, motivation can be known as a need or desire that "energizes people to initiate purposeful action sequences" (Wentzel & Brophy, 2014, p. 3). Similarly, Spinath et al. (2014) defined motivation as "the force that energises and directs experience and behaviour" (p. 234). Each motive has goals and objectives which are distinguishable from one another (Wentzel & Brophy, 2014). Murphy and Alexander (2000) asserted that initiation, direction, intensity, persistence and quality of behaviour have been defined theoretically as motivation. From the social cognitive theory's point of view, motivation is an internal state that raises, guides and supports behaviour to objective (Bryan, Glynn, & Kittleson, 2011). Psychologically, motivation has been defined differently in different approaches. For instance, motivation is defined as: "the process that initiates, guides and maintains goal-oriented behaviours" (Copeland, McNamara, Kelson, & Simpson, 2015, p. 403). From this definition, biologically, emotionally, socially and cognitively, motivation involves activated behaviour and describes the reasons of doing something (Cherry, 2012; Pérez Aguirre & Montes Rodríguez, 2012).

Several studies revealed the relationship between motivation and student behaviour in an attempt to exemplify academic achievement (Bryan et al., 2011; Schunk, Pintrich, & Meece, 2008). Motivation is regarded as "an internal state that arouses, directs, and sustains science-learning behaviour" (Bryan et al., 2011, p. 1050; Glynn et al., 2009, p. 2). Motivating the student to engage fully with learning is vital for enhancing and persisting in the process of learning (Abraham & Barker, 2015; Eccles, 2008). Students are mostly engaged in learning subjects if they are interested in the content (Bathgate, Schunn, & Correnti, 2014; Hidi & Renninger, 2006). Furthermore, motivation is the main enhancement factor helpful to surpass all barriers faced by the students (Al-Jarrah, Muflih, Al-Rabee, & Ghawanmeh, 2014). It has been asserted that the key components of student's motivation are understanding, learning and mastering tasks, which are known by learning goal orientation (Velayutham, Aldridge, & Fraser, 2012; Wigfield & Cambria, 2010).

There are two types of motivation theories: dualism and multifaceted theory (Al-Jarrah et al., 2014; Reiss, 2012). Dualism divides human motives into two types: intrinsic

(internal) and extrinsic (external) motivation (Reiss, 2012). Until the 1940s, "motivation was driven by external factors such as the need to eat and drink, or gain reward or avoid punishment" (Robins, 2012, p. 49). In 1949, Harlow identified intrinsic motivation as being as strong as other motivations (Harlow, 1949; Robins, 2012). On the other hand, "multifaceted theories recognize a number of genetically distinct motives, such as hunger, curiosity, positive self-regard, fear, sex, power, and so on" (Reiss, 2012, p. 152). Students' style of thinking and their response to school are impacted by personal experiences not just classroom experiences (Costa, 1995; Lau & Humphrey, 2014). Moreover, other factors such as family, the teacher, the subject, classmates and the school can help motivate students to study physics (Vedder-Weiss & Fortus, 2013).

The family is the first place where a child's creativity can be discovered and enhanced (Mahdavinejad & Moradchelleh, 2012) because the family is involved in "parenting, communicating, supporting school, learning at home, decision making and collaborating with the community" (Henderson & Mapp, 2002, p. 22). Moreover, parents have responsibility to motivate their children for learning but they can also discourage their children to learn (Pérez Aguirre & Montes Rodríguez, 2012). For example, if parents do not encourage the reading habit for their child, their child will not be excited to read. Also, research shows that the family is one of the main influences on student's attainment of learning goals either in general or in science learning (Sha, Schunn, Bathgate, & Ben-Eliyahu, 2015).

According to Britner (2008), teachers help students build and develop confidence in science at school which later leads to improved achievement and commitment in science. The students' relationship with the teacher potentially influences their approach to learning science (Ferguson & Fraser, 1998). Motivation is considered as an educational goal sought by any educational system, so many teachers seek to raise the motivations of their students by using a variety of teaching methods (Al-Jarrah et al., 2014). Some students are motivated by personal and environmental factors such as interest in physics instruction and the social climate of the physics classes (Abraham & Barker, 2015; Hoffmann, 2002). On the other hand, students who do not have personal and environment motivations may not be able to express their knowledge; they may lose confidence and fail to communicate within the classroom. Therefore, teachers have a responsibility to encourage these students to pursue scientific interests

in higher education (Alhammad, 2015; Chin, 2007; Hodgson & Pyle, 2010; Mortimer & Scott, 2003) and not avoid careers just because they are perceived as feminine and others that are perceived as masculine (BouJaoude & Gholam, 2013). Moreover, the teacher's stereotypical view could impact upon a student's decision to choose science (Kessels & Taconis, 2012).

2.7.1 Motivation for learning science

In examining the relation between motivation and learning science, researchers of science education try to understand the reasons why students struggle to learn science, and what students feel when they try seriously to learn science (Bryan et al., 2011). It is essential to motivate children to learn science at early ages to ignite their motivation and to support their future science learning (Bathgate et al., 2014). However, according to Bathgate et al. (2014), researchers face an issue that restricts their discovery of differences in children's science motivation. The problem is the division of science into different disciplines like physics, chemistry, biology, earth science and astronomy.

Research has shown that values like interest, expectancies of success and gender roles are motivational variables that influence students' science enrolment (Abraham & Barker, 2015). Motivation is not just temporary interest but also "a willingness to come to class, day after day, and put sustained effort into the work of learning science" (Anderson, 2003, p. 5). Bryan et al. (2011) stated that motivated students study science and develop science-learning behaviours that attain goals such as good science grades and careers related to science. Moreover, Bryan et al. (2011) concluded that motivation to learn science is essential and can lead students to scientific literacy, understanding of scientific knowledge, identifying important scientific questions, drawing evidence-based conclusions and making decisions about how human activity affects the natural world.

2.7.2 Girls' motivation for learning science

Motivation is one of the individual characteristics of students (Spinath et al., 2014). For both genders, motivation is essential for their persistence and continuous attention (Lee et al., 2008). Britner (2008, p. 967) recommended that students' interest in the

subject is one of the examples of motivation and can be used to "task goal orientation". Characteristics like experience, social persuasions and physiological state also play a vital role in motivating students towards science; further self-efficiency is impacted by motivation (Britner, 2008). Therefore, motivation is very important for both genders.

It has been noticed that there are gender-specific motivational differences across science disciplines in high school (Britner, 2008). Moreover, gender roles and the practice of physics can play a key role in becoming a competent physicist (Gonsalves, 2012; Velayutham et al., 2012). On the other hand, when a male or female chooses a physical science profession because he or she enjoys it, they each have the same motivation (Hazari, Potvin, Tai, & Almarode, 2012). Though boys are generally more motivated to study physics compared to girls, girls have been found to possess higher extrinsic motivation to study physics and mathematics (Mujtaba & Reiss, 2013). Moreover, girls often have more positive perceptions of their physics teachers and lessons, greater competitiveness and a tendency to isolation (Britner, 2008; Mujtaba & Reiss, 2013; Spinath et al., 2014; Velayutham et al., 2012).

2.7.3 Saudi girls' motivation towards learning science

According to Mansour and Wegerif (2013), culture is a helpful factor to engender motivation and the society and language used in that society can effect motivation and understanding science (Anderson, 2003; Koballa, 2008). In Saudi society, religion is a special motivating factor compared to other cultures (Al-Hariri, 1987) because the Prophet Mohammed said: "Every Muslim, male and female, is requested to seek knowledge" (Al-Hariri, 1987, p. 51). Moreover, educated women in Saudi society are expected to be more successful than other women in Western countries (Abraham & Barker, 2015; Al-Hariri, 1987; Almobaireek & Manolova, 2013). That expectation has come from single-sex education (Ministry of education, 2015) which, it has been suggested, produces enhanced motivation for both boys and girls (Jamjoom & Kelly, 2013). As noted earlier, access to education has increased dramatically between 1990 and 2004, especially for women (Dagher & BouJaoude, 2011). During this period, girls' mathematics achievement in Years 4 and 8 was higher than boys (Mullis et al., 2012). Today, compared to 30 years ago—when girls' participation in Science Technology Engineering and Mathematics (STEM) was very low and most women

were working in education and health (Al-Hariri, 1987) sectors—there are many more colleges that educate girls in STEM disciplines including science and physics (Effat University, 2015; King Abdullah University of Science and Technology, 2015; Ministry of education, 2015).

2.8 Self-image

Self-image can be defined as a student's awareness of his or her individual mental and physical characteristics (Abed, 2014). For example, according to Crocker and Canevello (2012), human beings mostly care about themselves and their needs, and they give some space for other concerns. Moreover, people construct their desired image directly or indirectly to convince others, get acceptance, gain admission into college and so on (Crocker & Canevello, 2012; Gibson & Poposki, 2010). Further, cognitive self-concept is related to self-image (Huitt, 2011) and in general people need to attain positive outcomes rather than negative outcomes. Each person acquires an impression of themselves from others such as the teacher, family, their culture and the society in which they live and these impressions are convoluted to personal perspectives (Crocker & Canevello, 2012; Kessels & Taconis, 2012). According to Abed (2014), there are differences between what the student perceives (Self-image) and what he or she would like to be (Ideal self) as is illustrated in Figure 2.4.

Science identity can be defined from a prototype perspective as a combination of competence, performance and recognition (Carlone & Johnson, 2007). For example, a student can exhibit competence by being able to understand, be motivated to understand and show understandable knowledge, perform his or her competence in a scientific way with others and make others recognize that he or she is a science person (Carlone & Johnson, 2007). On the other hand, it is a serious problem if the student's self-image is low (Alderman, 2013). Therefore, self-image should be considered as a combination of cognitive and emotional parts (Abu-Hilal, Abdelfattah, Alshumrani, Abduljabbar, & Marsh, 2013; Rivera Maulucci, 2013). Therefore, self-image has been included in different teaching and learning strategies to improve a student's opportunities to learn science (Rivera Maulucci, 2013).

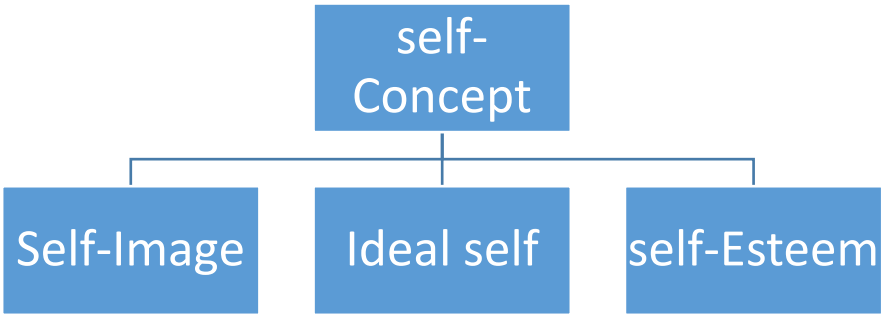

Figure 2.4: Self-Concept umbrella (Abed, 2014)

2.8.1 Girls' self-image

Research has shown that girls are more social and cooperative and are also less competitive than boys in developing a deep conceptual understanding of science and mathematics (Jones et al., 2000; Zohar, 2006; Zohar & Sela, 2003). However, boys and girls have mostly similar self-images; the difference is that girls have more social competence, creativity and emotionality (Hannover & Kessels, 2004; Makarova & Herzog, 2015). Moreover, the self-image for girls can change over the time and circumstances; for example, after the Second World War, the percentage of Swedish girls enrolled in science courses increased, thereby reducing the enrolment gap between males and females in science and physics (Lövheim, 2014). Furthermore, according to Offer, Ostrov, Howard, and Atkinson (1988), traditional gender roles can impact upon the gender differences in self-image. In this way, a girl's self-image is impacted by three vital factors, namely gender, peer relationships and attitudes towards changing appearance during adolescence (Simmons & Rosenberg, 1975).

According to Burrelli (2008) and Hill et al. (2010), women's under-representation in science, technology, engineering and mathematics—the so-called STEM disciplines —is often due to lack of self-concept (Fox, Sonnert, & Nikiforova, 2011; Packard & Nguyen, 2003). Before the 20th century, girls who would like to pursue a career in mathematics and scientific fields faced a daunting situation to exclude family life (MacCorquodale, 1984). Nowadays, girls can choose to have a career in mathematics and scientific fields and a family but do need to "make occupational sacrifices" (Eccles

& Wang, 2016, p. 101). Consequently, though girls have interest in mathematics and science disciplines, their ambition is restricted by different reasons other than competition with men but with feelings of responsibility to care for a family.

2.8.2 Saudi girls' self-image

According to Spencer, Fein, Wolfe, Fong, and Duinn (1998), self-image is threatened by stereotype. Therefore, a Saudi girl's self-image is impacted by the Saudi society's stereotype. Stereotype is defined as "mental picture held in common by members of a group, representing oversimplified opinions, prejudiced attitudes, or judgments" (Rudd, 2014, p. 4). Therefore, stereotype is a generalization of a particular self-image (Claiborne & Sirgy, 2014). For example, Solbrekke and Helstad (2016) showed that:

> Academic writing may increase academic reflection and transform students' self-images about who they are as writers and learners and who they want to become as professionals. Writing has the potential to become a crucial means in students' formation processes. (p. 963)

Moreover, improving Saudi girls' self-image can lead to a positive image of the stereotype (Collange, Fiske, & Sanitioso, 2009) (Collange et al., 2009). Therefore, improving self-image can lead to a rise of the stereotype. Moreover, because the stereotype becomes the role model, self-images are changed by many ways such as advertisement (Claiborne & Sirgy, 2014; Khan, 2013). For example,

> Women' issues in Saudi society and the gender inequalities that are obvious in its education system are institutionalised and difficult to dislodge through individual action…. The rationale for a need to focus on women's achievements in higher education is considered a key social development indicator measuring women's statues and conditions in any country. (Hamdan, 2005, p. 45)

2.8.3 Saudi girls' self-image and science and physics

Science achievement is affected by school connectedness, learning and students' attitudes and their self-perceptions (Tighezza, 2014). These factors play a serious role on the girls' general worldwide view and particularly in Saudi Arabia because school connectedness encourages students to perform better academically (Stromquist, 1989; Tighezza, 2014). In contrast, students who feel disconnected from school are "more

likely to drop out of school" (Tighezza, 2014, p. 724). Also, according to Reda and Hamdan (2015, p. 671), there has been a drop in Saudi girls' enrolment in science, engineering and agriculture courses as a consequence of "gender specialization specific to the Saudi society". It is well known that many Saudi girls are more attracted to arts and the humanities, therefore, it has been argued that for some girls "fashion and science don't mix" (Archer et al., 2010, p. 635).

According to Reda and Hamdan (2015), a woman's stereotype is impacted by life experiences when occupations like a scientist or physicist are perceived as being more masculine careers but a medical profession is more feminine (Reda & Hamdan, 2015). This kind of job segregation between men and women is a result of Saudi social culture discussed earlier (Thompson, 2015). However, there are changes in Saudi society: Saudi women are working in "hospitals, schools, universities, the media and banks" (Alshmemri, 2014, p. 10) and as "doctors, university teachers and professors and businesswomen .. in scientific laboratories, in the press and other media and in factories" (Jamjoom & Kelly, 2013). From these examples, current day Saudi women's life experiences are different from previous decades (Lefdahl-Davis & Perrone-McGovern, 2015).

Another example of the impact of stereotype on gender in Saudi Arabian society is that men have advanced in the utilisation of computers and the Internet because it embodies male values and it has content that favoured men (Baruch, 2014; Hu, Al-Gahtani, & Hu, 2013). Though, women in Saudi comprised 45% of the population, they constitute only 4% of Internet users (Hu et al., 2013). Identifying the reasons for Saudi girls' lower levels of computer and Internet usage, Al-Gahtani (2004) stated that "Saudi girls' curriculum does not include any computer courses until college where only specific majors require a computer basics course" (Al-Gahtani, 2004, p. 21). Also, Saudi women do not have high skills of computer and the Internet until they progress to higher education levels (Al Alhareth, 2013). On the other hand, improvement of education in Saudi Arabia leads Saudi women to be more attracted towards using technology such as personal computers (Almuqayteeb, 2009). For example, women are perceived to benefit more than men by using information technology in health sciences (Juris Bennett, Walston, & Al-Harbi, 2015).

2.9 Saudi culture impacts on girls choosing science and physics

In the past, education in the Arab gulf countries was for preserving and transmitting the traditional culture. But at the moment, the purpose of education is nation-building, building a foundation for economic development and for social change in the knowledge age (G-Mrabet, 2012; Mansour & Al-Shamrani, 2015). The Arabic gulf countries started to teach traditional science fields (physics, chemist and biology) in high school by using imported textbooks designed in the USA without any modification and, subsequently, these were not related to local socio-cultural aspects (Al-khalili, 2015; Hamdan, 2006).

Though, it is recommended that local socio-cultural issues should be taken into account in curriculum development (Alhammad, 2015, p. 121), there is a lack of connection between Saudi culture and science education research in the currently used textbooks (Alhammad, 2015). Moreover, socio-cultural issues—such as "religion, language, economic status, lifestyle, gender, ethnicity, inequality, politics, values, habits, memories and history"—that could be embedded into science education are missing (Ambusaidi & Al-Balushi, 2015, p. 25). Also, the type of learning that forced students to understand information is not related to their background (Hamdan, 2006). There is a strong argument that science education should be related to Saudi culture and this may help close the gap of enrolment in science between boys and girls (Al-Ghanem, 1999; Alhammad, 2015; J. George, 2001) because the relationships between students' attitudes towards science and their socio-cultural backgrounds were significantly positive (Ambusaidi & Al-Balushi, 2015; Kesamang & Taiwo, 2002). For instance, some students preferred to learn the ideas from the surrounding environment rather than from science textbooks (Ambusaidi & Al-Balushi, 2015).

Kranov, DeBoer, and Abu-Lail (2014) stated that women's interest towards STEM can be impacted by their lower status in society compared to men, the education structure and socio-cultural beliefs. In contrast, Alhammad (2015) stated that traditional values set limitations on the education system in Saudi Arabia where women still care about their gender roles and are firmly committed to Islamic values regardless of officially having a larger amount of independence (Litvin, 2010; Yusuf, Al-sharqi, & Durrani, 2015). Moreover, "social, and religious barriers like male authority, family honour, mixing genders, early marriage, and mobility …. played a

significant role in limiting opportunities in higher education for Saudi Arabian women" (Al Alhareth, 2013, p. 653). Also, Alhareth (2014) mentioned that "in general, women in Saudi Arabia live in a prison because they face five types of shackles, namely tribe, family, religious institutions, political organisation and society" (p. 75).

Nevertheless, although some Saudi Arabian cultural traditions and practices have limited women's education in the past, nowadays educational opportunities for females are equal to those for males and women do aim for more careers other than teaching and medicine (Hamdan, 2005, 2006). Recently, Saudi women have attained the highest career level as members in the Saudi Consultative Assembly and others are also leading ministries (Al-Gazali, 2013; Al Rashedi et al., 2015; Reda & Hamdan, 2015; Thompson, 2015).

Recent studies revealed that more than 60% of students with a Bachelor's degree in science were females (Al-Gazali, 2013; Shen, 2013); and they are contributing to the national economy in Saudi Arabia through working in both the government sector (35% of employees in the public sector are women) and private sector (35% of Saudi women working in the private sector) (Alzahrani, 2012). Furthermore, there are many Saudi women professors within the higher education system (Reda & Hamdan, 2015). Though this trend shows that science is attractive for Saudi girls, the number of female science researchers and engineers is still very low because of the impacts of Arabic traditions and culture (Al-Gazali, 2013). Moreover, Saudi society still tends to concentrate women's education around "teaching, human sciences, natural sciences, and Islamic studies" (Reda & Hamdan, 2015, p. 671).

2.10 Saudi girls' careers and science and physics

The 'leaky pipeline' is a metaphorical expression used to explain the situation of girls with science, technology, engineering and mathematics (STEM) careers (Abraham & Barker, 2015; Clark Blickenstaff, 2005). However, one way to increase the number of females participating in science careers is to improve females' perceptions of science from elementary levels (Tyler-Wood et al., 2012). Moreover, exploring reasons for girls' under-representation in high school physics may help eliminate the impact on the future such as teaching and economic productivity (Hannover & Kessels, 2004;

Mitrevski & Treagust, 2011), and the possibility of working in science related fields during high school could play an essential role to improve girls' scientific ability (Haworth, Dale, & Plomin, 2010; Velayutham et al., 2012). Supporting women to close the gap in science is required not just for women's rights but also to ensure that "women represent potential reserves of scientific talent" (Britner, 2008, p. 957). Moreover, Women's Internalization of Stereotypes Scale (WISS) asserted:

> three dimensions of attitudes towards women in science: (1) women possess characteristics that enable them to be successful in science careers, (2) women's roles as mother and wife are compatible with successful science careers, and (3) women and men should have equal opportunities to pursue science careers. (Owen et al., 2007, p. 1465)

According to Al Rashedi et al. (2015), religion, social, traditional and economic conditions remain as challenges for integrating women in the workforce in Saudi Arabia. From a social perspective, Saudi Arabia, as one of the developing countries, makes education a fundamental right of citizenship for boys and girls in an effort to improve education to support economic and social development (Forawi, 2015; Mansour & Al-Shamrani, 2015). Therefore, improving girls' participation in science would help prepare future generations in STEM disciplines, which are related directly or indirectly to physics. On the other hand, due to the lack of vision for the future, poor families are less motivated to encourage their children to choose a better education, which ultimately leads to limited future career opportunities (Aljabri & Alahmadi, 2012).

According to the Federal Research Division and Library of the United States Congress, wealthy Islamic countries do not have many women in the workforce in different fields, but developing Islamic countries such as Indonesia, Turkey and Tunisia have increased the number of women participating in the workforce (Offenhauer, 2005). However, the ratio of female workers to male workers in Saudi Arabia is around (22:78) much similar to Tunisia (20:80), Egypt (25:75), Syria (20:80), Yemen (25:75) and Jordan (17:83) (Hu et al., 2013). To increase female participation in the workforce, the government of Saudi Arabia has changed its strategies related to women such as the three events about these changes mentioned by Meijer and Wagemakers (2012). Firstly, the Saudi government Ministries of Labour and Social Affairs and Health have made especial divisions for women; secondly, the Ministry of Education has

recognized several careers such as receptionists, photographers and nutritionists that provide more opportunities for women and thirdly, there is a new strategy for women to occupy positions in the food processing industry such as a shrimp factory in Jizan. Further, the Saudi Vision 2030 encourages Saudi women to create their own business careers similar to those of men (*Saudi Vision 2030*, 2016).

2.11 Saudi girls' career and STEM areas

Moreover, according to the Saudi Council of Engineering (2015a, 2015b), Saudi women engineers are cooperatively working with men in the field contributing to the nation's improvement. These Saudi women engineers have earned their qualifications in one of three ways: Saudi government universities like King Abdulaziz Univesity (2015) and King Abdullah University of Science and Technology (2015); Saudi private universities such as Effat University (2015); and King Abdullah scholarship program (Ministry of education, 2015). Moreover, according to AlKhataf (2013), there are now hundreds of Saudi women engineers in the workforce.

2.12 Summary

This chapter has presented a variety of research perspectives concerning education in Saudi Arabia, learning theories, perceptions, motivation, self-image, education and culture and career. Development of education in Saudi Arabia, especially for girls, has been illustrated from pre-primary to higher education.

The reviewed literature has shown the factors impacting science education and its disciplines, including physics education. Issues relating to science education in the Saudi system and their improvement were identified. Moreover, the main learning theories and the reasons for creating them were reviewed. Theories of behaviourism, constructivism, social constructivism, learning cycle approach, generative learning model and visual learning technique were discussed.

The literature about perception, its definition and its relation with science and physics were reviewed and presented in a concept map. Girls' perceptions of science and physics, learning difficulties and solutions have been stated. Different cultural issues were discussed about Saudi girls' perception of science and physics. Also, motivation was defined and the main examples of motivation such as family and school teachers were expressed. Motivation, girls' motivation and Saudi girls' motivation towards

learning science were discussed. Furthermore, Self-image has been defined and the relation between self-concept and self-image was identified. Girls' and Saudi girls' self-image related to science has been stated.

How culture impacts upon the curriculum requirements have been debated and the impact of changing the Arabian Gulf's culture on science education was examined. It was asserted that a majority of higher education students in Saudi Arabia are females and that Saudi women would like to work in the professions of teaching or medicine. Those issues impacting on Saudi girls' careers in science and physics were argued as well as factors that can help girls improve their ability to study science. The relationship between Saudi girls' career and STEM was briefly discussed.

The main sources of this research are on the Western education system Glynn et al. (2009); Hannover and Kessels (2004); Hollins et al. (2006); Mitrevski and Treagust (2011); Taconis and Kessels (2009). These studies showed that most of Arabic educational research focuses on the development of the science curricula. In this research, we tried to similarly look at the main issues which is to focus on the curriculum experinced by the Saudi girls students.

Chapter 3
RESEARCH METHODOLOGY

3.1 Introduction

The purpose behind this study was to explore Saudi girls' perceptions, motivations, self-image and science career perspectives. This chapter describes and clarifies the methodology and research methods utilized by the researcher in answering the five research questions. Research Questions 1 to 3 are answered by analysis of the quantitative data. Research Questions 4 and 5 are answered by analysis of the qualitative data.

1. What are Saudi girls' perceptions of science and physics?
2. What are Saudi girls' motivations for learning science?
3. Does physics match Saudi girls' stereotype of a scientist or physicist?
4. How does Saudi culture impact on girls choosing science?
5. How does choosing science subjects impact on Saudi girls' future careers?

This chapter is partitioned into nine parts each representing an alternate part of the methodology utilized in this research. Section 3.2 describes the girls who participated in the study. Section 3.3 expresses the results of the pilot trial used to validate the instruments of the research. The research standards are discussed in Section 3.4 which stresses the utilization of the mixed methods design. The progressions of the data collection procedures are introduced in Section 3.5. The data analysis and their interpretation are introduced in Section 3.6. A vital component of the research is the affirmation of data quality; to meet this objective, criteria utilized to evaluate the study's quality are exhibited in Section 3.7. Ethical issues relating to the research are clarified in Section 3.8. Section 3.9 concludes this part of the thesis.

3.2 Participants

Almost 1000 girl students (178 students in the pilot study and 800 in the main study) participated in this study. Participants are selected by class rooms from three different schools. Two types of data were collected from the students—quantitative data from a pencil-and-paper instrument or questionnaire and qualitative data from interviews (Creswell, 2013; Creswell & Clark, 2007; Treagust, Won, & Duit, 2014). For the main study, quantitative data were collected from a sample of 800 female intermediate and

high school students who were in Years 9, 10 and 11 in the north of the city of Jeddah, which is the largest city in western Saudi Arabia. In total, 269 girls answered the questionnaire from Year 9 when the students study science as a subject; 265 students answered the questionnaire from Year 10 when students study physics as a subject; and 266 students in Year 11 responded to the questionnaire, with half of them from the science stream where students study physics as a subject and the other half from the literary stream not studying science and physics. The students in each year level were asked to list their four most and least favourite school subjects. Following the students' responses, the cohort in each year level was separated into two groups: one group with most favourite subjects and the other with least favourite subjects (Hannover & Kessels, 2004) (see Appendix A, Items 7 and 8). Data were collected from the Arabic translated instruments. To confirm the Arabic translated instrument, which was done by the researcher, another person fluent in Arabic and English back translated the instrument to the English original. A third person compared the two English versions for consistency.

Interviews were conducted with a sample of 35 female students who were in Years 9 (n = 9), 10 (n = 8) and 11 (n = 18) from a high school. The interviewed participants were selected randomly by teachers. The interview questions were translated to Arabic. The students' answers were recorded in Arabic and were later translated into English by the researcher.

3.3 Pilot Study

This section of the chapter discusses the planning of the pilot trial. The pilot study was intended to examine the results from a small scale implementation of the study and to explore whether the planned investigation was defective in any way. The pilot study likewise ensured that all the required data could be collected before advancing to the methods connected with the principal research. The pilot phase of the study included modifications to the adopted instrument, translation of the contents into Arabic and trial testing of the translated instrument with 179 girl students from different intermediate and high schools who were not included in the main study. The motivation behind the pilot study was to validate the Arabic version of the modified form of the instrument. Details of the pilot study are presented in Chapter 4.

Back translation. The original instrument was intended for Western students, and according to the recommendation of Brislin (1970, 1980), English statements need to be translated carefully and back translated by another person to the original. The researcher translated the instruments to the Arabic language. The Arabic version was then back-translated by a different person who speaks and writes English and Arabic fluently and who was not included in the first translation. It is essential to make sure that the contents of both original and back-translated versions of the questionnaire in the survey have the same meaning.

Checking time constraints and meaning. Another benefit of the pilot study was to help check the time needed (for the students) to complete the questionnaire survey, and receive feedback on the format and the ease of reading the survey. The researcher observed no issues in the administration of the survey with the classes. The participants did not recommend any issues relating to their understanding of the meaning of the Arabic statements in the questionnaire in the survey. The above discussed procedures further indicate that the Arabic-interpreted survey met the objective for gathering the data as all of the statements were clearly written and verified.

3.4 Mixed methods design

Quantitative research is often used to provide an explanation or prediction about the relationship among variables in a study, and how and why the variables are related. Furthermore, any explanation or prediction should be justified by the underlying theory used in the research study (Creswell, 2013). On the other hand, “in qualitative research, inquirers employ theory as a broad explanation, … It may also be a theoretical lens or perspective that raises questions related to gender, class, race, or some combination of these” (Creswell, 2013, p. 74).

Moreover, mixed methods research is defined as “an attempt to legitimate the use of multiple approaches in answering research questions, rather than restricting or constraining researchers' choices” (Johnson & Onwuegbuzie, 2004, p. 17). Qualitative and quantitative research approaches have basic agreement on several major points. For example, what appears reasonable for one person can vary for others (the relativity), also reality cannot be observed perfectly. Moreover, data can fit to more than one theory (Johnson & Onwuegbuzie, 2004). Utilizing a mixed methods approach

has both strengths and weaknesses as shown in Table 3.1. Utilising numerous approaches in a mixed methods study can improve the validity of any findings with a high level of accuracy, and provide opportunities for quality explanations to the undertaken research questions (Erickson, 2011; Golafshani, 2003). Therefore, this research utilized a mixed methods design using quantitative and qualitative data. However, numerous techniques need to be taken into account while looking for best results such as quantitative and qualitative data, individual and group interviews, face-to-face or remote interviews and short or long engagement (Creswell, 2013).

Table 3.1: Strengths and Weaknesses of Mixed Methods

Strengths	Weaknesses
- Words, pictures and narrative can be used to add meaning to numbers. - Numbers can be used to add precision to words, pictures and narrative. - Can provide quantitative and qualitative research strengths. - Researcher can generate and test a grounded theory. - Can answer a broader and more complete range of research questions because the researcher is not confined to a single method or approach. - A researcher can use the strengths of an additional method to overcome the weaknesses in another method by using both in a research study. - Can provide stronger evidence for a conclusion through convergence and corroboration of findings. - Can add insights and understanding that might be missed when only a single method is used. - Can be used to increase the generalizability of the results. - Qualitative and quantitative research used together produce more complete knowledge necessary to inform theory and practice.	- Can be difficult for a single researcher to carry out both qualitative and quantitative research, especially if two or more approaches are expected to be used concurrently; it may require a research team. - Researcher has to learn about multiple methods and approaches and understand how to mix them appropriately. - Methodological purists contend that one should always work within either a qualitative or a quantitative paradigm. - More expensive. - More time consuming. - Some of the details of mixed research remain to be worked out fully by research methodologists.

Source: (Creswell, 2013; Johnson & Onwuegbuzie, 2004)

The research questions are answered based on the quantitative and qualitative data; Research questions 1 to 3 relate to the quantitative data, whereas, research questions 4 and 5 relate to the qualitative data (Creswell & Clark, 2007). The way of understanding the data is by using different analysis techniques (Johnson & Onwuegbuzie, 2004). In this research, the results from quantitative analytical testing of data provided responses about high school girl students' science/physics motivations, perceptions, self-image and future careers. Interviews provided deep and detailed information.

3.5 Quantitative Data Collection

The instrument used in the research study contains 11 questionnaire items as shown in the following subsections and in Appendix A. The questionnaire survey instrument was developed by the author as explained in this section. The instruments were administered to the participants in the school by the teachers. Answering the instruments was under supervision of the author. All of the surveys were done in the lessons. Each lesson lasted for 45 minutes, the students took approximately 10 minutes to answer the instrument, and all students completed the instrument within this period of time.

3.5.1 Demographic information

Item 1: Students' demographic information such as age, sex, grade and mother tongue.

3.5.2 Profile choice

Item 2: Students' study profile choice reveals their decisions about which subjects/classes they want to choose/attend. (This Item was designed by Taconis and Kessels (2009). See Table 3.2 and Appendix A.

Table 3.2: Sample Item (profile choice)

Profile choice	Science	Literary
Why:	----------	----------
	----------	----------

3.5.3 View of Science

Item 3: View of science describes the participants' views of science as a subject in school (This item was constructed by Hollins et al. (2006) and Mitrevski and Treagust (2011). See Table 3.3 and Appendix A.

Table 3.3: Sample Item (view of science)

	Strongly Disagree				Strongly Agree
I like science because it's interesting	1	2	3	4	5
I like science because I get to discuss issues that are important	1	2	3	4	5
I like science because it's relevant to my life	1	2	3	4	5
I like science because it's relevant to the kind of work that I want to do	1	2	3	4	5
I like science because I get to discuss issues that are important	1	2	3	4	5

3.5.4 Different Interesting Science Topics

Item 4: Different interesting science topics (This item was constructed by Hollins et al. (2006) and Mitrevski and Treagust (2011). See Table 3.4 and Appendix A.

3.5.5 Understanding Different Science Topics

Item 5: Understanding different science topics. (This item was constructed by Hollins et al. (2006) and Mitrevski and Treagust (2011). See Table 3.4 and Appendix A.

Table 3.4: Sample Items 4 and 5 (same questions for interesting and understanding different science topics)

	Not at all				Very much
How the heart works	1	2	3	4	5
Light waves: reflection and refraction	1	2	3	4	5
Rocks and metals	1	2	3	4	5
Circuit symbols and devices	1	2	3	4	5
Respiration	1	2	3	4	5
The planets	1	2	3	4	5

3.5.6 View of physics

Item 6: View of physics. (This item was constructed by Hollins et al. (2006) and Mitrevski and Treagust (2011). See Table 3.5 and Appendix A.

Table 3.5: Sample Item (view of physics)

	Strongly Disagree				Strongly Agree
Physics is very relevant to the work I want to do	1	2	3	4	5
I find physics very practical but it is boring	1	2	3	4	5
Physics is important to study because it helps me to understand the world	1	2	3	4	5

3.5.7 Most Favourite Subjects

Item 7: Describe the most four favourite subjects. (This item was used by Hannover and Kessels (2004) .See Appendix A.

3.5.8 Least Favourite Subjects

Item 8: Describe the least four favourite subjects (This item was used by Hannover and Kessels (2004). see Appendix A.

3.5.9 Rank School Subjects

Item 9: Rank the 11 school subjects. (This item was used by Taconis and Kessels (2009). see Appendix A.

3.5.10 Motivation

Item 10: Motivation (This questionnaire was used by Glynn et al. (2009). See Table 3.6 and Appendix A.

Table 3.6: Sample Item (Motivation)

	Never				Always
I enjoy learning the science.	1	2	3	4	5
The science I learn relates to my personal goals.	1	2	3	4	5
I believe I can earn a grade of "A" in the science course.	1	2	3	4	5
Understanding the science gives me a sense of accomplishment.	1	2	3	4	5

3.5.11 Stereotype

Item 11: Students' stereotype (This item was constructed by Hannover and Kessels (2004). See Table 3.7 and Appendix A.

Table 3.7: Sample Item (Stereotype)

		Totally Agree						**Totally disagree**
1.	Respected	1	2	3	4	5	6	7
2.	Arrogant	1	2	3	4	5	6	7
6.	Sought-after	1	2	3	4	5	6	7
7.	Popular	1	2	3	4	5	6	7
19.	Sensitive	1	2	3	4	5	6	7

3.5.12 Sources for Questionnaire Items

Table 3.8: Sources for Questionnaire Item

Item	Source	Item	Source
1	It is used for general purpose	2	A
3	B, C	4	B, C
5	B, C	6	B, C
7	D	8	D
9	A	10	E
11	D		

Note: A) Taconis and Kessels (2009). B) Hollins et al. (2006). C) Mitrevski and Treagust (2011). D) Hannover and Kessels (2004). E) Glynn et al. (2009).

3.5.13 Relationship between Research Questions and Quantitative Data

The relation between research questions and qualitative data is revealed in Table 3.9

Table 3.9: Relationship between Research Questions and Quantitative Data

	QUESTIONNAIRE DATA	DATA SOURCE
1.	What are Saudi girls' perceptions of science and physics	Item 3: View of science Item 4: How interesting do you find different science topic Item 5: Experiences of science in school: indicate how much you think your understand about different science topics Item 6: What is physics?
2.	What are Saudi girls' motivations for learning science	Item 10: Motivation Questionnaire
3.	Does physics match Saudi girls' stereotype of a scientist or physicist?	Item 7: Describe the most four favourite subjects in Math/ Arabic/ Science/ English Item 8: Describe the least four favourite subjects in Math/ Arabic/ Science/ English Item 9: Rank the 11 school subjects according to your personal preference Item 11: You have an image in your mind while thinking about a girl which likes the subject science the most. Represent on the questionnaire to describe what is typical for her

3.6 Qualitative Data Collection

Interviews can provide information that is more authentic compared to a questionnaire survey (Lewin, 1990). There are two kinds of interviews. The first is a semi-structured interview where the researcher has an arrangement of interview questions (Smith, 1995) which are presented as a conversation about a topic which the researcher wants to investigate and have a list of questions (Fylan, 2005). However, the discussion is open and not done in a particular order and can change significantly between participants. The second type is a structured interview, where the researcher is guided by the schedule of questions instead of being directed by it (Smith, 1995). Structured

interviews are like “questionnaires administered verbally” because they are done in the same order for each participant (Fylan, 2005, p. 66).

In this research study, semi-structured interviews began with a discussion of the student’s current science and physics course and gradually moved to questions about their past and present science (physics) experiences and perceptions in and outside of school. In addition, the interview was designed to learn about the students’ social networks, hobbies and activities; their peer and family expectations and actions related to science and physics involvement; their perceptions of science/physics and scientists; sense of self-learning and doing science; influence of gender and ethnicity on their lives, particularly as related to science/physics and scientists opportunities; and their dreams and plans for their future career and in university (Aschbacher et al., 2010). A complete list of questions used in the semi-structured interviews in this study is included in Appendix B.

3.6.1 Impact of culture on the Saudi girls choosing science

This topic was discussed in response to Research Question 4. The researcher utilised students’ responses to 11 interview questions (3, 7, 8, 9, 10, 11, 12, 13, 14 and 15 as shown in Appendix B) for answering Research Question 4.

3.6.2 Impact of choosing science subjects on Saudi girls’ future careers

This topic was discussed in response to Research Question 5. The researcher utilised students’ responses to seven interview questions (1, 2, 4, 5, 6, 7, 15 and 16 as shown in Appendix B) for answering Research Question 5.

3.7 Data Analysis Procedures and Interpretation

Finding answers to the research questions from the collected data mainly depends on the selection of correct data analysis procedures. In this section, the researcher attempts to express the ways of analysing both the quantitative and qualitative data.

3.7.1 Quantitative Analysis

The procedure for the analyses of quantitative data obtained via a questionnaire survey consisted of many stages. First, the data have been tabulated and descriptive statistics such as means and standard deviations for the responses to all items in the

questionnaire were computed. This stage identified the background characteristics of the respondents so that they can be used to represent to the target population. The second stage involved comparison of groups, such as age and year levels and examining the association among variables by using appropriate statistical procedures. Examples of quantitative data analyses include reliability, validity, mean, standard deviations, correlations and regression analyses.

The Statistical Packages for Social Science (IBM-SPSS) computer software 20 for Windows was used to statistically analyse the quantitative data (Nie, Bent, & Hull, 1975). SPSS helped the researcher to estimate Cronbach's alpha reliability and discriminant validity values.

3.7.1.1 Reliability coefficients

Consistency of a trial or any implementation of quantitative data is measured by reliability coefficients (Wiersma, 2009). The Cronbach alpha coefficient is one way to determine reliability; a value of more than 0.70 is acceptable in the kind of questionnaires used in this study (Pallant, 2013). In this type of this research, it has been suggested that high reliability is an essential criterion for making decisions. In the questionnaire development, it is necessary to establish a test for each item in a scale to measure a common construct, then the scale can be mentioned as homogenous or having internal consistency (Creswell & Clark, 2007).

3.7.1.2 Validity

Validity is like understanding the concept and link between what we want and what we use to measure (Roberts, Priest, & Traynor, 2006). Therefore, the researcher in this study needed to guarantee what the trial measures were intended to measure. Moreover, validity depends on whether or not the instrument is well-constructed and the content covers the research area (De Silva et al., 2006). Therefore, the researcher needed to ensure that the measure covers the broad range of areas. Therefore, the researcher ensured that the questionnaire was related to the research questions and measured the required information. Moreover, the researcher ensured that the participants understood the questionnaire survey.

3.7.1.3 Descriptive statistics

The mean or average central value of the scales' scores is the sum of the values of scales' scores in a distribution divided by the number of scores in the distribution (Wiersma, 1995, 2009). The mean is the most important and common measure utilized to analyse the data average and central tendency. Moreover, measuring the variation is essential. Standard deviation is the most commonly applied to measure the variation and is a measure of variability that is the positive square root of the variance (Wiersma, 1995, 2009).

In this study, both means and standard deviations were used for the quantitative survey to understand the nature of participants who responded to the questionnaire and helped the researcher to answer the research questions (Epstein, Cullinan, Harniss, & Ryser, 1999).

3.7.1.4 Correlations and regression analysis

A correlation coefficient is a statistical test to measure "the strength and direction of the linear relationship between two variable" (Pallant, 2013, p. 133) and also is a description of the relationship between variables that allows for prediction of the value of one variable from other variable value. For example, a correlation between variables indicates "that when the variable is available at a certain level, other variables tend to be at a certain level" (Jackson, 2015, p. 158). Correlation coefficients can be a simple correlation, such as Pearson product-moment correlation coefficient (PPMCC), or can be multiple correlation which is the relation between dependent variables and a weighted composite of independent variables (Abdi, 2007). Regression analysis is the advanced correlation technique with more sophisticated exploration of the interrelationship among of variables (Jackson, 2015; Pallant, 2013). Also, regression has an advance type known as multiple regression analysis, which examines whether or not a set of variables predict a particular outcome (Pallant, 2013). Multiple regression has different types: standard, hierarchical and stepwise (Pallant, 2013). Correlation coefficients and regression analyses were utilised to find out the relation between Saudi girls in different year levels (Year 9, 10 and 11) in their views of science/physics and the impact on their perceptions, motivations, self-image, culture and future careers. Univariate Analysis of Variance and t-tests were used.

3.7.1.5 Factor analyses

3.7.1.5.1 Factorization of Motivation questions

The Motivation questionnaire by Glynn et al. (2009) was administered to the students in the main study and the data subjected to factor analysis resulted in four factors which were designated as Confidence, Enjoyment, Liking for Science and Extrinsic Motivation (see Table 3.10 below and Table 5.13 and Section 5.4.1 for the analysis).

Table 3.10: Factorisation of Motivation questions

Question No#	Question
Confidence	
Q17	I am confident I will do well on the science tests.
Q14	I believe I can master the knowledge and skills in the science course
Q18	I believe I can earn a grade of "A" in the science course.
Enjoyment	
Q15	The science I learn has practical value for me.
Q13	The science I learn is relevant to my life.
Q12	I find learning the science interesting.
Q16	I like science that challenges me.
Motivation	
Q4	I become anxious when it is time to take a science test.
Q6	I worry about failing the science tests.
Q3	I am nervous about how I will do on the science tests.
Q9	I hate taking the science tests.
Q7	I am concerned that the other students are better in science.
Relevance	
Q2	The science I learn relates to my personal goals.
Q5	I think about how the science I learn will be helpful to me.
Q8	The science I learn is more important to me than the grade I receive.
Q10	I think about how I will use the science I learn.
Q19	Understanding the science gives me a sense of accomplishment.

3.7.1.5.2 Factorization of prototype questions

The prototype questions, based on data from the main study, were subjected to factor analysis, resulting in three factors. Those factors are Intelligence & motivation, Physical, social & emotional attractiveness and Social competence (see

Table **3.11**). (See Section 5.5 and Subsection 5.5.2 for the analysis).

Table 3.11: Factorisation of prototype questions

Question No#	Question	Question No#	Question	Factor
Q1	Respected	Q29	Outgoing	Intelligence & motivation
Q4	Open-mined	Q33	Appreciates	
Q5	Persistent	Q35	Logical	
Q6	Sought-after	Q40	Imaginative	
Q11	Ambitious	Q41	Eloquent	
Q15	Emotional	Q44	Smart	
Q16	Diligent	Q47	Self-confident	
Q25	Intelligent	Q49	Motivating	
Q26	Interested	Q63	Eager to learn	
Q28	Clever	Q64	Witty	
Q3	Attractive	Q34	Easy-going	Physical, social & emotional attractiveness
Q12	Empathetic	Q36	Fashion	
Q17	Cheerful	Q42	Romantic	
Q18	Educated (emotionally)	Q45	Pretty	
Q19	Sensitive	Q50	Spontaneous	
Q23	Stylish	Q51	Athletic	
Q24	Good-looking	Q52	Sparkling	
Q30	Body-aware	Q57	Courted	
Q13	Lonely	Q54	Dry	social competence
Q14	One-sided	Q55	Stubborn	
Q27	Isolated	Q56	Inexperienced	
Q32	Boring	Q58	Inhibited	
Q37	Smart-aleck	Q61	Unworldly	
Q48	Self-centred	Q62	Pompous	

3.7.2 Qualitative Analysis

The most critical task in research, for both qualitative and quantitative, is to identify the important variables in the data (Lauer & Asher, 1988). One of the differences between qualitative and quantitative research is that analysis and interpretation of qualitative data is an immediate activity following observation, document reading and interviewing (Maxwell, 2012). In qualitative research, the researcher needs to translate the data twice, first from the participant discussion to written text, and then to new text by analysis (Nielsen, 1995).

In this research, for social circumstances discussed earlier, the interviews were recorded as text without the use of any digital equipment. Similar to the questionnaire

data analysis, the analysis of the interview data had passed through many steps. Firstly, the interview data were translated from Arabic to English. Secondly, a summary matrix of the data was created. Thirdly, the students' interview data were explored more deeply to understand how students talked about their lived experiences in school. Fourthly, the researcher identified relationships across data points and systematically looked within and across categories for possible relationships between science identity and performance, demographics and school/academy attended. Finally, the researcher found the group summaries, comparing and contrasting them as a way to explore and clarify group characteristics and boundaries (Wasserman & Faust, 1994).

3.8 Quality Criteria of the Study

If the data analysis were done accurately in response to the research questions, the result should be meaningful to the individuals (LeCompte, 2000). There is no single interpretation but care should be taken about the criteria used for evaluation purposes and should stress that "situated, relational, and textural structures of the ethnographic experience" (Denzin & Lincoln, 2008, p. 30). The following sections illustrate the standard for judging the soundness of the qualitative data to satisfy answering Research Questions 4 and 5 accurately.

3.8.1 Validity

Qualitative data validity links to truth issues, statement correctness and accurate measurements (Kvale & Brinkmann, 2009). There are three types of validity: (1) Internal validity (credibility), (2) External validity (transferability) and (3) hallmark validity (authenticity).

3.8.1.1 Credibility

For qualitative data, internal validity is preferred to be called credibility and is defined as "the extent to which variations in an outcome or dependent variable can be attributed to controlled variation in an independent variable "(Guba & Lincoln, 1989, p. 234). There are six basic approaches to ensure credibility (Guba & Lincoln, 1989; Merriam, 1991): (1) triangulation incorporates utilizing numerous information sources or different strategies to affirm emerging findings (this research utilises both qualitative and quantitative data); (2) member checks take information and translations

back to the participants and ask whether the results are reasonable; (3) long-term observations in the school or repeated observations of the same phenomena; (4) peer examination requesting partners for their comments on the findings; (5) participatory methods of exploration that include members in all periods of exploration; and (6) researcher's biases to clarify the researcher's expectations, perspectives and hypothetical introductions at the beginning of the study.

Credibility was addressed in this research by using approaches (4) and (6). Peer examination took place through discussion with the supervisor and with fellow doctoral students on a regular basis.

3.8.1.2 Transferability

Similarly to internal validity, Guba and Lincoln (1989) preferred to use the term transferability to generalizability. Transferability is concerned with the degree to which the discoveries and results of the study can be connected or can be generalized to different circumstances (Cohen, Manion, & Morrison, 2000; Merriam, 1998). Transferability requires sufficient descriptive data (Guba & Lincoln, 1989) which is made by the main researcher to enable another to judge and transfer the finding to a new framework.

Transferability in this research requires thick descriptions which the researcher provided for the settings of Saudi girl students and the education system in Saudi Arabia that included details about the context of the investigation.

3.8.1.3 Authenticity

According to Guba and Lincoln (1989, 1994), authenticity is a trustworthy guarantee and rigorous enquiry that includes fairness, educative authenticity and catalytic authenticity. Fairness is part of authenticity which means that the researcher is trying to avoid the study participants from being marginalized and to guarantee that all information is revealed in the text (Onwuegbuzie, Leech, & Collins, 2008). The researcher and participants' awareness of the criteria for research and its social purpose is known as educative authenticity. In this research, the voices and perspectives of many of the Saudi girl high school students were included.

3.8.1.4 Reliability

For interviews, reliability is defined as the degree of data stability over time and the degree to which discoveries may be duplicated (Guba & Lincoln, 1989; Merriam, 1998). Achievement of high reliability interview data with a different set of unique participants is always desired (Warren & Woodall, 1999); individual interviews with standardised questions make the highest reliability (Conway, Jako, & Goodman, 1995). In this research, the researcher standardised the questions for all interviewers in an effort to get clear answers from each participant. The description of quantitative and qualitative data collection in Sections 3.5 and 3.6 is intended for other researchers to follow the same procedure to carry out a similar study.

3.9 Ethical Issues

According to Creswell (2013), researchers need to anticipate the ethical issues that may happen during their studies. This research has encountered many ethical issues.

Firstly, in this research, there was need to consider the special needs of the students who were under the age of 19. Subsequently, Ethical Form C "Application for Approval of Research with Low Risk" was completed and submitted to Curtin University Ethics Office. In the consent form, participants and their parents have the right to withdraw, to know the purpose of the study and the procedures of the study, to ask questions and to know of the benefits of the study. The participants, their parents and the researcher needed to provide signatures agreeing to these provisions. Permission was also sought from individuals in authority at the schools and in the Ministry of Education to provide access to study participants at the research sites.

The second issue is to protect the privacy and identities of individuals in the project. For example, in survey research, investigators disassociate names from responses during the coding and recording process. In qualitative research, inquirers use aliases or pseudonyms for individuals and places to protect participants' identities. In this research, the researcher made a code number for individual participant such as "Student #1".

The third ethical issue is about the data, which is collected in this project by questionnaire surveys and interviews; the researcher faced many issues such as missing or losing the data. Therefore, the data need to be saved and recorded and kept

in safe place to utilise it for research purpose. Curtin University provides “Research Drive (R: Drive)” to help the researcher to store the data and keep it safely and in order to “comply with the Australian code for the responsible conduct of research and Curtin’s research data and primary materials policy” (Curtin University, 2016). However, it is recommended that data once analysed needs to be kept for seven years and should then be discarded.

3.10 Summary

This part of the thesis describes the research methodology used in the study. It is divided into different sections starting with participants of the study, a description of the pilot study and the research methods employed in the study. Details of the methodology are reported along with the validation of results of the pilot study in the third section of this chapter. The pilot study was necessitated to make the instruments easier for participants to complete and for the researcher to analyse the data. This chapter also describes the methods of data collection and statistical analyses of the data as well as the quality standards imposed on the study. The quality criteria of the research are discussed in the eighth section of the chapter. Finally, the issues relating to research ethics are highlighted.

Chapter 4
PILOT STUDY

4.1 Introduction

Currently, females represent more than half of all students in high schools and higher education institutions in Saudi Arabia but their opportunities in the workforce are not equitable with males. Therefore, one of the vital issues for Saudi Arabian citizens is the design of a system that can help to utilize the female workforce in a similar way as the male workforce.

Science is important in today's society. Encouraging students, especially female students, to study science and physics is possible but understanding physics concepts can be a complicated task. Enabling students to have an understanding of the science and physics concepts needs an appropriate curriculum, hard work by the educational institutions, science teachers and support from the society. The improvement of female high school students' understanding of science and physics will most likely have a positive impact on society.

The main purpose of this pilot study was to evaluate Saudi females' perceptions, motivations, self-image and science career perspectives. At the same time, the pilot test allowed the researcher to determine the validity of the instruments used and possible issues related to high school girl students' understanding of the items in the instrument prior to applying the study on a larger scale.

This chapter is divided into five parts with each expressing a different aspect of the pilot study of this research. Section 4.2 shows the methodology of the pilot test conducted in this research. Section 4.3 displays the results of the pilot trial of the research. Section 4.4 presents the reliability and validity of instruments used in the pilot trail. Finally, Section 4.5 concludes this chapter of the thesis.

4.2 Methodology

This section of the chapter illustrates the methodology of the pilot trial. This part is divided into three subsections that describe the sample, the diagnostic test and the statistical analysis procedures.

4.2.1 Sample

For the pilot study, the instruments were administered to 178 high school girl students from Years 9 to 11, selected by class rooms from three different schools located in the city of Jeddah in the west of Saudi Arabia. For the main study, the instruments were then administered to a larger and more diverse sample of 800 high school girl students from Years 9 to 11 in different schools in Jeddah city.

4.2.2 Diagnostic test

The pilot study had served to illuminate the possible results of the study on a small scale and whether the planned investigation outline was defective in any way. The pilot trial included modifying the test, translating test items into Arabic and conducting trials with 178 high school female students. One of the purposes of the pilot trial was to validate the Arabic modification forms of this instrument and make sure that both the original instrument and the back-translated instrument had the same meaning (see Section 3.3). Other benefits of the pilot trial were to help check the time needed to finish completing the instrument, to obtain feedback on the format and simplicity of reading the instrument, and to observe any issues in the instrument administered to the class and any participants' recommendations such as those about understanding the meaning of the Arabic statements on the instruments.

4.2.3 Statistical analysis

Quantitative statistical analyses were conducted by using the Statistical Package for the Social Sciences (SPSS) version 20 (Pallant, 2013) and Microsoft Excel version 13 (Winston, 2009). The statistical analysis software was used to compute means and standard deviations, and compare and examine the interrelations among the variables by using related statistical such as correlations and regression analysis. Also, reliability and validity were tested by the statistical analysis software (Pallant, 2013).

4.3 Results

Table 4.1 shows the results from the demographic data analysis. The number of participants in the pilot test was 178 female students in Years 9 to 11, the grade average year is 9.75 years, the mean of the participant's age is 15.79 years, and most of the

students speak Arabic as a native speaker. Moreover, Table 4.1 illustrates the mean profile choice of 1.29 in the pilot trail which means that participants mostly like to choose the science stream. In the instrument, the students were asked to state their preference for the future study (profile choice) as Science or Literary. There are two main reasons for the inclusion of these choices. The first reason is to know about students' future career ambitions; and the second reason is to understand their preferred science subjects. Forty-six participants of the pilot trial selected the science stream because it was related to their intended future career and 67 participants selected science stream because they preferred science or liked to understand science.

Table 4.1: Demographics' and Profile choice: Results from the Pilot trial

	Age	Year	Language	Profile Choice
Mean	15.79	9.75	1.03	1.29
N	178	178	178	175
Std. Deviation	1.10	0.82	0.20	0.45

Note: Language column (1) Arabic, (2) Somalian and (3) Urdu
Profile choice column (1) is Science and (2) is literary streams

4.3.1 Students' views of science (Item 3, Statements 1-5)

Table 4.2 presents the descriptive statistics for students' views of science results in the pilot trial. In Item 3, the range of statements is between 1 and 5 where 1 is "strongly disagree", whereas 5 is "strongly agree". The numbers shown in the second and third columns represent the mean and standard deviation values of students' rating for all of the statements in Item 3. Most students agree for all the statements is Statement 2, which is *I like science because it helps me to understand myself and the world*. The mean for Statement 2 is 4.13 for all the students, 4.28 for Year 9, 3.96 for Year 10 and 4.03 for Year 11. On the other hand, Statement 4, which is *I like science because it's relevant to the kind of work that I want to do*, has a lower agreement for this item. The mean for Statement 4 is 3.25 for all the participants, 3.47 for Year 9, 3.29 for Year 10 and 2.75 for Year 11.

Table 4.2: Descriptive statistics for Saudi girls' views of science (Item 3) in the Pilot study (n = 178)

Statement Numbers	Average		Year 9 (n = 88)		Year 10 (n = 46)		Year 11 (n = 44)	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
1. Interesting	3.77	1.18	3.98	1.05	3.48	1.18	3.3	1.28
2. Understand	4.13	1.01	4.28	0.89	3.96	1.19	4.03	1.04
3. Relevant	3.97	1.10	4.21	0.99	3.72	0.98	3.73	1.31
4. Future work	3.25	1.62	3.47	1.50	3.29	1.61	2.75	1.80
5. Important	3.53	1.22	3.77	1.17	3.53	1.14	3.07	1.30

4.3.2 Students' interest in different science topics (Item 4, Statements 1-13)

The descriptive statistics from the pilot study for students' perceived interest in different science topics are presented in Table 4.3. For each statement in Item 4, the range of statements is between 1 (not interesting) and 5 (very much interesting). In this item, some science topics are perceived to be more interesting, whereas other topics are of less interest. For all the participants, the most interesting topic was *Fighting disease* (Statement 9), followed by *Respiration* (Statement 12) and *How the heart works* (Statement 1). The three most interesting science topics mean scores were 4.17, 4.13 and 4.02 respectively. In contrast, the three least interesting Statements were *Polymers and plastics* (Statement 10), *Circuit symbols and devices* (Statement 11) and *Magnetic fields and electric motors* (Statement 5). The mean scores for the least interesting science topics were 2.50, 2.53 and 2.70, respectively. In Year 9, the most interesting topics were *Fighting disease* (Statement 9), mean was 4.16, followed by *The planets* (Statement 13), with a mean score of 4.12, and finally, *How the heart works* (Statement 1) with a mean of 4.02. In the opposite direction, the least interesting topics were *Circuit symbols and devices* (Statement 11) and *Polymers and plastics* (Statement 10). The mean scores of the least interesting science topics were 2.78 and 2.80 respectively. In Year 10, the most interesting science topics were *Genetics* (Statement 4), *Respiration* (Statement 12) and *Fighting disease* (Statement 9); and the mean scores were 4.46, 4.18 and 4.09. In contrast, the least interesting science topics were *Polymers and plastics* (Statement 10), *Magnetic fields and electric motors* (Statement 5) and *Circuit symbols and devices* (Statement 11); and the mean were 2.37, 2.44 and 2.66 respectively. In Year 11, the most interesting science topics were *Fighting disease* (Statement 9), *Respiration* (Statement 12) and *How the heart works*

(Statement 1) and their mean scores were 4.28, 4.21 and 4.05 respectively. Contrariwise, the least interesting science topics were *Circuit symbols and devices* (Statement 11), *Magnetic fields and electric motors* (Statement 5) and *Polymers and plastics* (Statement 10); and the mean scores were 1.89, 1.91 and 2.03 respectively.

Table 4.3: Descriptive statistics for students' perceived interest in different science topics (Item 4) in the Pilot Study (n = 178)

Statement Number	Average		Year 9 (n = 88)		Year 10 (n = 46)		Year 11 (n = 44)	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
1. Heart	4.02	0.99	4.08	1.04	3.85	0.98	4.05	0.88
2. Light	2.99	1.33	3.49	1.16	2.68	1.28	2.32	1.34
3. Rocks	2.92	1.42	3.22	1.37	2.81	1.39	2.44	1.45
4. Genetics	3.48	1.40	3.45	1.36	4.46	2.58	3.6	1.36
5. Magnetism	2.70	1.36	3.22	1.24	2.44	1.29	1.91	1.23
6. Plants	3.30	1.38	3.61	1.31	2.98	1.39	3.00	1.41
7. Chemicals	3.14	1.49	3.37	1.39	3.29	1.64	2.53	1.37
8. Stars	3.46	1.39	3.9	1.22	3.16	1.29	2.89	1.55
9. Disease	4.17	1.02	4.16	1.06	4.09	0.98	4.28	0.99
10. Polymers	2.50	1.18	2.8	1.10	2.37	1.14	2.03	1.24
11. Devices	2.53	1.34	2.78	1.31	2.66	1.33	1.89	1.20
12. Respiration	4.13	1.23	4.07	1.27	4.18	1.19	4.21	1.21
13. Planets	3.71	1.32	4.12	1.15	3.37	1.21	3.25	1.52

4.3.3 Students' understanding of different science topics (Item 5, Statements 1-13)

The descriptive statistics from the pilot trial of students' understanding of different science topics is presented in Table 4.4. In Item 5, the range of statements are scored between 1 and 5. A score of "1" means "not understanding", whereas "5" means "very much understanding". Among the results obtained from all students, the most understood topics were *Respiration* (Statement 12) with a mean of 4.22, and then *how the heart works* (Statement 1) with a mean of 4.06 and *Fighting disease* (Statement 9) with a mean of 3.95. In opposite, the least understood topics were *Circuit symbols and devices* (Statement 11) and *Polymers and plastics* (Statement 10) with means of 2.63 and 2.75, respectively. In Year 9, the most understood science topics were *Respiration* (Statement 12), *How the heart works* (Statement 1) and *Fighting disease* (Statement

9), with means of 4.38, 4.20 and 4.08, respectively. Inversely, the least understood science topics were *Circuit symbols and devices* (Statement 11) and *Polymers and plastics* (Statement 10), with means of 2.95 and 3.10, respectively. In Year 10, the most understood science topics were *How the heart works* (Statement 1), and *Respiration* (Statement 12), with means of 3.92 for both. Contrariwise, the least understood science topics were *Circuit symbols and devices* (Statement 11), and the *lifecycle of stars* (Statement 8) with means of 2.48 and 3.03, respectively. Finally, for Year 11, the most understood science topics were *Respiration* (Statement 12), followed by *Fighting disease* (Statement 9) and then *How the heart works* (Statement 1), with means of 4.21, 3.94 and 3.91, respectively. In contrast, the three least understood science topics statements were *Circuit symbols and devices* (Statement 11), *Magnetic fields and electric motors* (Statement 5) and *Polymers and plastics* (Statement 10), with means of 2.16, 2.19 and 2.37, respectively.

Table 4.4: Descriptive statistics for students' understanding different science topics (Item 5) in the Pilot Study (n = 178)

Statement Number	Average		Year 9 (n = 88)		Year 10 (n = 46)		Year 11 (n = 44)	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
1. Heart	4.06	1.09	4.2	1.03	3.92	1.18	3.91	1.07
2. Light	3.42	1.30	3.88	1.26	3.07	1.06	2.87	1.30
3. Rocks	3.39	1.32	3.72	1.30	3.16	1.21	2.98	1.35
4. Genetics	3.45	1.38	3.53	1.32	3.35	1.40	3.39	1.49
5. Magnetism	3.02	1.30	3.41	1.22	3.07	1.20	2.19	1.20
6. Plants	3.68	1.28	4.06	1.16	3.53	1.20	3.1	1.34
7. Chemicals	3.45	1.42	3.6	1.32	3.64	1.43	2.96	1.50
8. Stars	3.52	1.29	3.89	1.23	3.03	1.20	3.28	1.30
9. Disease	3.95	1.20	4.08	1.13	3.7	1.29	3.94	1.22
10. Polymers	2.75	1.26	3.1	1.25	3.46	1.10	2.37	1.27
11. Devices	2.63	1.27	2.95	1.22	2.48	1.24	2.16	1.23
12. Respiration	4.22	1.18	4.38	1.04	3.92	1.36	4.21	1.23
13. Planets	3.75	1.31	4.06	1.21	3.35	1.30	3.53	1.40

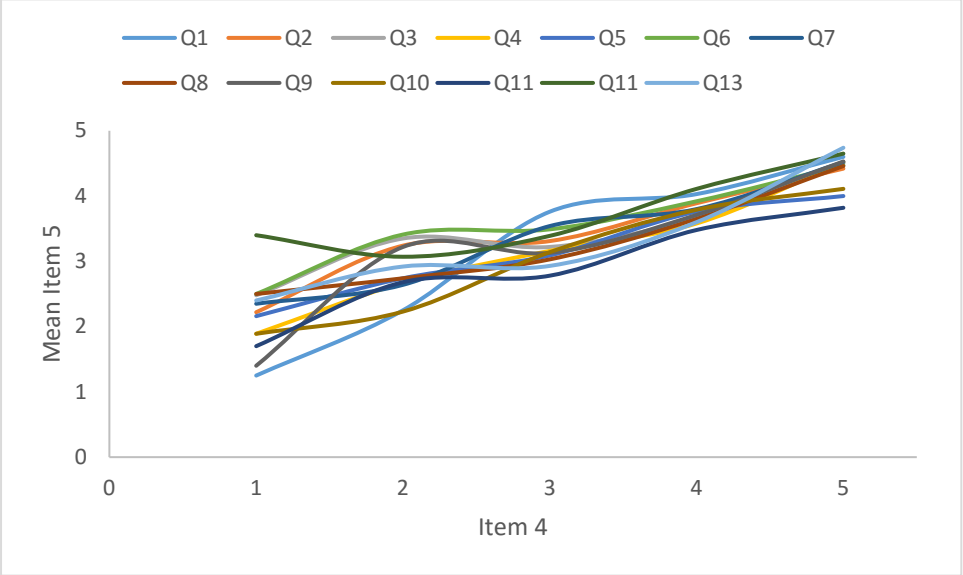

Figure 4.1: The correlation between interest and understanding of different science topics in the pilot trial

The correlation between students' interest and understanding of different science topics in the pilot trial is illustrated in Figure 4.1 which shows that interest correlates generally positively with students' understanding of the subject. On the other hand, decreasing interest in topics impacts on student understanding of other subjects. The average correlation coefficient between interest and understanding of different subject statements is 0.93 demonstrating that an understanding of science subjects is impacted by interest and is different from one science topic to another. Furthermore, increased interest in subject (as motivation) is one of the important factors for learning science. Therefore, increased interest in science topics helps to increase understanding of the concept.

4.3.4 Meaning of physics to participants (Item 6, statements 1-10)

Table 4.5 shows the descriptive statistics of participants' meaning of physics in the Pilot trial. This item was not answered by participants in Year 9 because these students did not study physics; these students studied only small chapters in science relating to Physics. For the all the students who answered this item, the mean of their scores that ranged between the strongest "disagree" (score 1) and the strongest "agree" (score 5) was 1.16. The statement with the highest agreement was on *Physics is interesting but not enjoyable* (Statement 5) with a mean of 3.49. The mean for Statement 5 was mostly neutral. In contrast, the most disagreed statement was *I'm not really sure what physics*

is (Statement 9) with a mean of 2.33. In Year 10, the most disagreed statement was *the laws and all of the maths makes physics difficult to learn and remember* (Statement 4) with a mean of 3.57. In the opposite direction, the most disagreed statement was *I'm not really sure what physics is* (Statement 9) with a mean of 2.31. Finally, in Year 11, the most disagreed statement was *Physics is interesting but not enjoyable* (Statement 5) with a mean of 3.60, followed by *I find physics very practical but it is boring* (Statement 2) with a mean of 3.57. On the other hand, the most disagreed statement was *Physics is very relevant to the work I want to do* (Statement 1) with a mean of 1.89.

Table 4.5: Descriptive statistics for physics meaning to participants' results in the Pilot Study (n = 90)

Statement Number	Average		Year 9		Year 10 (n = 46)		Year 11 (n = 44)	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
1. Relevant	2.48	1.54			3.05	1.61	1.89	1.22
2. Practical and boring	3.35	1.39			3.14	1.34	3.57	1.42
3. Understand	3.32	1.30			3.46	1.22	3.16	1.37
4. Laws	3.37	1.59			3.57	1.45	3.16	1.72
5. Interesting and 6. unenjoyable	3.49	1.37			3.4	1.37	3.6	1.38
7. Too difficult	2.65	1.53			2.5	1.44	2.8	1.63
8. Remote	2.94	1.20			3.03	1.16	2.85	1.25
9. Clever	2.89	1.31			3.16	1.29	2.62	1.29
10. Not sure	2.33	1.33			2.31	1.24	2.35	1.42
11. Not continue	3.07	1.45			2.98	1.45	3.16	1.46

4.3.5 Most and least favourite subjects (Item 7 and Item 8)

Table 4.6 and Table 4.7 show the descriptive statistics for the most and least favourite subjects, respectively, from four subjects, namely Mathematics, Arabic, Science and English, in the pilot study. As shown in Table 4.6, the subject with lowest mean is the most favourite and the subject with the highest mean is the least favourite, whereas in Table 4.7, the subject with the highest mean is the most favourite and the subject with the lowest mean is the least favourite. In both tables and in general, science is the most favourite subject and mathematics is the least favourite subject. As shown in both tables, science is the most favourite subject in Year 9. In Year 10, science is the least

favourite subject and mathematics is the most favourite subject (see Table 4.7). In Year 11, mathematics is the least favourite subject as shown in both tables.

Table 4.6: Descriptive statistics for most favourite subject in the Pilot Study (n = 89)

	Average		Year 9 (n = 44)		Year 10 (n = 23)		Year 11 (n = 22)	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Math	2.75	1.22	3.00	1.14	2.00	1.27	3.04	1.04
Science	2.11	0.89	1.86	0.82	2.26	0.91	2.45	0.91
Arabic	2.47	1.07	2.52	1.10	2.65	1.07	2.18	1.00
English	2.66	1.15	2.61	1.10	3.08	0.94	2.31	1.35

Table 4.7: Descriptive statistics for least favourite subject in the Pilot Study (n = 89)

	Average		Year 9 (n = 44)		Year 10 (n = 23)		Year 11 (n = 22)	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Math	2.24	1.18	2.23	1.11	2.39	1.34	2.14	1.20
Science	2.85	0.87	3.16	0.77	2.65	0.77	2.45	0.96
Arabic	2.37	1.18	2.23	1.17	2.35	1.19	2.68	1.17
English	2.52	1.12	2.39	1.12	2.61	1.15	2.73	1.12

4.3.6 Ranking of the 11 school subjects (Item 9)

Table 4.8 illustrates the results of the ranking of the 11 school subjects in the pilot study. This table contains 21 units. Some units are under one subject such as Fiqh, Hadeath, Quran and Tawhead units are under Religion. Also, Arabic, Poetry, reading, writing and criticism are units under Arabic. In Year 9, science subject shows the highest favourite subject with mean 8.25. Mathematics has a mean of 6.05. Year 9 students have a higher mean for all subjects except for computers because it is taught without any practice and just by memorising without conceptual understanding. In Year 10, students ranked mathematics similarly to students in Year 9. Computer has lower mean of 1.28 for the previous reason that is mentioned in Year 9. The most important observation is the science units (physics, chemist and biology) with means of 6.04, 7.24 and 4.46, respectively. Those means were high compared with other units such as English. In Year 11, because the students members were divided to two equal groups (the Science and Literary streams), the mean score for science subjects (physics, chemistry and biology) dropped to 4.05, 4.59 and 4.25, respectively, and that

for Mathematics also dropped to 4.52. Science subjects were ranked behind English and Psychology by Year 11 students.

Table 4.8: Results of the ranking of the 11 school subjects in the Pilot Study (*n* = 178)

	Average			Year 9 (*n* = 88)		Year 10 (*n* = 46)		Year 11 (*n* = 44)	
	Mean	n	SD	Mean	SD	Mean	SD	Mean	SD
Practical	1.65	178	2.71	3.05	3.05	0.32	1.30	0	0
Fiqh	5.85	178	3.17	7.10	2.71	4.78	3.64	4.50	2.53
Hadeath	5.91	178	3.07	6.26	3.03	5.69	3.60	5.45	2.48
Quran	3.94	178	3.86	6.28	3.15	2.15	3.55	1.13	2.33
Tawhead	6.15	178	2.98	6.15	2.90	6.45	3.22	5.84	2.91
Science	8.25	88	3.09	8.25	3.09				
Math	5.78	178	4.28	6.05	3.80	6.56	4.52	4.40	4.67
Arabic	5.14	178	3.21	5.28	2.82	3.86	3.53	6.18	3.24
Computer	2.21	178	2.68	2.88	2.63	1.28	2.43	1.86	2.73
English	5.53	178	4.02	6.68	3.43	3.22	4.16	5.63	4.03
Social	4.01	178	3.46	4.37	3.10	4.04	3.50	3.27	4.03
Art	1.87	178	2.58	3.15	2.91	0.67	1.47	0.54	1.15
Poem	5.12	90	3.55			3.89	3.25	0.25	1.36
Psychology	1.29	90	2.87			0.11	0.73	6.41	3.42
Reading	0.84	90	2.19			0.98	2.50	2.52	3.67
Critic	2.67	90	3.32			2.50	2.76	0.70	1.83
Library	1.13	90	2.12			1.17	2.30	1.09	1.95
Writing	0.48	90	1.27			0.50	1.18	0.45	1.37
Biology	4.36	90	4.12			4.46	3.66	4.25	4.45
Chemistry	5.94	90	3.94			7.24	3.02	4.59	4.35
Physics	5.07	90	3.93			6.04	3.52	4.05	4.12

4.3.7 Motivation (Item 10, Statements 1-19)

Table 4.9 shows the descriptive statistics for the results of the Motivation questionnaire discussed in Table 3.10 in Section 3.7.1.5.1. In the motivation questionnaire, the range of scores was between 1 to 5; "1" means a response of "never" for the statement and "5" means a response of "always" for the statement. Students' motivation mean scores for the Statements 1-19 ranged from 3.71 to 2.56. The statement with the highest mean was on *Understanding the science gives me a sense of accomplishment* (Statement 19), whereas that with the lowest mean was on *I hate taking the science tests* (Statement 9). In Year 9, the range of the result was from 3.95

to 2.25. The statement with the highest mean was on *I believe I can earn a grade of "A" in the science course* (Statement 18), whereas that with the lowest mean was on *I hate taking the science tests* (Statement 9). In Year 10, the range of results was from 3.50 to 2.76. The statement with the highest mean was on *I believe I can earn a grade of "A" in the science course* (Statement 18), whereas that with the lowest mean was on *I hate taking the science tests* (Statement 9). In Year 11, the results ranged from 3.79 to 2.95. The statement with the highest mean was on *The science I learn relates to my personal goals* (Statement 2), whereas that with the lowest mean was on *I am concerned that the other students are better in science* (Statement 7). In this stage of research, factorising was not done because the data was not large enough.

Table 4.9: Motivation results in the Pilot Study (n = 178)

Statement Number	Average		Year 9 (n = 88)		Year 10 (n = 46)		Year 11 (n = 44)	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
1. Enjoyment	3.24	1.35	3.50	1.35	2.93	1.34	3.04	1.29
2. Personal	3.41	1.49	3.37	1.51	3.13	1.42	3.79	1.48
3. Nervous	3.00	1.49	2.69	1.45	3.08	1.44	3.52	1.50
4. Anxious	3.01	1.54	2.64	1.51	3.17	1.55	3.59	1.41
5. Helpful	3.23	1.38	3.21	1.38	3.23	1.35	3.25	1.46
6. Worry	3.03	1.58	2.62	1.48	3.43	1.55	3.43	1.63
7. Concerned	2.74	1.44	2.42	1.32	3.15	1.44	2.95	1.53
8. Grade	3.06	1.36	3.15	1.42	2.93	1.20	3.00	1.41
9. Hate	2.56	1.47	2.25	1.49	2.76	1.33	2.97	1.47
10. Think about use	3.14	1.31	3.15	1.29	3.02	1.35	3.25	1.34
11. Confid in projects	3.45	1.35	3.55	1.28	3.50	1.32	3.20	1.50
12. Interest	3.52	1.27	3.59	1.24	3.41	1.39	3.50	1.22
13. My Life	3.35	1.35	3.46	1.38	3.06	1.30	3.43	1.33
14. Can be master	3.39	1.25	3.62	1.17	3.30	1.26	3.04	1.34
15. Practical	3.21	1.33	3.34	1.33	3.15	1.26	3.02	1.38
16. Challenges	3.24	1.44	3.34	1.42	3.28	1.37	3.00	1.57
17. Confid in tests	3.53	1.28	3.82	1.29	3.39	1.10	3.09	1.32
18. Getting A grade	3.63	1.33	3.95	1.32	3.50	1.16	3.13	1.35
19. Accomplishment	3.71	1.41	3.80	1.39	3.47	1.45	3.77	1.41

4.3.8 Stereotype Questions (Item 6, Statements 1-65)

Table 4.10 shows descriptive statistics for the stereotype results in the Pilot study. In the stereotype statements, the range was from 1 to 7 where "1" means "totally

disagree" with the statement and "7" means "totally disagree" with the statement. In the Total column, the stereotype pilot study results ranged between 6.19 and 2.61. The highest mean was on *Intelligent* (Statement 25), whereas the lowest mean was on *Self-centred* (Q48). In Year 9, students' responses to prototype statements ranged between 6.21 and 2.20. The highest mean was on *Intelligent* (Statement 25), whereas the lowest mean was on *Self-centred* (Statement 48). In Year 10, the pilot study results ranged between 6.28 and 3.00. The highest mean was on *Intelligent* (Statement 25), whereas the lowest mean was on *Inexperienced* (Statement 56). In Year 11, the Pilot study result varied from 6.15 to 2.65. The highest mean was on *Diligent* (Statement 16), whereas the lowest mean was on *Smart* (Statement 44).

Table 4.10: Descriptive statistics for stereotype results in the Pilot Study (*n* = 178)

Statement number	Total		Year 9 (*n* = 88)		Year 10 (*n* = 46)		Year 11 (*n* = 44)	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
1. Respected	6.10	1.59	6.14	1.55	6.08	1.51	6.00	1.77
2. Arrogant	2.89	1.81	2.45	1.70	3.10	1.95	3.52	1.66
3. Attractive	4.67	1.92	4.47	1.84	4.65	2.07	5.06	1.89
4. Open-mined	5.98	1.64	6.00	1.66	5.95	1.49	5.97	1.81
5. Persistent	5.73	1.77	5.70	1.85	5.73	1.58	5.77	1.84
6. Sought-after	5.37	1.68	5.47	1.64	5.02	1.63	5.50	1.79
7. Popular	4.29	2.08	4.13	2.11	4.52	2.07	4.36	2.05
8. To be "a known-it-all"	4.79	1.92	4.89	1.97	4.76	1.82	4.59	1.94
9. Cool	5.39	1.71	5.47	1.70	5.15	1.81	5.45	1.64
10. Talkative1	3.34	2.13	2.89	2.02	3.52	2.20	4.04	2.12
11. Ambitious	6.03	1.48	6.13	1.47	5.71	1.61	6.13	1.35
12. Empathetic	5.45	1.75	5.92	1.62	4.93	1.71	5.04	1.82
13. Lonely	3.03	2.05	2.65	2.03	3.58	2.14	3.18	1.87
14. One-sided	3.31	1.89	3.15	2.01	3.47	1.79	3.45	1.74
15. Erotic	5.38	1.89	5.47	1.94	4.82	1.88	5.77	1.69
16. Diligent	5.96	1.68	5.93	1.70	5.82	1.56	6.15	1.76
17. Cheerful	5.25	1.91	5.75	1.55	4.60	2.11	4.90	2.11
18. Educated (emotionally)	5.20	1.85	5.52	1.75	5.08	1.89	4.68	1.92
19. Sensitive	4.28	1.87	4.47	1.83	4.17	2.00	4.00	1.82
20. Brilliant	5.58	1.71	5.84	1.58	5.32	1.90	5.31	1.72
21. Garrulous	3.27	2.06	2.68	1.89	3.71	2.13	3.97	2.02
22. Talkative2	3.24	1.99	2.71	1.87	3.54	2.10	3.95	1.86
23. Stylish	5.24	1.88	5.30	1.82	5.47	1.78	4.86	2.07

24. Good-looking	5.11	1.86	5.13	1.85	5.32	1.66	4.84	2.09
25. Intelligent	6.19	1.44	6.21	1.40	6.28	1.39	6.02	1.59
26. Interested	5.78	1.73	5.96	1.60	5.78	1.80	5.40	1.90
27. Isolated	2.97	1.94	2.47	1.81	3.69	2.04	3.20	1.83
28. Clever	5.98	1.62	6.00	1.51	6.19	1.43	5.70	1.98
29. Outgoing	5.37	1.80	5.57	1.71	5.28	1.80	5.04	1.96
30. Body-aware	4.49	2.07	4.28	2.15	4.86	1.99	4.52	1.95
31. Creative	5.71	1.81	5.96	1.79	5.36	1.92	5.56	1.68
32. Boring	3.05	2.14	2.61	2.00	3.13	2.11	3.84	2.25
33. Appreciates	4.97	1.83	5.18	1.79	4.63	1.90	4.90	1.84
34. Easy-going	5.04	1.83	5.26	1.84	4.93	1.63	4.70	1.97
35. Logical	5.15	1.84	5.30	1.71	5.04	1.88	4.93	2.05
36. Fashion	4.13	1.87	4.31	1.73	4.58	1.89	3.29	1.91
37. Smart-aleck	2.92	1.93	2.56	1.89	3.06	1.90	3.45	1.92
38. Open	4.89	2.04	5.02	2.05	5.13	1.97	4.38	2.07
39. Original	4.79	1.88	4.95	1.79	4.65	1.93	4.59	2.02
40. Imaginative	4.73	2.00	4.96	1.96	4.41	2.03	4.59	2.02
41. Eloquent	5.13	2.04	4.85	2.15	5.56	1.93	5.25	1.86
42. Romantic	3.77	1.92	3.59	2.00	4.21	1.91	3.65	1.72
43. Slim	4.69	1.86	4.55	1.88	4.97	1.76	4.63	1.93
44. Smart	5.93	1.68	6.09	1.48	5.86	1.82	2.65	1.91
45. Pretty	5.20	1.71	5.14	1.76	5.41	1.49	5.09	1.82
46. Shy	3.97	1.90	3.84	1.97	4.76	1.63	3.38	1.80
47. Self-confident	5.65	1.86	5.68	1.89	5.52	1.81	5.72	1.88
48. Self-centred	2.61	1.76	2.20	1.62	3.15	1.99	2.84	1.62
49. Sensual (Motivating)	4.98	2.06	5.13	2.06	4.43	2.05	5.25	2.00
50. Spontaneous	5.33	1.83	5.55	1.74	5.26	1.84	4.93	1.94
51. Athletic	4.75	1.94	4.95	1.76	4.65	2.07	4.45	2.15
52. Sparkling	5.05	1.78	5.06	1.79	5.17	1.59	4.88	1.99
53. Over-ambitious	4.28	2.21	4.42	1.95	3.78	2.03	4.52	2.77
54. Dry	3.05	1.97	2.76	1.88	3.21	1.96	3.45	2.10
55. Stubborn	3.23	2.07	2.63	2.02	3.89	1.93	3.72	2.00
56. Inexperienced	2.89	1.99	2.64	1.91	3.00	1.90	3.27	2.21
57. Courted	5.10	1.87	5.34	1.85	5.13	1.65	4.59	2.07
58. Inhibited	3.32	1.85	2.63	1.67	3.95	1.71	4.02	1.87
59. Opinionated	4.04	1.88	3.62	1.89	4.32	1.62	4.56	1.96
60. Versatile	4.57	1.90	4.40	1.84	4.65	1.82	4.81	2.09
61. Unworldly	3.08	1.79	2.86	1.83	3.28	1.78	3.31	1.69
62. Pompous	2.75	1.89	2.44	1.92	3.10	1.99	3.00	1.65
63. Eager to learn	5.69	1.83	5.76	1.78	5.54	1.95	5.70	1.86
64. Witty	5.57	1.91	5.73	1.84	5.41	2.06	5.40	1.93
65. Reserved	5.08	1.94	4.92	1.94	5.45	1.74	1.93	2.11

4.4 Instrument reliability and validity

Quantitative research needs to emphasise validation of the instruments to ensure that the results are meaningful. Instrument validity depends on the data accuracy. This research used instruments developed by Taconis and Kessels (2009), Hollins et al. (2006), Mitrevski and Treagust (2011) and Hannover and Kessels (2004). These instruments cannot be supposed to be valid with the Saudi sample, therefore, they were validated in this study. The researcher was helped by experts to check the validity of the instrument. Also, during the pilot test, the researcher recorded the observations, comments of the participants and the time required for completing the instrument.

The questionnaire was administered to 178 High school girls' student from Year levels 9 to 11. The construct validity was evidenced by assessing the scales reliability and securing evidence by using Cronbach's alpha coefficient (Cronbach, 1951). Cronbach's alpha values for the internal reliability of the 6 items (based on their corresponding statements) ranged between 0.63 and 0.94 as shown in Table 4.11.

Table 4.11: Cronbach Alpha Reliability Coefficients for Pilot Study items

	No of Statements	Cronbach's Alpha		
		Year 9	Year 10	Year 11
Item 3	5	0.67	0.63	0.71
Item 4	13	0.83	0.80	0.70
Item 5	13	0.82	0.82	0.76
Item 6	10		0.69	0.72
Item 10	19	0.78	0.85	0.80
Item 11	65	0.92	0.94	0.94

4.5 Summary

A pilot study provides evidence of reliability and validity of the instruments used to ensure the results are meaningful. The results of this pilot study provided evidence that many of these Saudi girl students preferred to study science. The participants thought that science subjects can help them to understand the world. They were attracted to biological sciences mostly and physics was their least favourite subject of science because physics is missing the emotional sense and is linked to mathematics, their least favourite subject. There was proportional correlation between subject interest and

its understanding. Science subject was the most favourite subject in Year 9 and that its favourite status gradually dropped in Years 10 and 11. Most participants believed that a scientist is intelligent. The results of this pilot study showed that Year 9 students were more motivated to study science, whereas Year 11 students were more impacted by examination stress in science.

Chapter 5
PRESENTATION OF QUANTITATIVE DATA, ANALYSIS AND RESULTS

5.1 Introduction

This chapter presents the research data from the main study, its analysis and the explanations of the results. Section 5.2 shows the analysis results of the data related to the demographics and the girls' choice of science. In Section 5.3, the science conception data are described. In Section 5.4, the student motivation data are illustrated. Saudi girls' stereotype data are discussed in Section 5.5. Finally, Section 5.6 describes the summary of the chapter.

5.2 Girl student demographics: Age, native language, Year level and choice of science or literary stream

The total number of participants was 800 students, all of whom were girls from Years 9, 10 and 11 classes at intermediate and high schools. All participants were living in the city of Jeddah in the Mecca region in February 2014. Participants were selected from 27 class rooms in seven different schools. All participants attempted to answer all questionnaire items except Item 6, which was answered by Year 10 and 11 students only because Year 9 students did not study physics.

According to George (2011) that normal distribution for data need to be ± 2 kurtosis to be considered acceptable. In this research, all data are between +2 and -2. Therefore, the research data has a normal distribution.

To gauge the range of Saudi girl participants' age, native language, Year level and profile choice for Science or Literary steams of study, the researcher collected the data from students' responses to Item 1 (demographic) and Item 2 (academic stream choice for the participants) of the questionnaire (see Appendix A). Figure 5.1A displays the percentage of students who selected science or literary streams as their direction of study. Figure 5.1B illustrates the relationship between participants' age and their profile choice. Figure 5.1C and Figure 5.1D, respectively, show the relationship between their native languages and profile choice and Year level and stream choice.

As shown in Figure 5.1A, approximately 60% of the participants selected the science stream and the remaining 40% chose the literary stream. The difference between the two streams is around 20%. There were several reasons for the participants' selection of the science stream. Those reasons can be grouped as internal or external. An example of an internal reason involves emotional words such as "like", "don't like", "prefer" and "hate". There were 213 students who used emotional words; of these students, 83 were from Year 9, 55 from Year 10 and 75 from Year 11. Another example of an internal reason is the students' way of thinking. About 120 students expressed that they liked understanding subjects and disliked memorising subjects. When categorised according to Year group, 44 students were from Year 9, 38 were from both Year 10 and 11. On the other hand, external reasons can be exemplified as future goals. There were 167 students who selected the science stream based on their ambition of attending university for a future career; when distributed as categories—55 students were from Year 9, 66 were from Year 10 and 46 were from Year 11. Also, there seemed to be a minor parental impact on the students' choice of the science stream as evidenced from the answers of the reasons of choice for the science stream (6 answers). Among the participants who selected the science stream, their frequency of using science was higher (115 answers) than using mathematics (33 answers).

Figure 5.1B illustrates the relation between profile choice and age. As shown in the figure, the participants in the age group from 13 to 16 mainly selected the science stream, whereas those in the age group from 17 to 21 mainly selected the literary steam. The main reason for this variation may be attributed to the education system in Saudi Arabia where the age of the students in Years 9, 10 and 11 range from 15 to 17 years. But, there are some exceptions such as gifted students who can skip one or two educational years, and under-performing students who fail to pass the examinations of a Year level and have to repeat that year.

Figure 5.1C shows the relation between stream choice and the students' native language; only 11 participants from a total of 800 were non-Arabic native speakers. The low rate of non-Arabic speakers in Saudi public schools indicates that there is little or no interaction with the other languages and cultures compared to experiences such as those in Australian public schools. In Saudi Arabia, most of the foreign students choose to go to international schools rather than public schools because they are expatriates living in Saudi Arabia temporarily, and the curriculum in the

international schools is similar to the one in their home country. The cultural interchange with the other cultures in Saudi public schools is very low.

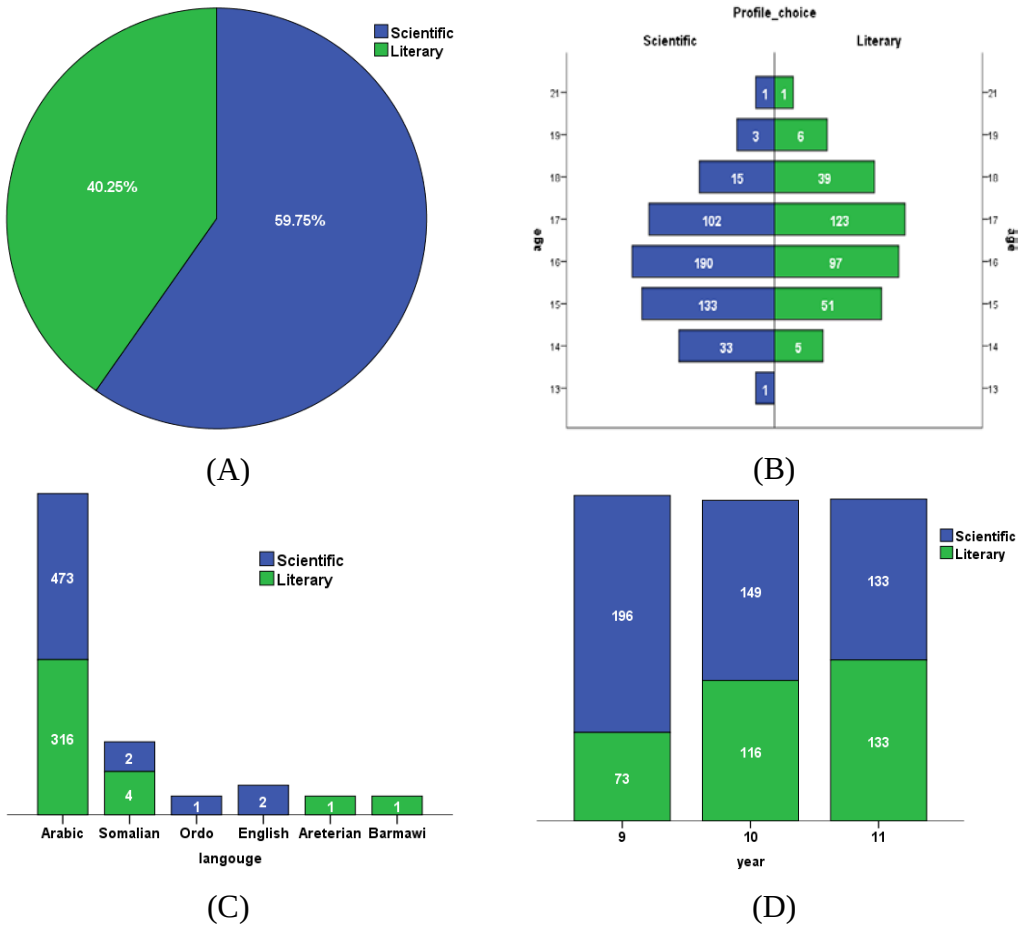

Figure 5.1: (A) The percentage of profile choice for all participants, (B) The relation between profile choice and age, (C) The relation between profile choice and native language and (D) The relation between profile choice and Year level.

Figure 5.1D displays the relationship between stream choice and the year of study. The majority of participants like to select the science stream of the upper school curriculum (see Figure 5.1). As shown in Figure 5.1D, three fourths of the participants from Year 9 would like to choose the science stream. The number of Year 10 students who chose the science stream was 149, comprising 56% of all the Year 10 participants. Finally, half of the Year 11 students selected the science stream of the upper school curriculum because the number of classes in Year 11 for both streams (science and literary) that participated in this study was similar. A greater proportion of students from Years 9 and 10 chose the science stream compared to literary stream.

More than half of Saudi girls selected the science stream of the upper school curriculum. The rate of choosing science stream was higher for the younger girls (between 13 to 16 years) at the lower education level (Year 9).

5.3 Response to Research Question 1: What are Saudi girls' perceptions of science and physics?

The first research question is split into four ancillary research questions: a) What are Saudi girls' views of science (from Item 3), b) What are Saudi girls' views about why people should study science (from Item 4), c) What are Saudi girl students' perceptions of their understanding different science topics (from Item 5) and d) What are Saudi girls' views about physics (from Item 6).

5.3.1 RQ 1a. What are Saudi Girls' Views of Science (From Item 3)

Saudi girls' perceptions of science and physics is one of the research project's objectives. Therefore, the ancillary research question 1a, as shown in Chapter 3 (see Section 3.5), was designed to measure this variable. The descriptive statistics for Saudi girl students' views of science as evidenced from Item 3 that contained 5 statements are shown in Table 5.1. For Item 3, the response format of the 5-point Likert-type statements was between 1 and 5; "1" indicates "strongly disagree", whereas "5" indicates "strongly agree". Statement 2 (*I like science because it helps me to understand myself and the world*) and Statement 3 (*I like science because it's relevant to my life*) in Item 3 were the most agreed by the students from all year groups (Year 9, 10 and 11). Statements 2 and 3 illustrate that the students gave attention to the learning of knowledge related to them, their life and their society because both statements link science to the students' background. As shown in Table 5.1, the passion to understand themselves and the surrounding world (Statement 2) decreased gradually from Years 9 to 11. For example, the mean for Statement 2 was 4.33 in Year 9, 3.77 in Year 10 and 3.40 in Year 11. Also, the mean for Statement 3 gradually decreased from 4.04 in Year 9 to 3.62 in Year 10 and later 3.42 in Year 11. On the other hand, students in Year 11 disagreed with Statement 4 (*I like science because it's relevant to the kind of work that I want to do*) because half of the participants in Year 11 belonged to the literary stream of the curriculum and with that decision it is most likely that they would not be studying any scientific topic in the future.

Table 5.1: Descriptive statistics for girls' view of science (*n = 800*)

	Average		Year 9 (*n* = 269)		Year 10 (*n* = 265)		Year 11 (*n* = 266)	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
1. Interesting	3.56	1.24	4.08	1.08	3.41	1.23	3.17	1.22
2. Attentiveness	3.84	1.23	4.33	0.97	3.77	1.15	3.40	1.37
3. Relevant	3.70	1.30	4.04	1.18	3.62	1.32	3.42	1.34
4. Future work	3.26	1.60	3.70	1.45	3.24	1.59	2.85	1.67
5. Important	3.38	1.31	3.78	1.21	3.37	1.34	2.98	1.28
TOTAL	3.55	0.97	3.99	0.83	3.48	0.92	3.16	0.97

5.3.1.1 Univariate analysis of variance

The data presented in Table 5.1 shows that there were dissimilarities in the views of science between student respondents in the different year groups (Year 9, 10 and 11). To determine if there were statistically significant dissimilarities between the year groups a one-way ANOVA was conducted to examine the effect of grade on the sum of the mean scores of the five statements in Item 3 (Table 5.2). The analysis showed that there was a statistically significant difference between the grades, $F(2, 797) = 55.34, p < .0005$.

Table 5.2: Item 3_ Univariate analysis of variance

Source	*df*	*F*	Significance, *p*
Grade	2	55.34	.00
Error	797		

Table 5.3 illustrates the *Post hoc* tests for Item 3 showing the different relation level between grades; the difference described in Table 5.2 do show a statistically significant difference between each of the three different grades ($p < .0005$).

Table 5.3: Item 3- Post hoc analysis between different year levels

Year	Mean	SD	Significance, *p*
9	3.99	0.83	.00
10	3.48	0.92	
9	3.99	0.83	.00
11	3.16	0.97	
10	3.48	0.92	.00
11	3.16	0.97	

5.3.2 RQ 1b. What are Saudi Girls' Views about Why People Should Study Science? (From Item 4)

Table 5.4 represents the results for students' interest in studying different science topics relating to Item 4. For Item 4, the response format of the 5-point Likert-type statements was between 1 and 5; "1" means "not very interesting", whereas "5" means "very interesting". The list of topics relating to Statement 1 to Statement 13 in Table 5.4 can be divided into four subjects, which are chemistry, biology, astronomy and physics. In general, biology topics, especially the topics related to medical science, were considered the most interesting topics by the students. Also, based on the trend in the mean scores among the three Year groups (9, 10 and 11), it is observed that, topics in biology were more interesting to students. On the other hand, chemistry and physics topics were perceived to be the least interesting. Moreover, Year 9 girls in general, had expressed more interest in science (3.52 ± 0.78), followed by Year 10 (3.19 ± 0.73) and Year 11 (3.10 ± 0.63).

Table 5.4: Descriptive statistics for interesting science topics (n = 800)

Science Topics	Average		Year 9 (n = 269)		Year 10 (n = 265)		Year 11 (n = 266)	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
1. Heart	4.04	1.13	3.99	1.16	3.97	1.20	4.17	1.03
2. Light	2.67	1.27	2.99	1.31	2.64	1.25	2.37	1.19
3. Rocks	2.88	1.33	3.16	1.34	2.85	1.28	2.62	1.34
4. Genetics	3.67	1.33	3.64	1.35	3.63	1.35	3.74	1.32
5. Magnetism	2.56	1.37	3.03	1.40	2.48	1.33	2.18	1.27
6. Plants	3.15	1.40	3.52	1.32	3.00	1.47	2.91	1.35
7. Chemicals	2.84	1.53	3.29	1.46	2.73	1.52	2.50	1.53
8. Stars	3.50	1.37	3.78	1.31	3.42	1.37	3.32	1.42
9. Disease	4.24	1.10	4.33	1.06	4.15	1.14	4.23	1.08
10. Polymers	2.43	1.26	2.74	1.34	2.32	1.19	2.22	1.21
11. Devices	2.56	1.39	2.89	1.44	2.53	1.37	2.24	1.30
12. Respiration	4.29	1.06	4.36	0.10	4.25	1.14	4.24	1.06
13. Planets	3.70	1.33	4.01	1.20	3.55	1.38	3.52	1.37
TOTAL	3.27	0.74	3.52	0.78	3.19	0.73	3.10	0.63

5.3.2.1 Univariate analysis of variance

The data presented in Table 5.4 show that there was dissimilarity in the interests in different science topics between student respondents in the different year groups (Year

9, 10 and 11). To examine the similarity between different year groups, a one way ANOVA was used to examine the effect of grade on students' interest in different science topics (Table 5.5). As shown in Table 5.5, there was a statistically significant difference between the grades, $F(2,797) = 25.18, p < .0005$.

Table 5.5: Item 4 Univariate analysis of variance

Source	*df*	*F*	Significance, *p*
Grade	2	25.18	.00
Error	797		

Table 5.6 shows the Post hoc tests for Item 4 in relation to interest level between grades. As shown in Table 5.6, there was a statistically significant difference between Year 9 and other grades ($p < .0005$). On the other hand, there was no significant difference between Year 10 and Year 11 ($p = .26$).

Table 5.6: Item 4_ Post hoc tests between different years

Year	Mean	SD	Significance, *p*
9	3.52	0.78	.00
10	3.19	0.73	
9	3.52	0.78	.00
11	3.10	0.63	
10	3.19	0.73	.26
11	3.10	0.63	

5.3.3 RQ 1c. What are Saudi girl students' perceptions of their understanding of different science topics? (From Item 5)

Table **5.7** shows the descriptive statistics for the students' understanding of different science topics as evidenced from their responses to the statements in Item 5. For Item 5, the response format of the 5-point Likert-type statements was between 1 and 5; "1" means "not understood", whereas "5" indicates "understood very much". The list of topics relating to Q1 to Q13 in Table 5.7 are the same as those in Table 5.4, which can be divided into four subjects: chemistry, biology, astronomy and physics. Biology topics, especially the topics related to medical science, were the most understood topics. Based on the mean scores for the contents of Item 5, topics related to *Respiration*, *Function of heart*, and *Fighting disease* appeared to be more understood by students. In contrast, chemistry and physics topics were least understood by

students. Based on the mean scores for the contents of item 5, topics related to *Polymers and plastics*, *Circuit symbols and devices*, and *Magnetic fields and electric motors* appeared to be the least understood topics for students. Furthermore, in general, girls in Year 9 reported more interest in science (3.73±0.69), followed by Year 10 (3.36±0.79), and finally Year 11 (3.31±0.68).

Table 5.7: Descriptive statistics for students' **u**nderstanding different science topics (*n* = 800)

Science Topic	Average		Year 9 (*n* = 269)		Year 10 (*n* = 265)		Year 11 (*n* = 266)	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
1. Heart	4.11	1.07	4.07	1.08	4.07	1.13	4.19	1.00
2. Light	3.28	1.30	3.71	1.21	3.07	1.28	3.07	1.30
3. Rocks	3.41	1.32	3.74	1.22	3.32	1.31	3.17	1.35
4. Genetics	3.75	1.27	3.97	1.22	3.59	1.37	3.68	1.17
5. Magnetism	2.86	1.36	3.20	1.28	2.87	1.38	2.49	1.32
6. Plants	3.72	1.25	4.10	1.06	3.49	1.35	3.55	1.22
7. Chemicals	3.05	1.48	3.43	1.35	2.91	1.50	2.81	1.53
8. Stars	3.42	1.35	3.71	1.28	3.32	1.35	3.24	1.36
9. Disease	3.99	1.24	4.12	1.20	3.88	1.33	3.95	1.19
10. Polymers	2.62	1.28	2.82	1.31	2.58	1.26	2.45	1.25
11. Devices	2.75	1.33	2.99	1.31	2.77	1.36	2.48	1.28
12. Respiration	4.29	1.04	4.44	0.93	4.15	1.13	4.27	1.03
13. Planets	3.84	1.29	4.19	1.08	3.70	1.35	3.64	1.35
TOTAL	3.47	0.74	3.73	0.69	3.36	0.79	3.31	0.68

5.3.3.1 Univariate analysis of variance

The data presented in Table 5.7 shows there was dissimilarity in perceived understanding of different science topics between student respondents in different year groups (Year 9, 10 and 11). To examine the similarity between different year groups' perceived understanding of science topics, a one way ANOVA was used for Item 5 (Table 5.8). The results showed that there was a statistically significant difference between the grades, $F(2,797) = 27.15, p < .0005$.

Table 5.8: Item 5 - Univariate analysis of variance

Source	*df*	*F*	Significance, *p*
Grade	2	27.15	.00
Error	797		

Table 5.9 presents the results of the post hoc tests for Item 5 showing the different level of grades and showed that there was a statistically difference between all three different grades ($p < .0005$).

Table 5.9: Item 5_ Post Hoc tests between different years

Year	Mean	SD	Significance, *p*
9	3.73	0.69	.00
10	3.36	0.79	
9	3.73	0.69	.00
11	3.31	0.68	
10	3.36	0.79	.00
11	3.31	0.68	

A comparison between students' perceived interest (Item 4) and perceived understanding of certain science topics (Item 5) showed that students' responses were quite similar. Figure 5.2 illustrates the correlations between students' perceived interest and understanding of different subjects. As shown in Figure 5.2, generally the relation between students' interest in topics (Item 4) and the mean for understanding of different subjects (Item 5) is positive. For all topics, when the interest is low, the average understanding is also low. On the other hand, if student interest is high, the average of their perceived understanding is also high. This relationship shows how the perceived interest can influence perceived understanding of the different science topics for Saudi girl students. Moreover, the average of correlation coefficient between interest and understanding of the different subject statements is 0.95. Increasing subject interest (as motivation) is one of the important factors for learning science. Therefore, increasing students' subject interest helps to increase their understanding of the subject.

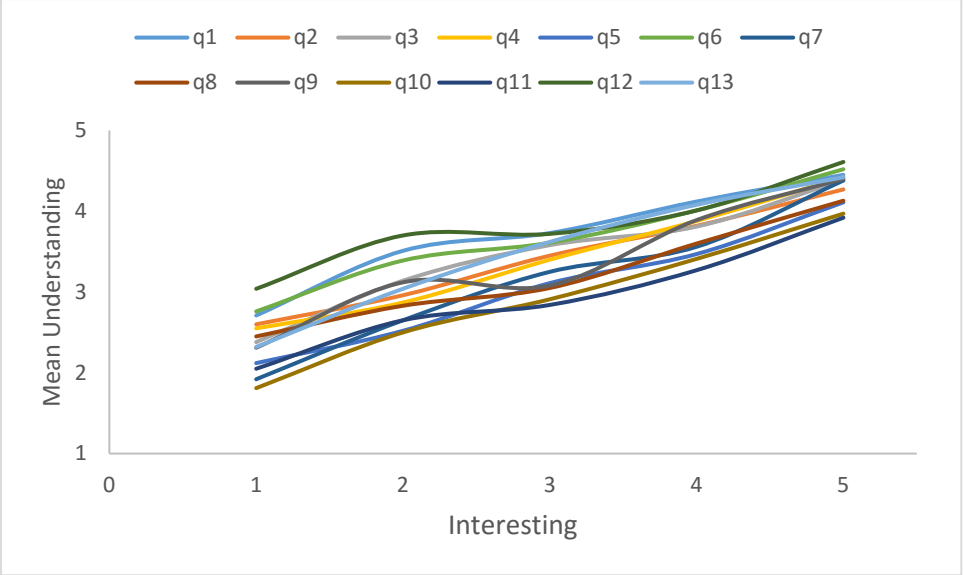

Figure 5.2: Correlation between interesting and understanding for different subjects

5.3.4 RQ 1d. What are Saudi Girls' Views about Physics? (From Item 6)

The descriptive statistics for students' responses to Item 6 are presented in Table 5.10. Students from Year 9 did not answer Item 6 because physics was not included in their curriculum. For Item 6, the response format of the 5-point Likert-type statements was between 1 and 5; "1" means "strongly disagree", whereas "5" means "strongly agree". Saudi girls in Years 10 and 11 gave a higher rating to the Statements 2 and 5. Statements 2 (*I find physics very practical but it is boring*) had the highest mean score (3.71, 3.68 and 3.74); similarly, statement 5 (*Physics is interesting but not enjoyable*) had mean scores of 3.55, 3.61 and 3.49. Observing the trend in students' responses to these statements, it is evident that Saudi girls viewed Physics as boring and unenjoyable, despite their agreement that Physics is practical and interesting. Furthermore, the participants also agreed with Statement 9 (*I'm not really sure what physics is*) and Statement 10 (*Physics is fascinating but I won't continue with it. What's the point?*). Therefore, students disagreed with the Statement 1 (*Physics is very relevant to the work I want to do*). Also, the participants disagreed with Statement 4 (*The laws and all of the maths makes physics difficult to learn and remember*) and Statement 6 (*Physics is too difficult for me*). This result means that most of the students who did not plan to go further in studying physics because they thought there was no benefit of studying in this field and they would not work in it. As would be expected, most of the disagreements came from Year 11, where half of students already selected the literary stream.

Table 5.10: Descriptive statistics for physics meaning to participants (n = 531)

Statement Numbers	Average		Year 9		Year 10 (n = 265)		Year 11 (n = 266)	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
1. Relevant	2.51	1.53	--	--	2.82	1.54	2.20	1.46
2. Practical and boring	3.71	1.39	--	--	3.68	1.34	3.74	1.44
3. Understand	3.17	1.31	--	--	3.34	1.31	2.99	1.31
4. Laws	2.44	1.53	--	--	2.45	1.50	2.44	1.57
5. Interesting and unenjoyable	3.55	1.40	--	--	3.61	1.38	3.49	1.44
6. Too difficult	2.72	1.47	--	--	2.83	1.44	2.61	1.50
7. Remote	2.79	1.36	--	--	2.78	1.36	2.80	1.35
8. Clever	2.79	1.43	--	--	2.97	1.46	2.62	1.38
9. Not sure	3.31	1.42	--	--	3.29	1.42	3.33	1.41
10. Not continue	3.33	1.51	--	--	3.41	1.51	3.26	1.50
TOTAL	3.03	0.62	--	--	3.12	0.56	2.95	0.66

5.3.4.1 Independent samples *t*-test

The data presented in Table 5.4 shows that there was a dissimilarity between students' interests in different science topics as evidenced from the responses of students in Year 10 and 11. To examine the difference statistically between these two groups, an independent t-test was used to examine the effect of grade on students' views about physics (Item 6) (Table 5.11). The analysis showed that Saudi girls in Year 10 had statistically higher interest in physics topics (3.25 ± 0.56) compared to Saudi girls in Year 11 $(3.11 \pm 0.66), t(529) = 3.70, (p < .0005)$.

Table 5.11: Item 6_ Independent samples t-test

Source	N	Mean	SD	*df*	t-value	Significance, *p*
Grade	265	3.25	0.56	529	3.70	.00
Error	266	3.11	0.66			

Based on the results presented in Table 5.1: Descriptive statistics for girls' view of science, Table 5.4, Table 5.7, Table 5.10 and Figure 5.1, it is evident that Saudi girl students were attracted to science subjects that are relevant to them. These girls were more interested in the medical subjects like *Respiration*, *How the heart work and Genetics* (see Table 5.4). In contrast, they had lower interest and understanding in physical science topics like *Magnetic fields and electric motors*, and *Circuit symbols*

and devices. Saudi girls' students feel bored in the physics class as shown in Table 5.10. This feeling leads the students to stay away from the physics content. Moreover, the relation between perception and interest as shown in Figure 5.2 explains why the girls understand medical subjects more than other subjects (see Table 5.7).

5.3.5 Cronbach Alpha Reliability Coefficients

Table 5.12: Cronbach Alpha Reliability Coefficients for Items 3, 4, 5 and 6

	No. of Items	Cronbach's Alpha			
		Average	Year 9	Year 10	Year 11
Item 3	5	0.77	0.74	0.73	0.74
Item 4	13	0.82	0.86	0.81	0.74
Item 5	13	0.84	0.83	0.85	0.80
Item 6	10	0.71		0.70	0.71

Table 5.12 shows that the Cronbach alpha reliability coefficients for Item 3, 4, 5 and 6 are acceptable to give confidence for the researcher to use the results for the all the three years or individual years (Hof, 2012). All items, in Table 5.12, have Cronbach's alpha coefficients higher than 0.6 either for average or individual Years 9, 10 and 11. The average Cronbach's alpha for Items 3, 4, 5 and 6 are 0.77, 0.82, 0.84 and 0.71, respectively.

5.4 Response to Research Question 2: What are Saudi girls' motivations for learning science?

The analysis of data with respect to Item 10 needs to be meaningful. Exploratory factorisation of the data is one of the strategies to minimise research bias and make meaningful conclusion from the data (Kim & Mueller, 1978; Pallant, 2013). Factorising was not done in the pilot trial because the data set was not large enough.

As shown in Table 5.13, the motivation statements mean results can be distributed to four factors: *Confidence*, *Enjoyment*, *Personal relevance of science* and *Extrinsic motivation*. The results of factoring with eigenvalues higher that 0.9 revealed that there are four factors, and the lowest eigenvalue was 0.94 (see Table 5..13). The four factors accounted for 54.5% of the variance.

Table 5.13: Exploratory factor analysis of Saudi girls' motivation instrument

Statement	Original Statement	Factor loadings (λ)			
		Enjoyment	Extrinsic motivation	Confidence	Personal relevance of science
1	15	0.71			
2	13	0.62			
3	12	0.47			
4	16	0.40			
5	4		0.78		
6	3		0.73		
7	6		0.66		
8	7		0.40		
9	9		0.39		
10	18			0.64	
11	17			0.60	
12	14			0.46	
13	5				0.61
14	8				0.44
15	2				0.43
16	19				0.41
17	10				0.39
Eigenvalues		5.90	2.55	0.97	0.94
% variance		31.03	13.43	5.10	4.95

Table 5.14 displays the Motivation mean score results (Item 10). In Item 10, the response format of the 5-point Likert-type statements was between 1 and 5. “1” means “never”, whereas “5” means “always”. In Item 10, most of the statements were positive except for Statements 7 and 9 which were negative and had mean score values less than 3.0. The highest mean score was for Statement 19 (*Understanding the science gives me a sense of accomplishment*) with a mean score of 3.72 for all the participants, and 3.86 for Year 9, 3.63 for Year 10 and 3.68 for Year 11. This information is consistent with the data from Item 3 (see Statement 2 in Table 5.1) “*I like science because it helps me to understand myself and the world*”. The Saudi girl students had feelings of accomplishment as a result of understanding themselves and the surrounding world which encouraged them to continue and look for new goals. On the other hand, the lowest mean score in the Motivation questionnaire (Table 5.14) was for Statement 7 (*I am concerned that the other students are better in science*). The mean score for Statement 7 is 2.71 for all the participants, 2.57 for Year 9, 2.80 for Year 10 and 2.78 for Year 11. This statement gives an indication that there was competition between the girl students which they did not necessarily like.

Table 5.14: Descriptive statistics for the motivation instrument results based on four factors (n = 800)

Statement Numbers	Average		Year 9 (n = 269)		Year 10 (n = 265)		Year 11 (n = 266)	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Enjoyment								
12. Interest	3.32	1.37	3.63	1.35	3.20	1.29	3.14	1.42
13.My Life	3.35	1.30	3.60	1.30	3.28	1.29	3.18	1.26
15. Practical	3.25	1.31	3.52	1.32	3.23	1.29	3.02	1.29
16. Challenges	3.22	1.42	3.70	1.29	3.13	1.40	2.84	1.44
Extrinsic Motivation								
3. Nervous	3.26	1.44	3.04	1.44	3.35	1.42	3.41	1.45
4. Anxious	3.34	1.47	3.07	1.45	3.32	1.46	3.66	1.45
6. Worry	3.15	1.53	2.88	1.57	3.17	1.51	3.42	1.48
7. Concerned	2.71	1.47	2.57	1.53	2.80	1.42	2.78	1.44
9. Hate	2.77	1.51	2.28	1.49	2.83	1.44	3.23	1.51
Confidence								
14. Can be master	3.36	1.27	3.52	1.30	3.29	1.23	3.29	1.26
17. Tests	3.40	1.27	3.77	1.32	3.25	1.22	3.18	1.20
18. Getting A grade	3.57	1.36	3.89	1.34	3.42	1.33	3.42	1.37
Personal relevance								
2. Personal	3.51	1.37	3.65	1.26	3.48	1.38	3.42	1.45
5. Helpful	3.37	1.29	3.43	1.34	3.29	1.29	3.41	1.24
8. Grade	3.17	1.36	3.43	1.40	2.99	1.32	3.10	1.33
10. Think about use	3.23	1.29	3.41	1.32	3.04	1.26	3.26	1.27
19. Accomplishment	3.72	1.42	3.86	1.36	3.63	1.42	3.68	1.49
TOTAL	3.29	0.68	3.40	0.72	3.23	0.64	3.24	0.68

5.4.1 Motivational factors

5.4.1.1 Enjoyment

The first factor—Saudi girls' science enjoyment—includes Statement 12 (*I find learning the science interesting*), Statement 13 (*The science I learn is relevant to my life*), Statement 15 (*The science I learn has practical value for me*) and statement 16 (*I like science that challenges me*). Figure 5.3 illustrates Saudi girls' science enjoyment. Saudi Girls' in Year 9 expressed more interest, liking and enjoying than students in Year 10 and Year 11. Also, it was found out that the Saudi girls in Year 9 were enjoying science more than having their interest in science. Saudi girls in Year 9 have average mean score of more than 3.5 for the factor Enjoyment. In contrast, the joy of learning of science appeared to be lower than their interest for Years 10 and 11 students. This result matches the view of the physics results, Statement 5 (*Physics is interesting but not enjoyable*) (see Table 5.10).

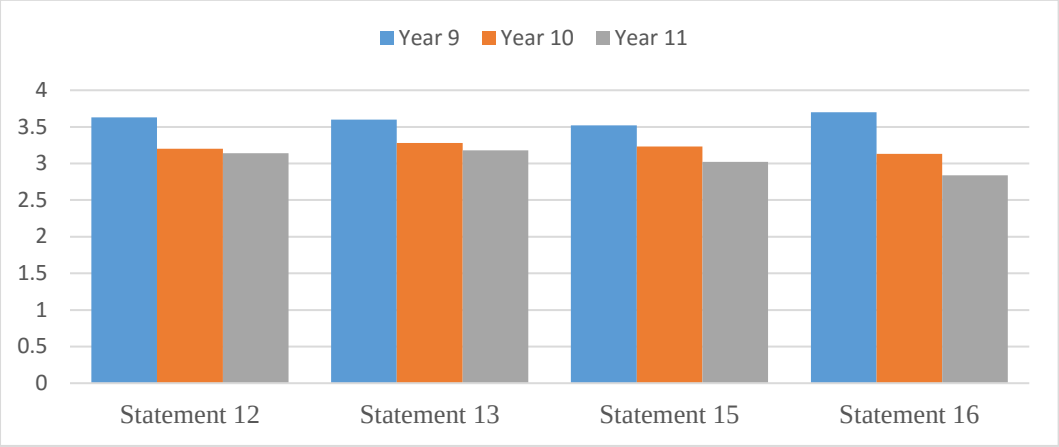

Figure 5.3: Saudi girls' science enjoyment based on the four items in the Motivation instrument

5.4.1.2 Extrinsic motivation

The second factor—Extrinsic motivation—includes Statement 3 (*I am nervous about how I will do on the science tests*), Statement 4 (*I become anxious when it is time to take a science test*), Statement 6 (*I worry about failing the science tests*), Statement 7 (*I am concerned that the other students are better in science*) and Statement 9 (*I hate taking the science tests*). Figure 5.4 presents students' mean scores for their responses to the statements representing extrinsic motivation. Girls in senior years groups (Year 10 and 11) tended to hate and worry about science more than those in the lower year group (Year 9). Moreover, students in the upper year groups (Year 10 and 11) had a general inferiority feeling (that other students are better in science) that those in Year 9.

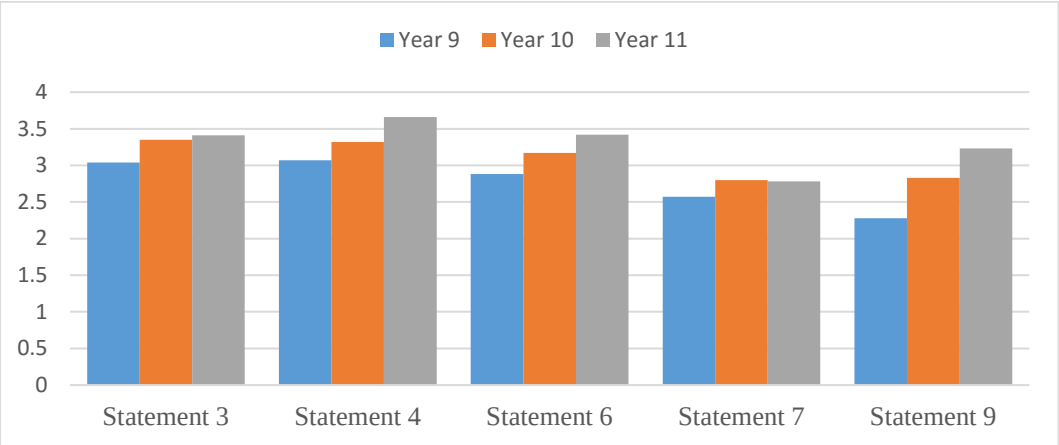

Figure 5.4: Extrinsic motivation based on the four items in the Motivation instrument

5.4.1.3 Confidence

The third factor—Saudi girls' confidence—includes Statement 14 (*I believe I can master the knowledge and skills in the science course*), Statement 17 (I am confident I will do well on the science tests) and Statement 18 (*I believe I can earn a grade of "A" in the science course*). Figure 5.5 shows the Saudi Girls' confidence in learning science and physics. Girls in Year 9 had more confidence than those in Year 10 and Year 11. Saudi girls in Year 9 had mean scores of 3.52, 3.77 and 3.89 for Statements 14, 17 and 18, respectively. But Saudi girls in Year 10 and 11 had mean scores less than 3.55 for the statements in this factor generally.

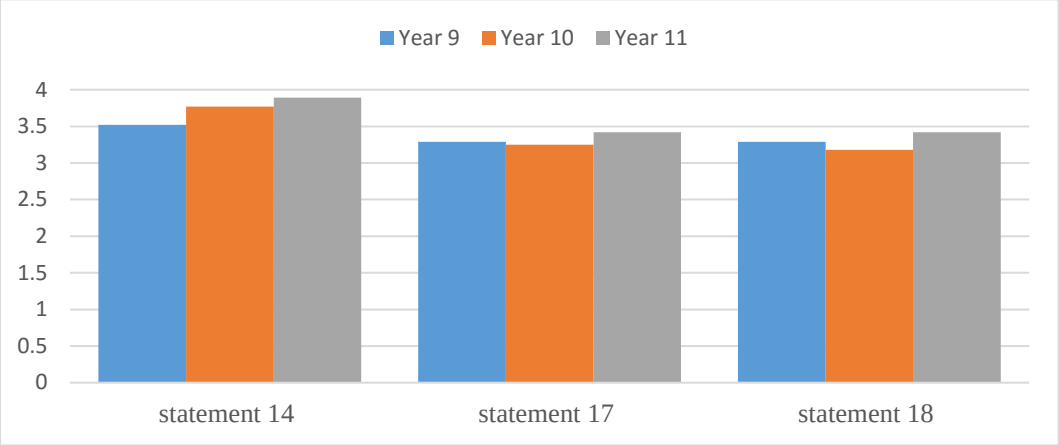

Figure 5.5: Saudi girls' confidence based on the four items in the Motivation instrument

5.4.1.4 Personal relevance of Science

The fourth factor—Saudi girls' personal relevance of science—includes Statement 2 (*The science I learn relates to my personal goals*), Statement 5 (*I think about how the science I learn will be helpful to me*), Statement 8 (*The science I learn is more important to me than the grade I receive*), Statement 10 (*I think about how I will use the science I learn*) and Statement 19 (*Understanding the science gives me a sense of accomplishment*). Figure 5.6 clarifies the Saudi girls' perceptions on personal relevance of science. Saudi girls in Year 9 were more closely associated with science than students in Years 10 and 11. However, the Year 9 students appeared to have more understanding, enjoying and thinking of the use of science knowledge, followed by students in Year 11, and lastly, students in Year 10.

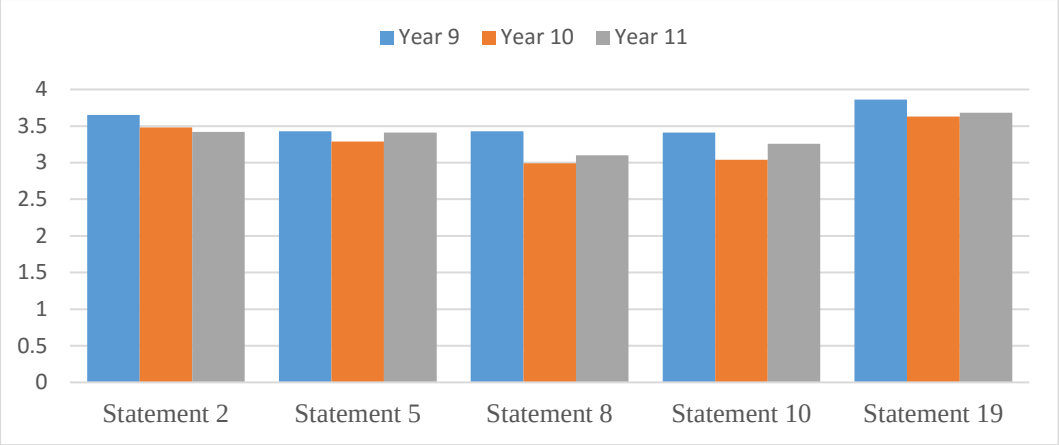

Figure 5.6: Saudi girls' perception on personal relevance of science based on the four items in the Motivation instrument

5.4.1.5 Univariate analysis of variance

The data shown in Figures 5.3, 5.4, 5.5 and 5.6 in Section 5.4 indicate that there was a dissimilarity in motivation between student respondents in the different year groups (Years 10 and 11). In order to statistically compare the different year groups. A two way ANOVA was used to examined the effect of grade on motivation (Item 10). As shown in Table 5.15, there were a statistically significant difference between the grades: for Confidence factor, $F(2,797) = 11.95,\ p < .005$, for Enjoyment factor, $F(2,797) = 21.80,\ p < .005$, for Extrinsic motivation factor, $F(2,797) = 18.90, p < .005$, and for Personal Relevance of Science factor, $F(2,797) = 11.67, p < .005$.

Table 5.15: Item 10_ Univariate analysis of variance for all different factors

	Source	*df*	*F*	Significance, *p*
Enjoyment	Grade	2	21.80	.000
	Error	797		
Extrinsic motivation	Grade	2	18.90	.000
	Error	797		
Confidence	Grade	2	11.95	.000
	Error	797		
Personal relevance of science	Grade	2	11.67	.000
	Error	797		

Table 5.16 shows the post hoc tests for Item 10 for the different factors and grade levels. The results in Table 5.14 showed that there was a statistically significant

difference between the mean scores of Year 9 and other grades ($p < .005$) for all the four factors. On the other hand, there was no significant difference between the mean scores for Year 10 and Year 11 (for Confidence, $p = 0.32$; for Enjoyment, $p = .06$; for Personal Relevance of Science, $p = .08$; and for Extrinsic Motivation, $p = .02$).

Table 5.16: Item 10 Post Hoc tests between different years and all different factors

	Grade	Mean	SD	Significance, *p*
Confidence	9	3.68	1.05	.00
	10	3.36	0.98	
	9	3.68	1.05	.00
	11	3.28	0.98	
	10	3.36	0.98	.32
	11	3.28	0.98	
Enjoyment	9	3.61	1.06	.00
	10	3.21	1.00	
	9	3.61	1.06	.00
	11	3.04	1.01	
	10	3.21	1.00	.06
	11	3.04	1.01	
Extrinsic motivation	9	2.77	1.01	.00
	10	3.09	0.98	
	9	2.77	1.01	.00
	11	3.30	1.02	
	10	3.09	0.98	.02
	11	3.30	1.02	
Personal relevance of science	9	3.60	0.94	.00
	10	3.26	0.83	
	9	3.60	0.94	.00
	11	3.30	0.86	
	10	3.26	0.83	.08
	11	3.30	0.86	

5.4.2 Cronbach Alpha Reliability Coefficient

Table 5.17 shows the Cronbach alpha reliability coefficients for the four factors or scales of Motivation from Item 10. The reliability for four scales of Item 10, *Confidence, Enjoyment, Personal relevance of science and Extrinsic motivation*, was high enough for using the results with confidence for all the three years and individual years in this research (Hof, 2012).

Table 5.17: Cronbach Alpha Reliability Coefficients for Item 10 Motivation factors

Scales	Number of Statements	Cronbach's Alpha		
		Year 9	Year 10	Year 11
Confidence	4	0.81	0.76	0.73
Enjoyment	4	0.81	0.75	0.72
Extrinsic motivation	5	0.70	0.70	0.73
Personal relevance of science	6	0.76	0.75	0.67

5.5 Response to Research Question 3: Does physics match Saudi girls' stereotype of a scientist or physicist?

5.5.1 What are Saudi Girls' Favourite Subjects?

In 65Item 7, the participants' descriptive statistics indicated their favourite subjects from 1 to 4. "1" means "the most favourite subject", whereas "4" means "the least favourite subject". Item 7 has four subjects (Mathematics, Science, Arabic and English). Only half of the participants had responded to Item 7. As shown in Table 5.18, Science was the most favourite subject with a mean score of 2.19 on average for all year groups, 1.72 for Year 9 and 2.39 for Year 10. Science was the second most favourite subject for Year 11 with a mean 2.47. On the other hand, Mathematics was the least favourite subject with a mean score of 2.78 on average for all, 2.87 for Year 9, 2.63 for Year 10 and 2.82 for Year 11.

Table 5.18: Descriptive statistics for students' choice of most favourite subject (n = 400)

	Average		Year 9 (n = 134)		Year 10 (n = 133)		Year 11 (n = 133)	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Math	2.78	1.13	2.87	1.04	2.63	1.20	2.82	1.14
Science	2.19	0.95	1.72	0.79	2.39	0.92	2.47	0.96
Arabic	2.52	1.11	2.51	1.05	2.48	1.15	2.57	1.13
English	2.49	1.18	2.88	1.14	2.47	1.16	2.12	1.11
TOTAL	2.5		2.5		2.5		2.5	

In contrast to Table 5.18, the results in Table 5.19 show the least favourite subject (Item 8). For Item 8, which is exactly opposite in meaning to Item 7, the participants had orderly listed the subjects from 1 to 4. "1" means "the least favourite subject", whereas "4" means "the most favourite subject". Item 8 has the same four subjects like that of Item 7 (Mathematics, Science, Arabic and English). Half of the participants responded to Item 7 (the most favourite subject) and the other half completed Item 8 (the least favourite subject). Comparing students' most favourite and least favourite subjects helps to indicate that students' stereotypes. Mathematics is the least favourite subject by an average mean score of 2.03 for all year groups, with mean scores of 2.10, 2.05 and 1.94, respectively, for Years 9, 10 and 11. Science is one of most favourite subject with mean scores of 2.68 and 3.12 for all year groups and Year 9, respectively. Both Table 5.18 and Table 5.19 have almost similar results; both tables show that Mathematics is the least favourite subject, the most favourite subject in Year 9 is Science and the most favourite subject in Year 11 is English. The responses of Year 10 students to Items 7 and 8 were different. Science is their most favourite subject in Table 5.18 but their second least favourite subject in Table 5.19.

Table 5.19: Descriptive statistics for students' choice of least favourite subject (n = 400)

	Average		Year 9 (n = 135)		Year 10 (n = 132)		Year 11 (n = 133)	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Math	2.03	1.16	2.10	1.14	2.05	1.21	1.94	1.12
Science	2.68	0.96	3.12	0.86	2.51	0.91	2.39	0.95
Arabic	2.60	1.05	2.47	1.05	2.70	1.03	2.63	1.06
English	2.68	1.15	2.29	1.12	2.72	1.15	3.02	1.06
TOTAL	2.5		2.5		2.5		2.5	

Table 5.20 shows the results of ranking of the 11 school subjects (Item 9). In Item 9, the popularity of the school subjects was scored on a 'continuum' from 1 to 11. The most popular school subject received the highest score (11) and the least popular school subject was assigned a score of 1. The topics in the Table **5.20** can be divided to 11 subjects: 1) Religion subjects, which include Fiqh, Hadeath, Quraan, Tafseer and Tawhead. 2) English. 3) Mathematics. 4) Computer. 5) Science subjects, which include Biology, Chemistry, Physics and Science. 6) Arabic subjects, which include Arabic or Grammar, Poetry, Reading, Critic and Writing. 7) Practical subjects such as

Cooking and sewing. 8) Phycology. 9) Library. 10) Art. 11) Social subjects, which include History and Geography.

In Year 9, it is obvious that Science was the most favourite subject for the students with a mean score of 8.21. The second favourite subject was religion, especially the topics of Tawhead (mean = 6.75) and Fiqh (mean = 6.37). The third favourite subject was Mathematics with a mean of 5.85. Arabic language came in the fourth favourite subject with a mean of 5.60. English came in the fifth favourite subject with a mean of 5.03. Social, Art, Practical and Computer came in the positions from sixth to ninth with means of 4.75, 4.40, 4.22 and 3.04, respectively. For Science, this results were similar to those in Table 5.18 and Table 5.19 which indicates that Science was an attractive subject for students in Year 9.

Moreover, in Year 10, the most favourite subject for students was religion especially the topics of Tawhead (mean = 6.34) and Fiqh (mean = 5.64). The Year 10 Saudi students' ranking of their favourite school subjects was: 2) Mathematics. 3) Chemistry. 4) English. 5) Biology. 6) Physics. 7) Arabic language, especially poetry and grammar. 8) Social. 9) Computer. 10) Practical. 11) Art and Psychology. There is a variation in Year 10 students' subject preferences (see Table 5.18, Table 5.19 and Table 5.20); and the variation might have occurred due to the change in the school environment and topics. Students generally experience a change in the learning environment as a consequence of moving from middle school to high school upon graduation from middle school. The change of school results in a change of teachers, classmates, school management, school rules and so on. Also, the curriculum in high school is different from that in middle school. For example, Science is divided to three subjects (Biology, Chemistry and Physics).

Furthermore, for those students in Year 11 science stream, the most favourite subject was Biology with a mean of 7.58. The ranking of their other favourite school subject was: 2) Religion especially Tawhead, 3) Chemistry, 4) English, 5) Mathematics, 6) Physics, 7) Arabic language, 8) Computer, 9) Practical, 10) Art and 11) Social. On the other hand, for the students in the Year 11 literary stream, the most favourite subject was Psychology with a mean of 6.56. They ranked their other favourite school subjects as: 2) Arabic especially Poetry, 3) English, 4) Religion especially Tawhead, 5) Social, 6) Practical, 7) Computer and 8) Art.

Table 5.20: Descriptive statistics for ranking of the 11 school subjects (n = 800)

	Year 9 (n = 269)		Year 10 (n = 265)		Year 11 (SCIENCE) (n = 133)		Year 11 (LITERACY) (n = 133)	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Fiqh	6.37	2.76	5.64	3.43	5.55	2.86	4.36	3.08
Hadeath	4.25	3.20	4.20	3.70	4.97	3.23	4.95	3.37
Quraan	3.79	3.90	1.78	3.19	1.21	2.50	3.00	3.86
Tafseer	3.15	3.67	0.01	0.13				
Tawhead	6.75	2.70	6.34	3.72	6.77	3.17	5.62	3.56
English	5.03	4.04	4.96	4.49	6.57	4.04	5.85	4.25
Math	5.85	3.92	5.54	4.30	6.16	3.91	0.15	1.00
Computer	3.04	3.09	1.46	2.42	2.33	2.54	2.27	3.29
Biology			4.54	0.97	7.58	2.97	0.12	0.96
Chemistry			5.01	3.95	6.67	3.17	0.02	0.19
Physics			4.38	3.94	5.03	3.43	0.09	0.49
Science	8.21	3.24	0.07	3.72				
Arabic	5.60	3.39	3.90	3.43	4.35	3.20	5.12	3.67
Poetry			4.16	2.50	4.33	3.03	6.33	3.29
Reading			1.22	0.72	0.24	1.29	1.31	2.77
Critic			3.22	2.49	0.18	1.15	5.43	3.58
Writing			0.23	1.92	0.63	1.66	1.06	2.32
Practical	4.22	2.94	1.18	3.48	1.72	2.77	3.21	3.96
Psychology			0.06	3.25			6.56	4.10
Library			0.71	3.29	0.05	0.33	1.41	2.24
Art	4.40	3.10	0.60	1.82	0.83	2.30	0.39	1.43
History	4.75	3.23	3.48	3.80	0.34	1.51	4.15	3.17
Geography	0.40	1.66	3.22	3.58	0.39	1.78	4.51	3.43

The subject not studied in the year

The subject not studied in the year but some students include it in their favourite subjects

This result matches those in Table 5.4 and Table 5.7. Moreover, for all participants, the topics on religion and English (as foreign language) were highly favourite subjects.

5.5.2 Factorial structure of stereotype

Item 11 has been used to test the perceived stereotype of high school Saudi girls' students for students who study science. Participants were asked about their liking of science as a subject. The main purpose of Item 11 is to understand Saudi girl students'

perspectives about being a scientist in an attempt to explore their stereotype. Item 11 was created by Hannover and Kessels (2004) and contains 65 Likert-type statements with a 7-point response format, where “1” indicates “totally disagree”, whereas “7” indicates “totally agree”.

To analyse the huge amount of data obtained from Item 11, exploratory factor analysis was performed to identify the factorial structure of the perceived stereotype. Factorisation of the data is one of the strategies to eliminate research bias and make meaningful conclusion from the data (Kim & Mueller, 1978; Pallant, 2013). When the factor analysis is performed, it not only establishes the latent structure of the construct stereotype but also enables the researcher to utilise the latent constructs for meaningful conclusions in the study.

Hannover and Kessels (2004, p. 57) conducted “a factor-analysis on students’ self-descriptions on the 65 trait adjectives and five factors were extracted”. Those factors are Physical, social and emotional attractiveness, Social competence & integration, Intelligence & motivation, Arrogance & self-centredness, and Creativity and emotions.

Similarly, a factor analysis was conducted on Saudi girls’ stereotype on the 65 statements. As shown in

Table 5.21, the factor analysis of the data obtained from Item 11 revealed three latent factors or constructs which were identified as: 1) Intelligence and Motivation, 2) Physical, Social and Emotional Attractiveness, and 3) Social Competence. The second phase of the data analysis of Item 11 involved a discussion on students’ responses to the individual constructs which is presented in the next sections of this chapter. The results of factoring with eigenvalues higher than 1 revealed that there are three factors, and the lowest eigenvalue was 3.79. These three factors accounted for 36.9% of the variance.

Table 5.21: Exploratory factor analysis of Saudi girls' perceptions based on stereotype instrument

Statement number	Original Statement number	Factor Loadings (λ)		
		Intelligence & Motivation	Physical, Social & Emotional Attractiveness	Social Competence
1	1	0.53		
2	4	0.58		
3	5	0.61		
4	6	0.44		
5	11	0.66		
6	15	0.44		
7	16	0.73		
8	25	0.72		
9	26	0.62		
10	28	0.71		
11	29	0.55		
12	33	0.45		
13	35	0.49		
14	40	0.42		
15	41	0.52		
16	44	0.72		
17	47	0.64		
18	49	0.49		
19	63	0.64		
20	64	0.63		
21	3		0.50	
22	12		0.54	
23	17		0.58	
24	18		0.49	
25	19		0.57	
26	23		0.66	
27	24		0.65	
28	30		0.66	
29	34		0.42	
30	36		0.62	
31	42		0.64	
32	45		0.62	
33	50		0.41	
34	51		0.43	
35	52		0.58	
36	57		0.43	
37	13			0.52
38	14			0.45
39	27			0.55
40	32			0.53
41	37			0.57
42	48			0.62
43	54			0.63
44	55			0.56
45	56			0.42
46	58			0.49
47	61			0.47
48	62			0.63
Eigenvalues		8.32	5.97	3.79
% variance		16.97	12.18	7.74

5.5.2.1 Factor 1 - Intelligence & Motivation

Table 5.22 presents the mean scores of Year 9, 10 and 11 students for each of the statements that make up the Intelligence and Motivation factor. This factor has high agreement from participants. The mean score of the factor which contained 20 statements ranged between 4.92 and 6.05 (see notes in Table 5.22). Statement number 25 (Intelligent) had the highest mean (6.05). In Arabic interpretation, this factor has three statements containing synonymous words "ذكية": 1) *Intelligent* (# 25); 2) *Clever* (#28); and 3) *Smart* (#44). These statements have a higher agreement as indicated by mean scores for Year 9, 10 and 11 students of 6.05, 5.94 and 5.86 respectively.

Table 5.22: Descriptive statistics for the Intelligence & Motivation factor results (*n* = 800)

Statements	Average		Year 9 (*n* = 269)		Year 10 (*n* = 265)		Year 11 (*n* = 266)	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
1) Respected	5.89	1.60	6.00	1.49	5.69	1.72	5.98	1.58
4) Open-mined	5.93	1.60	6.18	1.44	5.69	1.76	5.90	1.55
5) Persistent	5.66	1.70	5.72	1.64	5.54	1.79	5.72	1.66
6) Sought-after	5.13	1.79	5.11	1.76	5.05	1.81	5.22	1.82
11) Ambitious	5.93	1.82	5.97	1.63	5.78	1.80	▲6.04	2.01
15) Emotional	5.28	2.22	5.19	1.86	5.13	1.89	5.51	2.78
16) Diligent	5.98	1.61	6.15	1.44	5.76	1.84	6.03	1.48
25) Intelligent	▲6.05	1.54	▲6.23	1.42	▲5.87	1.66	6.03	1.51
26) Interested	5.67	1.69	5.86	1.55	5.47	1.76	5.69	1.73
28) Clever	5.94	1.60	6.07	1.55	5.77	1.73	5.96	1.51
29) Outgoing	5.26	1.79	5.28	1.76	5.10	1.88	5.40	1.72
33) Appreciates	5.03	1.79	5.22	1.77	4.85	1.82	5.03	1.77
35) Logical	5.18	1.78	5.24	1.80	5.10	1.76	5.19	1.77
40) Imaginative	4.99	1.84	5.04	1.79	4.89	1.85	▼5.03	1.88
41) Eloquent	5.34	1.85	5.40	1.93	5.19	1.92	5.45	1.68
44) Smart	5.86	1.66	5.89	1.70	5.68	1.80	6.02	1.44
47) Self-confident	5.77	1.69	5.91	1.60	5.50	1.84	5.89	1.60
49) Motivating	▼4.92	1.91	▼4.97	1.88	▼4.73	1.99	5.06	1.85
63) Eager to learn	5.67	1.78	5.84	1.72	5.38	1.88	5.78	1.70
64) Witty	5.58	1.81	5.74	1.68	5.37	1.98	5.64	1.73
Notes:	▲	The highest mean score						
	▼	The lowest mean score						

Moreover, statements like *persistent* (#25), *ambitious* (#11) and *diligent* (#16) are related to hard work in the Arabic language. Participants' responses to these statements were also high. Also, for statements like *Emotional* (#15), *Appreciates* (#33) and *Motivating* (#49), the participants' agreement was lower than those for the statements of *Smart* and hard work.

Furthermore, in Year 9, the participants' mean scores for the construct of Intelligence and Motivation ranged between 4.97 and 6.23. When observing the constituent statements individually, Intelligent (#25) had the highest mean (6.23), whereas Motivating (#49) had the lowest mean (4.97). The Year 9 participants' perception of a scientist as a smart and hardworking person might have led to their lowest rating for motivating statement (see Table 5.22). Moreover, in Year 10, the mean score for the factor ranged between 4.73 and 5.87. Statement 25 (Intelligent) had the highest mean (5.87), whereas Statement 49 (Motivating) has the lowest mean (4.73). Similar to the participants in Year 9, Year 10 participants believed that a scientist is a smart, hard worker and were assigned a lower score for motivation. However, participants of Year 10 gave the lowest mean scores for all statements in the Intelligence and Motivation factor. Finally, in Year 11, the mean score for the construct ranged between 5.03 and 6.04. Statement 11 (*Ambitious*) had the highest mean (6.04) while Statement 40 (*Imaginative*) had the lowest mean (4.73) for these Year 11 students. The descriptive statistics for Intelligence and Motivation indicate that Year 11 students had lower mean scores than Year 9 participants, which was the reason for Saudi girls in Year 9 to choose science subject as their highest favourite subject (see Table 5.18 and Table 5.19 in Section 5.5.1). In contrast, the mean scores for the motivation statements were higher for Year 11 participants which indicated that Saudi girls in Year 11 had more respect for women scientists, and they had confidence that a woman scientist can motivate them to reach their higher education level. The trend in students' mean scores for items of Intelligence and Motivation indicates that girls who like science as a subject consider that being a woman scientist is also Smart, Ambitious and Motivating.

5.5.2.2 Factor 2 - Physical, Social & Emotional Attractiveness

Table **5.23** presents the mean scores of Year 9, 10 and 11 students for each of the items that make up the Physical, Social & Emotional Attractiveness factor. The statements

in this factor were accepted by participants. The mean score for the construct of physical, social and emotional attractiveness ranged between 4.06 and 5.26. Statement 12 (*Empathetic*) had the highest mean score (5.26), whereas Statement 42 (*Romantic*) had the lowest mean score (4.06) (see notes in Table 5.23). Furthermore, some of the statements under this construct are grouped as 1) Social and Emotional attractiveness and 2) Physical attractiveness. Social and Emotional attractiveness statements include Statements 3 (*Attractive*), 12 (*Empathetic*) and 17 (*Cheerful*). Physical attractiveness includes Statements 23 (*Stylish*) and 45 (*Pretty*). In their responses to this factor, the participants believed that the girl who likes the subject science can be beautiful and empathetic. Moreover, they slightly agreed with that the girl who likes the subject science is caring for fashion.

Table 5.23: Descriptive statistics for the Physical, Social & Emotional Attractiveness factor results (*n* = 800)

Statements	Average		Year 9 (*n* = 269)		Year 10 (*n* = 265)		Year 11 (*n* = 266)	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
3) Attractive	4.91	1.81	4.89	1.69	4.90	1.82	4.92	1.93
12) Empathetic	▲5.26	1.81	▲5.51	1.70	5.12	1.86	5.15	1.84
17) Cheerful	5.20	1.89	5.46	1.71	4.93	1.97	5.20	1.94
18) Educated (emotionally)	5.07	1.81	5.24	1.77	4.84	1.87	5.13	1.79
19) Sensitive	4.20	1.99	4.23	1.99	▼4.09	2.00	4.29	1.97
23) Stylish	5.15	1.83	5.26	1.72	4.93	1.95	5.26	1.79
24) Good-looking	5.23	1.83	5.20	1.85	5.11	1.82	▲5.37	1.82
30) Body-aware	4.79	1.97	4.85	1.89	4.78	1.94	4.75	2.09
34) Easy-going	4.82	1.91	5.08	1.80	4.72	1.91	4.65	1.98
36) Fashion	4.22	1.99	4.32	1.87	4.24	1.95	4.11	2.13
42) Romantic	▼4.06	2.01	▼4.07	1.97	4.11	2.02	▼4.00	2.06
45) Pretty	5.18	1.82	5.18	1.87	▲5.13	1.80	5.22	1.78
50) Spontaneous	5.03	1.83	5.20	1.77	4.90	1.85	4.99	1.86
51) Athletic	4.82	1.86	4.87	1.85	4.70	1.94	4.87	1.80
52) Sparkling	4.91	1.88	5.07	1.81	4.69	1.93	4.96	1.90
57) Courted	4.82	1.83	4.89	1.89	4.74	1.81	4.82	1.78
Notes:	▲	The highest mean score						
	▼	The lowest mean score						

5.5.2.3 Factor 3 - Social Competence

Table 5.24 presents the mean scores for Year 9, 10 and 11 students for each of the items that make up the Social Competence factor. The mean scores of the students across all the year levels for the construct of social competence ranged between 3.06 and 3.74 with Statement 14 (*One-sided*) having the highest mean (3.74) and Statement 56 (*Inexperienced*) having the lowest mean (3.06) (see notes in Table 5.24). Furthermore, Table 5.24 shows the statements in the Social Competence factor that described negative characteristics and descriptive statistics of how students disagreed with these statements. For this factor, most of the students across Year 9, 10 and 11 disagreed that the girl who likes the subject science is lonely, pompous, stubborn and inexperienced.

Table 5.24: Descriptive statistics for the Social Competence factor results (*n* = 800)

Statements	Average		Year 9 (*n* = 269)		Year 10 (*n* = 265)		Year 11 (*n* = 266)	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
13) Lonely	3.29	1.98	3.37	2.02	3.14	1.92	3.36	1.99
14) One-sided	⮝3.74	1.87	⮝3.76	1.89	⮝3.78	1.87	3.68	1.87
27) Isolated	3.52	1.88	3.51	1.87	3.42	1.91	3.62	1.87
32) Boring	3.29	2.07	3.34	2.01	3.17	2.10	3.37	2.10
37) Smart-aleck	3.31	1.95	3.26	1.96	3.38	1.99	3.29	1.92
48) Self-centred	3.25	1.94	3.30	1.92	3.15	1.98	3.29	1.92
54) Dry	3.46	1.92	3.47	1.92	3.38	1.91	3.52	1.93
55) Stubborn	3.72	2.02	3.67	1.97	3.64	1.99	⮝3.83	2.09
56) Inexperienced	⮟3.06	2.05	⮟3.01	2.06	⮟2.90	2.00	3.28	2.08
58) Inhibited	3.56	1.87	3.66	1.88	3.30	1.80	3.73	1.92
61) Unworldly	3.20	1.90	3.24	1.84	3.13	1.93	⮟3.24	1.92
62) Pompous	3.13	1.98	3.10	1.96	3.00	1.99	3.28	1.99
Notes:	⮝	The highest mean score						
	⮟	The lowest mean score						

5.5.3 Cronbach Alpha Reliability Coefficients

The instrument's construct validation was assessed by determining Cronbach alpha reliability coefficients to ascertain whether or not it was adequate to provide evidence to support the instrument's construct validation (Hof, 2012) of the different stereotype factors (see Table 5.25). For all three factors of Item 11, the Cronbach alpha reliability coefficients were higher than 0.80, which means those factors are reliable.

Table 5.25: Cronbach Alpha Reliability Coefficients for factors of Item 11

Scales	Number of Statements	Alpha Cronbach's reliabilities
Intelligence & Motivation	20	0.92
Physical, Social & Emotional Attractiveness	16	0.90
Social Competence	12	0.83

5.6 Summary

This chapter illustrates the results, analyses and discussions of the collected quantitative data in this research. Many factors have been found to have an impact on girl students' selection of the science stream. The first factor was age; with increasing age the probability of selecting science stream is reduced. Also, Year 9 students were more highly motivated than others in Year 10 and 11 as a result of being more interested and confident in learning science, and having a better understanding of science, as well as having a purpose with less worries about science tests and in-class competition. The second factor was student's experience; most of the students preferred science subjects relevant to their experience. The third factor was interest; there was a proportional relationship between subject interest and conceptual understanding. Also, girls prefer medical subjects than other science subjects. Biology and chemistry were the most favourite subjects for Year 11 students. On the other hand, Year 11 students had the lowest interest and confidence in learning science, yet they felt more responsible for their future, which might make them feel stressed during examinations more than others.

Moreover, this chapter describes the results pertaining to Item 11—the stereotype of Saudi girls' students. Based on the results of the factor analyses, the constituent statements of Item 11 can be grouped into three scales/factors: Intelligence and Motivation, Physical, Social and Attractiveness, and Social Competence. The participants believed that the girl who likes the subject science is smart, ambitious, motivated, can be beautiful and empathetic, and is not lonely, pompous, stubborn or inexperienced.

Chapter 6
PRESENTATION OF QUALITATIVE DATA, ANALYSIS AND RESULTS

6.1 Introduction

This part of the thesis gives a synopsis of the interviews conducted with 35 girl students from Years 9, 10 and 11 classrooms in a high school located in Jeddah, one of the largest cities of Saudi Arabia. The interview discussion was through semi-structured questions (see Section 3.6 and Appendix B) to gather information about their understanding of the relation between studying science, their family's support and the school environment. The responses of the students were translated from Arabic to English as described in Section 3.6.2.

This chapter presents the results from interviews conducted with girls from Years 9 to 11. Section 6.2 illustrates the interviewees' responses to their subject choices as shown in Section 3.5.2. Section 6.3 describes the relation between Saudi culture and Saudi girls choosing science. Moreover, the discussion on Saudi girls and future careers is stated in Section 6.4. Section 6.5 discusses interview trustworthiness. The limitations of interviews are discussed in Section 6.6. Finally, a summary of the chapter is provided in Section 6.7.

6.2 Interviewees' responses

As mentioned in Section 3.6.2, the total number of interviewed respondents was 35 girl students from Years 9, 10 and 11 at intermediate and high schools. The interviewees were from the 800 students who answered the questionnaire survey, they were selected randomly by their teachers and the interviews were conducted in the schools. All the interviewees were living in Jeddah at Mecca region and answered all interview questions. Interviewees were asked 16 questions (see Appendix B).

Interview questions were designed in English language and then translated into the Arabic language. Respondents answered in the Arabic language and their answers were back translated into the English language. In the next stage, the researcher summarised the respondents' answers. The translated answers were later converted into matrix data and relationships across data points were identified (see Appendix F).

The researcher created the codes to analyse the data. Finally, codes were merged to find the group summaries (DeCuir-Gunby, Marshall, & McCulloch, 2011).

In this part of the research, the reliability and validity of qualitative data were confirmed. For checking the validity and reliability, the researcher ensured that the participants understood the questions and they were able to answer them. Also, the researcher used these answers clearly in the results and discussion presentation so that they can be used by other researchers. The interview questions were related to Saudi culture and future career possibilities for Saudi girls choosing science. Students' responses to these topics are presented in the following sections.

6.3 Response to Research Question 4: How does Saudi culture impact on the girls choosing science?

How does choosing science subjects impact on Saudi girls' future careers?

Girls in Saudi's society are like blood in the circulatory system. The heart (*family*) forces blood to go to the lungs (*school*). Therefore, most families encourage their daughters to go to school for many reasons such as education, acquisition of values and tradition and gaining friends. The students' responses to why they chose to study science are presented as categories, for example, parental support, parental expectation, equity between girls and boys within the family, siblings, teacher impact, peer impact and intermingling between different sexes.

6.3.1 Parental support for a better education than they had

One of the reasons for encouraging their daughters to have an education is for them to have a chance to learn which the parents may have missed. One of the interviewees, Student #1 in Year 10, said:

> *"My mother did not complete her studying and she has a high school certificate. She says, I see myself in you. She encouraged us to learn science and study towards becoming a medical doctor. But I do not like studying medicine. My elder sister is studying first year medicine and she will be a doctor".*

Another interviewee, Student #6 in Year 11, said that

> *"My father went to an intermediate school, and my mother graduated from a high school. They do not like us making a similar mistake. Since our current circumstances are different from the past, they said you have to learn as much as you can. Now, my elder sister has a psychology degree from King Abdul-Aziz University"*.

Also, one of the interviewees, Student #13 in Year 9, narrated an advisory message given by her father:

> *"My father always says, our time was different than yours. During our time hard work is enough, but now you (student) need to be smart, be a hard worker and be educated to be successful"*.

Acknowledging a similar parental support system, another interviewee, Student #29 in Year 11, said that

> *"They (parents) are supporting my study and it depends on my objective and ambition. They do not force me to study the subject I do not like"*.

These are different messages from different parents conveyed to their children about the importance of learning and education. The essence of all these messages point towards enhancing their daughters' confidence to carry on with their learning in any subject or disciplinary area they most liked.

6.3.2 Parental expectation is to achieve like they did

Another reason for encouraging their daughters to study is making the children follow the same track of a successful education. Each family attempts to transfer its life experience to their children. For example, one of the interviewees, Student #31 in Year 11, said that

> *"My father is a mathematics specialist. He likes mathematics and he always helps me in assignments and preparation for exams. The problem is when he teaches me, he always asks me about the previous lessons. Therefore, I do not like to ask him for help"*.

Her father would like her to be similar to him in understanding of mathematics.

Another interviewee, Student #22 in Year 11, said that

"Both my parents have bachelors' degrees. They are supporting my study to ensure my future. They do not have a problem to support my intention to study electrical engineering and they support me to accomplish it. They always said… study what you like but think about your future job".

Her parents, who had graduated from university or its equivalent level of education, had a clear idea about the best future for their children. Parental educational background and their academic experience play a vital role in enhancing their children's interest in specific disciplines either in high school or university.

6.3.3 Equity between girls and boys within the family

When it comes to education, parents have a similar priority for both girls and boys. Most of interviewees revealed that their parents supported them to approach their goals in a similar way as their male siblings. One of the interviewees, Student #8 in Year 9, said that

"My parents are supporting my study because there is no difference between boys and girls in my family".

From this response, there seems to be no difference between boys and girls in term of parental support towards their children's education. Moreover, girls have exceeded the limit of equity with their brothers, meaning they receive full support from their parents as evidenced from the following excerpt from Student #4 in Year 10, said that

"They (parents) are supporting my study and it depends on my objective and ambition. They do not force me to study the section (i.e. the science or literary stream) I do not like".

Furthermore, some girls experience excellent support and are given encouragement to be what they would like to be (in their future). For example, Student #9 in Year 9, said that

"My parents encourage me to study what I would like to study either scientific subjects or not. My ambition is to study medicine".

However, sometimes, there is a conflict between what the girl wants and what the parents like as evidenced from the following comment from Student #6 in Year 11, said that

"I would like to become an architecture designer (decoration) or attend architecture engineering at university because I love this level of organisation. But my parents would like me to become a nurse. However they support me to study what I like".

Within the Saudi cultural context, the man is responsible for caring about his family. Therefore, in the past, some parents were careful to see that their sons learn more than their daughters. However, in a transforming Saudi cultural context, more recently, the woman is sharing the responsibility of her family. This change of social life makes parents anticipate the academic success and future careers for both their sons and their daughters.

6.3.4 Brother and sister influence

Social life in Saudi Arabia is different from Western countries. In public, there is no or limited interaction between males and females. However in the family, this is not the case. The relation between brothers and sisters in Saudi society normally exceeds the limit of friendship. Brothers and sisters sit together for long time, chat, discuss, reveal each other's' secrets and have an impact upon each other. Daily chat and discussion about different topics can create similar opinions. Moreover, the mutual trust between brothers and sisters can help to change each other's beliefs.

This association within the family was mentioned by interviewees such as Student #6 in Year 11, said that

"During my free time, I am browsing the Internet, sitting with my family and chatting with them and reading books in my free time".

The chatting and discussion with brothers, sisters and parents can influence students directly or indirectly. The direct influence was evident in interview with Student #3 in Year 10 who mentioned that

"There are some of my relatives who have the highest degrees in several scientific disciplines. But in my close family, my father has a Bachelor's degree, my mother has completed high school and my elder brother is studying mathematics at university".

And she continued about her ambitions for the future

> *"In the future, I would like to study mathematics at university and be an academic because I love teaching"*.

This interviewee was influenced by her brother and was considering to select the same field for future career. Though she could select a different field and be a teacher, the influence of her brother led her to choose mathematics. Moreover, an indirect siblings' influence has been explicit in the answers of one of the interviewees; Student #6 in Year 11, said that

> *"My parents did not study at university level and my father had attended intermediate school, my mother had completed high school but they supported my elder sister to acquire a degree in psychology"*.

The interviewee's attitude was affected by her sister's background. Therefore, in her free time, she said that

> *"I like writing especially recording my thoughts (similar to a novel), organising things and for enjoyment. I am rarely reading to release stress"*.

Student #16 in Year 11 liked to be innovative and understands its meaning, which came from general chatting daily with her family especially her elder sister, who was studying project administration. Furthermore, her sister's influence had helped her understand innovation concepts and chose her favourite field to study and work in the future.

> *"I like research and innovation for my future. I was involved in an innovation competition but I was not successful. I will do it again. I would like to be a neurologist because the brain is the main part of a human"*.

This interviewee analysed herself and decided to choose neurology because she wished to explore the link between the brain and the process of thinking. She was empowered by her sister's encouragement she is now attracted to projects and innovation.

Science disciplines play a serious impact on the student's choice of favourite subjects and future career fields. When surrounded by their family, such as brothers and sisters, girl students are influenced to select their favourite disciplines, which further lead the student to a favourite future career.

6.3.5 Teacher influence

The heart cannot oxygenate the blood but it sends the blood to a right place (lungs) to get oxygenated. Similarly, a family that cannot give their children enough knowledge in mathematics, science, religious, languages, art, culture and values send them to professionals in schools who are prepared to teach and educate students in a proper manner and place. Moreover, the school has an impact on students, especially girls, on their selection of future study at university and career.

The teacher is one of the most important factors in enhancing students' learning of science and physics and the students' interest in it. Most of the interviewees said clearly that their teacher was the main factor for their liking of physics or science as one of the preferred subjects as evidenced by this comment from Student #11 in Year 9, who said that

> *"The teacher has an influence on my liking of physics and science learning. The teachers' ways of teaching differentiates my level of interest. Some of the teachers made me love science and others did not".*

Changing the teacher every year gives the students more experience in learning science subjects and there is a change of curriculum and teaching style. Sometimes, students do not like the teacher's teaching strategy and sometimes they do like it. Moreover, another participant, Student #27 in Year 11, said that

> *"There are many factors but the most important one is the teacher and her explanation of the subject and experiments. The availability of these factors helps to increase the attractiveness of science, especially physics, to the students".*

Another participant, Student #7 in Year 11, gave the teacher the highest mark of making her interested in science subjects:

> *"I like science classes especially those in the laboratory, it depends on the imagination and it expands our perceptions. My interest in the science subject depends on the teacher and her explanations."*

Another student gave her opinion about the teacher from a different perspective. Student #1 in Year 10 believed that

"The teacher makes science attractive to students with experiments, inquiry groups and competitions, which makes the students excited about the subject and makes them eagerly awaiting the lecture"

The teacher is one of the main factors that have an impact on the Saudi girl students' liking of physics or science subjects. The teacher can attract students to science subjects by making the science subject interesting or she can do the opposite. Therefore, the teacher is very important in the education system for the future of girls choosing science.

6.3.6 Peers' impact: Equity of boys and girls

Saudi girls acquired their knowledge and understanding of the culture of Saudi society from home and school. Usually, that knowledge and understanding is acquired from home and school and is controlled by parents and the school, namely, through the management and the teachers. However, there are different factors that are not under the control of parents and school such as peers and friends. This factor can be somewhat controlled by the school and it impacts directly on the girl students.

Trying to recognize the culture of learning physics found in Saudi girls' schools is the main point in this section. Most of the Saudi girls who participated in the interviews believed that they (participants and other classmates) can learn physics and become specialists because they do not perceive any difference between the learning of boys and girls. One of the participants, Student #10 in Year 9, mentioned that

"In my view, the girls possess more attention and interest in this field, therefor my answer is yes".

Another participant, Student #16 in Year 11, said that

"Yes, there is no difference between boys and girls in their ability. There are some of my friends who like physics and they would like to study physics, engineering, and computers".

Also, another participant, Student #17 in Year 11, said that

"I would like to be an architectural engineer because I like it, and some of my friends like a similar thing".

Furthermore, another participant, Student #19 in Year 9, declared that girls can be better than boys.

> *"Yes because some girls possess more ability and initiative than boys and I don't think physics is especially for boys".*

On the other hand, one of the participants, Student #1 in Year 10, thought that

> *"Some of my classmates believe that topics in physics, chemistry and biology are easy and interesting; whereas others believe they are difficult and boring. For me, I think that [they are] referring to the teacher and how she deals with the class. For myself, I don't think physics is suitable for girls because it is masculine and the boys like it more".*

Also, Student #14 in Year 9 liked and thought medical studies is more feminine.

> *"I would like to attend a medical school in the university to become a surgeon because this discipline is more feminine than masculine"*

From the last two transcripts, it is found that there was deliberation of subjects as being seen as either feminine or masculine. But because the girls are mostly isolated from non-relative boys, the responses about this factor, namely, the deliberation of subjects being feminine and masculine, is somewhat limited. However, most of the interviewees believed that they can study and specialise well in science and physics like the boys.

6.3.7 Saudi culture and males' and females' career choices

The oxygenated blood goes back into the heart and directly sent to the different organs of the body. Those organs are the *culture*. One of the organs is the brain, which sends a signal to the heart to increase its pulses if oxygen is reduced. The brain is part of the culture which has an effect on girls indirectly to study and learn the subjects related to the culture and to the girls in their society. Therefore, the societal culture is passed to Saudi girl students through and under the control of the family and school.

When I started this research, I thought that overall, girls were not ambitious to work or study any topic related to physics, like engineering, because this required intermingling between males and females. But after interviewing the girl participants, I found that more than 50% of the participants would like to work in jobs such as

medicine and law where men and women work together. For example, Student #12 in Year 9, said that

> *"I like to be a doctor. Therefore I work hard to get high marks to study medicine at university"*.

And another participant, Student #33, said that

> *"I would like to complete my study in law"*.

Though intermingling—namely, men and women working together—is prohibited in Saudi culture, more than 50% of the participants chose jobs where men and women could work together. Therefore, the Saudi culture requirement for no intermingling between males and females does not appear to have had a very negative influence on these Saudi girl students with respect to their selection of physics and other science subjects for future study and career.

In this part of the chapter, the analysis of the interviews showed that these Saudi girl students have encouragement and support, especially from family, to study what they would like in the future. The teacher is the main attractive factor to the students for their selection and study of science and physics. Brothers, sisters and friends play a vital role to develop their affinity towards science and physics.

6.4 Response to Research Question 5: How does choosing science subjects impact on Saudi girls' future careers?

Science subjects can be one of the important factors that lead the Saudi girl students to future scientific careers. However, science subjects may not lead the Saudi girl students to select future careers or university courses, but these science subjects mainly give Saudi girl students four important things: 1) gaining scientific knowledge; 2) expanding their understanding of science; 3) helping Saudi girl students to understand the relation between science and life; and 4) Saudi girls' aspiration to work related to science in the future.

In this part of the chapter, the interview responses of Saudi girl participants about the importance of science and its effects on them are presented.

6.4.1 Gaining scientific knowledge

Learning of science and physics guides the students' acquisition of skills and knowledge through experiments, projects, continuous research and discovering new knowledge. Scientific skills are built through the Saudi girl students' studies during this stage of their lives. In this research, most of the interviewees recognised the importance of science or physics in developing their scientific skills. One of the interviewees, Student #2 in Year 10, said that

> *"I was thinking about many science topics. During practical laboratory study on these topics, I understand how these topics are done and how to relate them together".*

Some students explained that more new lessons are not understandable and they have no conceptual background for it. To overcome this issue, students try linking the new lesson to previous lessons. Therefore, linking the topics helps the students to make an integrated picture of their culture, society and surrounding things. As an example, one of the interviewees, Student #3 in Year 10, said that

> *"There are many things I didn't understand before I studied it in science. Science makes me understand things around me".*

Moreover, science learning is not just learning topics. One of the interviewees, Student #7 in Year 11, mentioned that

> *"Science helped me a lot. At least, what I learn from previous science classes is that I am always asking myself "how" and "why" that happened".*

Other interviewees, *S*tudents #6 and #25 in Year 11, said similar things.

Therefore, several students perceived that learning science is to prepare students for their future life and is a self-learning practice that keeps these Saudi girl students searching for the reasons and consequences. Learning science impacts positively on the Saudi girl students to keep learning in all subjects. Also, Saudi girl students have to think about expanding their knowledge which is discussed in the next subsection.

6.4.2 Persistence of learning

One of the most important things that the Saudi girl students should do is to learn for their continuous development. In this way, learning science subjects can help improve

their development and increase their life experiences. One of the interviewees, Student #1 in Year 10, said that

> *"Learning of science is not just for passing the examination but also for student's experience which will increase as a consequence of studying science, which is implied in daily life"*.

Moreover, other interviewee, such as Student #5 in Year 11, linked learning of science with her understanding of the surrounding environment.

> *"My perceptions have expanded. I had misunderstandings of many subjects. Learning of science simultaneously improved my knowledge and understanding of the surrounding environment"*.

Also, one of the interviewees, Student #2 in Year 10, said that

> *"In the science class, I gained a lot of knowledge, some of my prior knowledge was corrected and my thinking has improved"*.

Finally, another interviewee, Student #10 in Year 9, said that her knowledge has increased in every term:

> *"For each new term, my knowledge has strengthened and expanded"*.

An expanded understanding of Saudi girl students in different sciences provides them with a chance to select the appropriate subject for future study. There are different subjects of science such as physics, biology, chemistry and geology. When the Saudi girl student learns about these different disciplines of science, she will compare it with each other and also with other subjects, like mathematics, language and religion. The variety of subjects offered allows for an interdisciplinary curriculum. For example, when a Saudi girl student studies some theory of mathematics, she may not recognise the importance of this theory until she applies it in the context of physics. Therefore, learning science is not just passing the subject. It provides opportunities for an interdisciplinary transfer of knowledge. It has a positive impact on the Saudi girl students. Also, it helps the Saudi girl students to select their future career.

6.4.3 Relationship between science and life

It is very important that Saudi girl students have a good sense of what they are taught. A Saudi girl student's feeling towards science subjects not only attracts her to the

subject and also leads her to understand its concepts. Therefore, most of the Saudi girl participants realised the importance of science subjects because they are linked to their life which is very perceptible for them. Most of the interviewees had such a belief as evidenced by Student #35 in Year 9 who stated that

> *"Science is considered the primary subject among all of the educational subjects because it is related to our life and my body parts".*

Not only normal life is science related to but also other things; another interviewee, Student #8 in Year 9 specified her understanding of science as follows:

> *"Science is one of the important school subjects because it is related to our daily life, our environment and our community".*

Also, the relation between science subjects and life is explained by one of the interviewees, Student #28 in Year 11, when she said that

> *"Science explains many phenomena in our life".*

Another interviewee, Student #16 in Year 11, made a link between her interest and the subject's relation to her life.

> *"I like science and I find it interesting and it is related strongly to our life".*

Studying science subjects is very important because it impacts on the decisions of Saudi girls about their future study and career. Also, science subjects are essential to gain knowledge linking Saudi girl students to the societal culture and life.

6.4.4 Saudi girl students' aspirations to have careers that involve science

These Saudi girl students have different ambitions for their future careers. In this research, the interview sought to identify the most ambitious job for the Saudi girl students. The most favourite job is a medical doctor and the second is in the field of education as a teacher or educator. Whereas the participants willing to pursue careers related to physics are few, the number of participants willing to pursue careers related to physics is higher than the number of participants willing to pursue careers related to judiciary or business, and management. The following subsection discusses the reasons for the girls choosing jobs relating to medical, educational and engineering and computer fields.

6.4.4.1 Medical

More than one third of the interviewed participants would like to study medicine at university and become doctors in the future. Most of the interviewees who wish to study medicine stated that it was their ambition that drove them to pursue science education towards achieving their goal. The following excerpt from Student #18 in Year 11 supports this dedicated approach towards realising their ambitious future plan:

> *"I would like to become a doctor. Therefore I work hard to get high marks to gain entry into a medical program and study medicine at university".*

Students who wish to pursue a medical program in the future seem to have received support and encouragement from their families, as evidenced from the following comment from Student #24 in Year 11, who said that

> *"There is support from my family because my ambition is to study medicine and become a doctor".*

Most of the interviewees, like Student #19 in Year 11, who would like to be doctors, cared about their knowledge and expanded their conceptual understanding through reading, writing, drawing and Internet research.

> *"I like reading and drawing to develop my mind and expand my perceptions".*

Another Student #1 in Year 10 who would like to be a doctor recognised the importance of practicals, competitions and inquiry-groups in the science class.

> *"I like practical exercise, working in groups and the external practical that distributed by teacher and made competition among the class groups".*

The most important factors for this group are that all of them like science as evidenced by the comment from Student #2 in Year 10 who said that

> *"Science is one of the very important subjects but also it is the most important topic because it is related to daily life".*

And some of them believe that the medical profession is more feminine. Like Student #14 in Year 9 quoted earlier, Student #24 in Year 11 had similar goals and aspirations:

> *"I would like to attend to a medical program at university because this profession is more feminine than masculine". (Student #24 in Year 9)*

6.4.4.2 Education

The second most common ambition for a profession preferred by the interviewees is teaching in both normal primary and secondary schools and in higher education. However, some of the interviewees, who are ambitious to become teachers, do not like science, therefore, they selected the literacy stream in high school, such as Student #2 in Year 10 who said this comment:

> *"Though I find science is helpful and related to our life and reading scientific books could help us, I think science and physics are boring and I feel nervous when I am studying them and I do not contribute to the class exercises"*.

Other interviewees who are ambitious to become teachers did not share this same view, as for example, Student #15 in Year 9, said that

> *"Science is considered as the primary subject of all educational subjects and it is related to all things surrounding us. Also, it is interesting and wonderful"*.

However, the main reason for the interviewees to choose a career in the teaching profession was their ambition and passion as illustrated by Student #3 in Year 10, who said that

> *"I would like to study mathematics at university and be an academic because I love teaching"*.

and Student #10 in Year 9 also said that

> *"I would like to be an academic staff member and/or researcher because this is my ambition and I like inventions"*.

6.4.4.3 Computers and Engineering

Six of the interviewees expressed an interest to work in jobs related to computers and engineering. Similar to the previous groups of student interviewees listed under Sections 6.4.4.1and 6.4.4.2, these students who selected computers and engineering as future careers have reasoned out their interest towards the subject and had parental support for their intended career choice. For example, Student #30 in Year 11 stated that

> *"I would like to be an engineer. My parents' support depends on my objective and ambition. They don't force me to study the stream I don't like"*.

Another interviewee, Student #22 in Year 11, would like to leave Saudi Arabia to study electrical engineering.

> *"My family is supporting my intention to study electrical engineering to ensure my future and ambition. Therefore, I would like to study in the USA and work outside of Saudi Arabia"*.

At the beginning of this research, I predicted that there would not be many Saudi girls who would like to study engineering. However, fortunately there were many girls who wished to study engineering, even more than those who would like to work in management or fashion design. The impact of science subjects on these interviewees, who would like to become engineers or computer science specialists, is very obvious as evidenced by the comment from Student #17 in Year 11, who said that

> *"Science is an essential subject because it is related to our daily life and it is important to learn it"*.

For the interviewees, like Student #32 in Year 10, who would like to be engineers, competition and working in inquiry-groups appeared to be helpful in improving their understanding of scientific knowledge.

> *"I think using group competition allows students to explain the lessons rather than a teacher-focused traditional strategy of teaching"*.

For all three groups of students (see Sections 7.5.1, 7.5.2 and 7.5.3) presented in this subsection, more than half of the interviewees would like to work, in the future, in a job related to science. I expected that medicine and teaching would have the highest career choice by these Saudi girl students, respectively. However, computers and engineering professions also occupied as a third preference career choice made by these interviewees.

6.5 Interview trustworthiness

During the interviews, the researcher made sure that the interviewees understood the questions. Also, the researcher discussed the results with expert people and compared them with the hypothesis. Moreover, the results were compared with the quantitative

data results. The researcher made sure the voices of the interviewees were clear and obvious.

6.6 Limitations

There are three main limitations in the interviews used as part of the study. One of the limitations is related to the researcher, another related to the interviewees and another is related to schools and education system.

1. The researcher could not ask direct questions on intermingling, men and women working together in the same place, because of the possibility of misunderstanding from the girls, the school and their families.
2. The conversation with most of the interviewees was very short and not extensive.
3. The schools did not allow the researcher to record interviews with the interviewees.

The researcher tried to address these issues by:

1. Avoiding any question(s) that could lead to any misunderstanding from interviewees, parents and school and trying to arrive at a conclusion from results indirectly from different questions. Participants were asked whether their families support them studying science disciplines especially physics and working in scientific fields especially related to physics. Also, the researcher anticipated answers from interviewees' relating to career they would like to pursue in future and also whether they accept to work with men or not.
2. Repeating the questions by using different phrases during open discussion with interviewees, and helping them to think in different ways and have greater comprehension.
3. Replacing the tape recording of students' conversations with writing of students' responses as notes by the researcher.

6.7 Summary

This chapter has discussed the encouragement of these Saudi girl students' to study what they liked in the future especially from family perspectives. The interviewees were 35 girl students, from Years 9, 10 and 11 at an intermediate and a high school.

The teacher is the main attractive factor for the students' selection of science and physics. Brothers, sisters and friends play a vital role in students being attracted towards science and physics. Moreover, it is asserted that science subjects are very essential to gain knowledge and to link the Saudi girl students to their society and life. Also, science subjects help the Saudi girl students to decide their future career. Finally, it was found that the main three groups of future career for interviewed research participants are medicine, education and computing and engineering. Those three groups were preferred by more than half of the interviewed participants. Saudi girls who participated in this study appeared to have career preferences towards medicine and teaching. For me, surprisingly, many of these Saudi girl students were also keen on career choices relating to engineering and computers.

Chapter 7
DISCUSSION OF RESULTS

7.1 Introduction

This chapter examines the data accumulated to answer the five research questions undertaken in the study and discusses the findings in relation to the extant literature. Quantitative and qualitative data were gathered from the instruments and interviews, respectively. This chapter has eight sections. Section 7.2 discusses the results with respect to Research Question 1 (What are Saudi girls' perceptions of science and physics?). Section 7.3 presents a discussion of the results obtained for answering Research Question 2 (What are Saudi girls' motivations for learning science?). Discussion of the portrayed results in support of Research Question 3 (Does physics match Saudi girls' stereotype of a scientist or physicist?) is revealed in Section 7.4. Section 7.5 describes the findings on Research Question 4 (How does Saudi culture impact on the girls choosing science?). Section 7.6 presents the discussion of results of Research Question 5 (How does choosing science subjects impact on Saudi girls' future careers?). Finally, a summary of the chapter is provided in Section 7.7.

7.2 Saudi girls' perceptions of science and physics

There are a number of findings in this research that identify Saudi girls' perceptions of science and physics. First, Saudi girls students are attracted to disciplines that have personal relevance to them. The study has found that biology topics, especially topics related to medicine, are most interesting to these Saudi girls. These results were consistent with those reported in the literature (Baker & Leary, 1995; Baram-Tsabari et al., 2006; Baram-Tsabari & Yarden, 2005; Christidou, 2006; Howe et al., 2000; Miller et al., 2006). Moreover, girls' attraction to the medical sciences may have been a consequence of their stereotypical views about biological sciences being more suitable for females (Howe et al., 2000; Kessels, 2005).

In many Western education systems, girls' progression to high school often leads to decreased interest towards science subjects (Brotman & Moore, 2008). This change in interest may have been caused by changes in educational environments (Ferguson & Fraser, 1998). A similar trend was found for Saudi girl students in this research.

Information presented in Figure **5.1**, Items 3, 4, 5, 7, 8 and 9, Sections 5.2, 5.3.1, 5.3.2, 5.3.3 and Section 5.5 respectively, confirm that the Saudi girls' interest in science often declines after intermediate school. Such diminishing interest can affect Saudi girl's motivations towards science learning.

Moreover, according to Murphy and Whitelegg (2006), perceptions of science subjects are closely linked to and influenced by what students find interesting and motivating. Referring to Item 6 in Section 5.3.4, many Saudi girl students reported that they felt bored in the physics class. Skryabina (2000) and Tanko and Atweh (2012) inferred that linking the girl students' learning to their social setting would make physics more enjoyable. Also, Saudi girls thought there is no benefit of studying physics because it is not related to their future careers. Furthermore, religious, social, traditional and economic conditions influence Saudi girls to focus on teaching, medical and finance fields rather than careers related to physics (Al Rashedi et al., 2015; Hamdan, 2005).

There are two perspectives about the relationship between interest and understanding with reference to perceptions on science/physics. The first perspective claims that interest enhances perceptions (Murphy & Whitelegg, 2006). The second perspective claims that understanding of concepts enhances interest (Lee et al., 2008; Wittrock, 1991). In this research, it is evident that there is a relationship between interest and understanding. Figure 5.2 (see Chapter 5) shows that there is a positive correlation between the mean scores related to interest and understanding for science subjects. An increase in interest in a science subject is reflected as an increased rate of understanding of disciplinary concepts/content.

7.3 Saudi girls' motivations for learning science

The present study examined four factors of motivations that influence science learning. The first factor is confidence. According to Britner (2008), confidence leads to improved achievement and commitment in science. Furthermore, from an educational perspective, confidence is one of the reasons to split the careers into those that are feminine and those that are masculine (BouJaoude & Gholam, 2013). From the business and management perspective, lack of confidence can be a barrier for girls to achieve and meet their goals (Institute of Leadership and Management, 2010). Both education and business management reveal that confidence is essential to encourage girls to study and work in science fields, especially physics. In this research, Saudi

girls were confident enough to study science and physics, as in the example of what they said: *"Yes because some girls possess more ability and initiative than boys and I don't think physics is special for boys" (Student #19).* Moreover, as a consequence of their confidence, more than half of the interviewed participants planned to join a career related to science.

The second motivational factor is enjoyment. According to Hazari et al. (2012) and Abraham and Barker (2015), enjoyment is the main reason for choosing a profession in physical science. In this research, the Saudi girls reported enjoying and having interest in science subjects when 120 students expressed that they liked understanding and disliked memorising (see Section 5.2).

The third factor is a liking for science. Learning goal orientation is a key component of each student's motivation and is a combination of understanding, learning and mastering the task at hand (Velayutham et al., 2012; Wigfield & Cambria, 2010). In this research, many of the Saudi girls thought that understanding and using the scientific knowledge that they learn are essential.

The first three motivational factors are described as intrinsic motivation. From a constructivist point of view, if a science topic is relevant and connected to familiar things, students are more likely to find it interesting and decide that it is worth studying (Ballard, 2011; Harrison & Coll, 2008). A strong intrinsic motivation is as important as an extrinsic motivation for girls to study physics and mathematics (Britner, 2008; Harlow, 1949; Mujtaba & Reiss, 2013; Robins, 2012; Spinath et al., 2014; Velayutham et al., 2012). In this research, intrinsic motivation was found to play a vital role, as evidenced from the results presented in Section 5.3.1, in enhancing these Saudi girls' interest to study science/physics. Feeling confident and accomplished as a result of understanding may encourage Saudi girls to continue and look for new goals in science. This finding is an indication of the relationship between perception and motivation mentioned by Murphy and Whitelegg (2006). Saudi girls in the intermediate schools appeared to possess more enhanced intrinsic motivation than the students in the high schools.

The fourth factor is extrinsic motivation which includes the impact of examinations and concerns about other students. The impact of examinations directly emerges from teachers' viewing the purpose of education as passing an examination in all subjects

(Hamdan, 2006). Examination stress also can have a negative effect on students' grades and their ambitions for a career in science (Bryan et al., 2011). The impact of examination stress is more prevalent among students at the high school level than other girl students at the intermediate school level. Saudi girls who are at an earlier education level (such as intermediate school level) have less examination stress because their grades do not impact upon their study choices in the next year level. Moreover, the findings showed that Saudi girls do not like competition as evidenced by the lowest mean of motivation questions (*I am concerned that the other students are better in science*) (see Section 5.4). Similar views have been reported by other researchers (Gneezy et al., 2003; Rosser, 1989). However, not all of the girls in this study think in this way; in the interviews (see Chapter 7 Section 7.5.3), some of the interviewees agreed that working in groups and using group competition promoted their learning: *"I like practical exercise, working in groups and external practical that distributed by teacher and make competition among the class groups" (Student #1).*

7.4 Does physics match Saudi girls' stereotype of a scientist or physicist?

It has been stated that a combination of cognitive and emotional aspects is considered to contribute to self-image (Abu-Hilal et al., 2013; Rivera Maulucci, 2013). Therefore, two types of questions were used in this research. Firstly, from the cognitive perspective; Items 7, 8 and 9 (Appendix A) were used to examine the favourite subjects for Saudi girls. Similar to their perceptions and motivations as outlined in Sections 7.2 and 7.3, a greater proportion of the Saudi girls in Year 9 favoured science more than those students in Years 10 and 11. On the other hand, physics is not a highly favoured subject by Years 10 and 11 Saudi girls when they are in high school. There are many reasons for the lack of interest in physics such as cultural preferences, life experiences and the school curriculum (Alhammad, 2015; Reda & Hamdan, 2015). In this study, the non-preference of physics was not rooted in mathematics because mathematics was a more desirable subject than physics. On the other hand, the most favourite science subject was biology as evidenced from the results in Subsections 7.2 and 7.3.

Secondly, from an emotional perspective, Item 11 (Appendix A) was used to understand the views of Saudi girls about scientists. Three main factors were found to

be contributing to emotional perspective: 1) Intelligence and motivation factor, 2) Physical, social and attractiveness factor and 3) Social competence factor. These factors may influence the Saudi girls' choice of science for their future, that is, whether for a job or social life.

From the first factor—intelligence and motivation—the participants believed that girls who like science subjects are smart, ambitious and motivated. Also, the results from the qualitative data indicated that most of the participants believed that Saudi girls have the ability to study physics, engineering and computers as evidenced by Student #16 when she said: *"Yes, there is no difference between boys and girls in their ability. There are some of my friends who like physics and they would like to study physics, engineering, and computers"*. Therefore, there are many Saudi girls who plan to study science or mathematics courses at university.

As for the second factor—Physical, social and attractiveness—the participants believed that the girl who likes science subjects can be beautiful and empathetic. Also, in this research, the participants slightly agreed that the girl who likes the subject science can also be caring about fashion. According to Owen et al. (2007), one of the factors towards participation of women in science is that their roles as mother and wife are not always well-matched with their successful science career. The results for Item 11 gave an indication of Saudi girls' studying science / physics and their intention to become a science professional if the government gives attention to the girls' needs, and create "national strategic goal of creating a diverse and egalitarian STEM workforce" (Banchefsky, Westfall, Park, & Judd, 2016, p. 107).

From third factor—Social competence—the participants disagree that girls who like science subjects are lonely, pompous, stubborn and inexperienced. This factor, as much as other factors, gives an indication how much the Saudi girls respect participation in the scientific field. According to Al-Gazali (2013), Saudi girls are attracted towards science and engineering but Arabic traditions and culture impact on their decision and reduce the number of girls in science and engineering fields. The impact of tradition and culture is discussed in the next subsection.

7.5 Impact of culture on the Saudi girls' choice of science

There are two points related to Saudi culture and girls' choice of science which involve: 1) the relation between the culture and the science curriculum and 2) How the culture impacts on Saudi girls' learning of science.

7.5.1 Relation between culture and the science curriculum

It is argued by Al-khalili (2015); Alhammad (2015); Alshammari, Mansour, and Skinner (2015); Hamdan (2006) that Saudi tradition and culture is disconnected with the science curriculum and not suitable for Saudi students. Therefore, according to Alhammad (2015), Saudi social and cultural issues should be taken into account in the curriculum. Though those expert people assert that the curriculum is not properly connected with the Saudi culture, many of the Saudi girl students who participated in the interviews of this research confirmed that the science subject is related to their life. For example: *"Science is one of the important school subjects because it related to our daily life, our environment and our community" (Student #8)* and *"It is related to our life and my body parts" (Student #35).*

Moreover, in Item 3 (see Table 5.1) of the questionnaire there are two questions that are related to culture and science. Those questions received the highest agreement, with mean scores of 3.84 and 3.70, by all participants. The variation between what experts stated and what students believed is due to a difference in vision. Experts believe that the science curriculum designed for communities differ from Saudi society and this may cause a lack of demand for learning science by students. However, these girl students believe that there is a link between the curriculum and culture of Saudi society for two reasons. Firstly, these Saudi girls are commenting about the educational system from the inside; and secondly, there is a cultural rapprochement between communities caused by the development of traditional media such as television and new social media. For example, media and social media make students watch the lifestyle in different societies and learn from them.

7.5.2 Impact of culture on Saudi girls' learning of science

Saudi girls experience and learn about local tradition and culture from their home and from school. From the interviews with many of the students, it was found that most of

the Saudi girls receive enough support from family to study any chosen science disciplines they wish. For example, Student #29 said: *"They (parents) are supporting my study and it depends on my objective and ambition. They do not force me to study the subject I do not like"*.

On the other hand, the school plays a vital role and impacts upon girls' selection towards science disciplines (Alhammad, 2015; Chin, 2007; Hodgson & Pyle, 2010; Mortimer & Scott, 2003). More precisely, the teacher is an essential part of the education system (Albirini, 2006; Entwistle, 2013). From the student participants' perspectives, the teacher and her teaching skills are the main factors attracting students to study science, as evidenced by Student #27 who said that *"There are many factors but the most important one is the teacher and her explanations of the subject and the experiments. Availability of these factors help increase the attractiveness of science especially physics for the students"*.

Moreover, students can have a clear impact on their peers. Student's self-image is impacted by three factors, one of which is peer relations (Simmons & Rosenberg, 1975). The research participants believe that many Saudi girls can have careers as scientists and engineers; their comments give the impression that many of Saudi girls have the ability and an affiliation for disciplines related to science and engineering.

> *"Some of my classmates believe that topics in physics, chemistry and biology are easy and interesting; whereas others believe they are difficult and boring. For me, I think that [they are] referring to the teacher and how she deals with the class. For myself, I don't think physics is suitable for girls because it is masculine and the boys like it more". (Student #1)*

Finally, Saudi culture and intermingling between males and females is one vital factor that impacts on the Saudi girls' selection for science. From historical literature reviews, there are two points: Firstly, Jamjoom and Kelly (2013) stated that single-sex education often enhances motivation for girls; and secondly, gender segregation may be the cause of the drop in Saudi girls' enrolment in science, engineering and agriculture courses at university (Reda & Hamdan, 2015). The findings in this research from quantitative and qualitative data resonate with the relevance of these two statements. In this research, it was found that more than half of the interviewed participants plan to work in intermingling jobs such as medicine and law: *"I like to be*

a doctor. Therefore I work hard to get high marks to study medicine at university" (Student # 12) and *"I would like to complete my study in law" (Student #33).*

7.6 Choice of science subjects and their impact on Saudi girls' future careers

There are three reasons that clearly explain Saudi girls' choice of school science subjects and their impact on future careers: 1) gaining of knowledge, 2) persistence of learning, 3) relation between science and life and 4) Saudi girls' aspiration to work in careers related to science in the future.

Firstly, from an Islamic perspective, the search for knowledge is compulsory (Halstead, 2004) and knowledge is gained by the action of study to make new behaviours (Pritchard, 2013). In this research, many of the participants believed that studying science is helpful to gain new knowledge. Also, using different strategies to learn science like doing practical work in laboratories helps Saudi girls to understand the relationship between different topics in science as evidenced by the comment from Student #2: *"I was thinking about many science topics. During practical laboratory study on these topics, I understand how these topics are done and how to relate them together"*.

Moreover, persistent learning is one of the most important factors to develop and shape an individual's future career. Students' achievement in science is impacted by their perceptions, confidence and learning (Britner, 2008; Freedman, 1997; Tighezza, 2014). Persistence of learning is the traditional measure of learning (Argote, Beckman, & Epple, 1990). In this research, many students recognised that learning science subjects can help improve continuous development and increase life experience: *"Learning of science is not just for passing the examination but also student's experience will increase as a consequence of studying of science, which is implied in daily life". (Student #1)*

On the other hand, life experience can impact upon students' response to school and their style of thinking (Costa, 1995; Lau & Humphrey, 2014). The link between life experience and science subjects necessitates Saudi girls to learn how they can relate science subjects into their real life. *"Science is considered the primary subject among*

all of the educational subjects because it is related to our life and my body parts". (Student #35)

Moreover, it is stated that currently Saudi women's occupations are focused on teaching and medicine (Berkery, Morley, & Tiernan, 2013; Hamdan, 2005). The present research is not going far away from this argument. In this research, it is found that the most favoured profession is a medical doctor followed by a profession in education as a teacher or educator. Also, whereas the preference towards a physics-related career is less than teaching and medicine, it is greater than those preferring other careers in the judiciary or in business, and management. However, more than half of the interviewed participants would prefer work related to science. The most common reason for this preference of most participants is that they have family support for their choice. *"My family is supporting my intention to study electrical engineering to ensure my future and ambition". (Student #22)*

Moreover, this result is a consequence of the government's strategy to improve the education system and career opportunities especially those related to science subjects (Meijer & Wagemakers, 2012; Ministry of education, 2015). Also, the guarantee of work is the secret in their search for occupations related to medicine and education because these professions are still in demand in Saudi society and are considered not to involve hard work as much as engineering. Therefore, Saudi girls would like to enrol and study medicine or teaching which can help them to find jobs easily and guarantee a path to a professional career.

7.7 Summary

In this chapter, a discussion on the results for answering the research questions is presented. It was stated that there is a relationship between interest and means of understanding concepts. Saudi girls in intermediate and high school levels are attracted to biology and medicine. In contrast, culture, life experience and curriculum make physics less enjoyable and it tends to be an unfavoured subject. Saudi girls' perceptions need to be motivated and it was found that intrinsic motivation played a vital role in enhancing Saudi girls' intention to study science/physics. On the other hand, examination stress has a great impact at the higher education level. Also, academic competition between the girls is low. Moreover, from a stereotypical perspective, there are three factors that have an impact on these Saudi girls' choice of

science: 1) Intelligence and motivation factor, 2) Physical, social and attractiveness factor and 3) Social competence.

In this chapter, the discussion further includes the relationship between culture and science curriculum, the impact of culture on Saudi girls' learning of science such as gaining knowledge, persistent learning and relation between science and life. Moreover, more than half of the participants would prefer a career position related to science and most of them favoured the medical profession (doctor) followed by the education-related profession (teacher/educator).

Chapter 8
CONCLUSIONS, RECOMMENDATIONS AND LIMITATIONS

8.1 Introduction

The main purpose of the research reported in this thesis was to determine whether or not Saudi girl students like science and physics and to examine the relationship between science and physics and students' perceptions, motivations, self-image and future careers. The data were collected from the instruments initially developed by Taconis and Kessels (2009), Hollins et al. (2006), Mitrevski and Treagust (2011), Glynn et al. (2009), and Hannover and Kessels (2004). The previous chapters have presented the results of this research. The purpose of the present chapter is to reflect on the study results and how the data from the participants was used to answer each of the five research questions, discuss the implications of the research, describe the limitations of the research and provide recommendations for further research.

This chapter comprises four main sections. Section 8.2 presents the summary and discussion of the results of this study in relation to each of the five research questions proposed in Chapter 1. The study implications are revealed in Section 8.3. Moreover, Section 8.4 discusses the recommendations of the study. The suggestions for future research are given in Section 8.5. The limitations of the study are presented in Section 8.6. The chapter concludes with a summary in Section 8.7.

8.2 Major Findings of the Study

The main findings of the research are organised around the five research questions presented in this research.

Research Question 1: What are Saudi girls' perceptions of science and physics?

This research question was answered through the administration of four main questionnaire items—views of science, interests in different topics, understanding different topics and views of physics—each of these sections has subsections. The instruments used in this part were designed and validated by methods from Hollins et al. (2006) and Mitrevski and Treagust (2011).

The research showed that Saudi girl students are attracted to disciplines that have personal relevance, stereotypic views and motivation (see Section 5.3 and Section 8.2). Therefore, the study has found that biology topics, especially the topics related to medicine are most interesting to most Saudi girls. In contrast, many Saudi girls students feel bored in the physics class and thought that there is no benefit of studying physics because it is not related to their future careers. In this research, it is evident that there is a relationship between interest and understanding.

Research Question 2: What are Saudi girls' motivations for learning science?

This research question was answered through the administration of questionnaire items from a motivation instrument designed and used by Glynn et al. (2009).

The present study reported in this thesis examined four motivational factors that influence science learning (see Section 5.4 and Section 8.3). Those factors can be divided into intrinsic and extrinsic motivations; the first three factors are intrinsic motivation. The first factor is confidence; the research showed that Saudi girls had enough confidence to study science or physics. The second motivational factor is enjoyment; Saudi girls enjoyed and were interested in the science subjects especially biology topics. The third motivational factor is making links between Saudi girls and science subject. In this research, Saudi girls thought about science theories and how they could use them (see Section 5.4 and Section 8.3). Feeling confident, having enjoyment and accomplishing success as a result of understanding would enhance Saudi girls to continue and look for new goals related to science.

In contrast, the fourth factor is extrinsic motivation which contains the impact of science tests and competition with other students. The impact of the stress from science tests is more prevalent among students at higher grade levels (Year 10 and Year 11) than others and is less prevalent in earlier education level (Year 9). Moreover, the present study reinforces the finding that Saudi girls do not like competition; nevertheless, some of the interview respondents agreed that working in groups and using group competition promotes learning.

Research question 3: Does physics match Saudi girls' stereotype of a scientist or physicist?

This research question was answered through the administration of four questionnaire items: Most Favourite Subjects, Least Favourite Subjects, Ranking of School Subjects and Prototypes. The instruments used in this part of the research were designed and validated by Hannover and Kessels (2004) and Taconis and Kessels (2009).

Therefore, two types of questions were used in this research. Firstly, from the cognitive perspective (see Section 5.5 and Subsection 5.5.1 in Chapter 5), Year 9 students favour science more than other students in Years 10 and 11. On the other hand, physics is not a highly favoured subject by Saudi girls in high school. The non-preference of physics is not rooted in mathematics because mathematics is more desirable than physics. On the other hand, the most favourite science subject is biology.

Secondly, the emotional perspective was used to understand the view of Saudi girls about scientists (see Sections 5.5.2 in Chapter 5). Three main factors were found to be contributing to the emotional perspective: 1) An Intelligence and Motivation factor—the participants believed that the girl who likes science subjects can be smart, ambitious and motivated, 2) A Physical, Social and Attractiveness factor—the participants believed that the girl who likes science subjects can be beautiful and empathetic and 3) A Social Competence factor—the participants disagreed that the girl who likes science subjects is lonely, pompous, stubborn and inexperienced. Therefore, there were many of the Saudi girls in this study, around 60% of participants, who planned to study science and physics courses at university.

Research Question 4: How does Saudi culture impact on Saudi girls choosing science?

This research question was answered through several questions in the interview with participants from Year 9, Year 10 and Year 11 (see Section 6.3 in Chapter 6). There are three reasons that clearly explain Saudi girls' choice of school science subjects and their impact on future careers. First, the interviewees believed that the science is helpful to gain knowledge and they used different strategies to learn science such as practical work in laboratories which helps Saudi girls to understand the relationship between different topics in science. Secondly, learning science subjects can help improve their continuous development and increase their life experience. Finally, Saudi girls chose science subjects that can relate science to their real life.

Research Question 5: How does choosing science subjects impact on Saudi girls' future careers?

This research question was answered through several questions in the interviews with participants from Year 9, Year 10 and Year 11 (see Section 6.3). Two concepts related to culture were discussed in this research. Firstly, when the relationship between Saudi culture and the science curriculum was investigated, it was found that Saudi girls believed that science subjects are related to their Saudi life; this is opposite to the experts' view (see Section 6.4 in Chapter 6).

Secondly, when seeking to investigate how the culture impacts on Saudi girls learning science, the interview data showed that Saudi girls receive enough support from their families to study any of the chosen science disciplines. Also, these interviewees believed that their teacher and her teaching skills are one of main factors that attract students to study science. Moreover, many of Saudi girls believed in their own ability to study science disciplines and engineering. Moreover, they also believed that a strong desire to study science disciplines and engineering was due to peer influence. Furthermore, though Saudi culture prohibits intermingling between males and females which impacts on the Saudi girls' selection for science, more than 50% of the interviewed participants planned to work in intermingling jobs such as medicine and law.

In this research, it is found that the most favourite profession is medical doctor and followed by profession in education (teacher/educator). Also, while the preference towards a physics-related career is less, it is greater than those preferring other careers in judiciary or business, and management. However, more than half of the participants preferred a job related to science.

8.3 Implications of the Study

Saudi Arabia is heading towards economic integration or Vision 2030 (Saudi Vision 2030, 2016). This move needs the support of the entire Saudi population from all fields in order to reach the desired goal. Women, as a component based on the demographics of Saudi society, can contribute to many responsibilities towards this immense task in addition to taking care of the family. Consequently, the Saudi government made a plan to encourage girls to join the workforce and be productive workers (Meijer &

Wagemakers, 2012). In 2030, the vision is for a woman to be a doctor, a teacher or looking to share responsibilities with her brother and every man, and tasks such as business management, construction and development of Saudi Arabia (Saudi Vision 2030, 2016). So women's education should continue to be improved in order to reach the goal of what the Saudi officials are looking for (Alhammad, 2015; Almazroa & Al-Shamrani, 2015; Hamdan, 2006; Litvin, 2010). In the research reported in this thesis, the ability of Saudi girls to reach this lofty goal has been explored in this direction.

8.4 Recommendations

1) *Teachers should make the science subject related to Saudi girl students' interests.*

Saudi girls are attracted to those school subjects that are related to them—this attraction could be perceptible, audible, visible, or from society and the culture surrounding them. Therefore, the teacher should link the Saudi girls' students with their surrounding environment by utilizing experiments, pictures and so on. This link could help Saudi girls connect their previous experiences, by making science subjects interesting and enjoyable, and making the concepts of science subjects easy to understand.

2) *Making a plan for consistent development of the teacher.*

The development of education is a consequence of the efforts of many scholars, educators and researchers over many years of research and investigation. Teachers should follow new developments in education, and have access to modern technologies in education to illustrate the students' abilities and potential development. There should be a development plan to make sure that all teachers attain the minimum requirements of quality learning.

3) *Increase the girls' confidence by increasing family's and school's attention.*

As presented in this research report, confidence is one of the main motivation factors towards studying science. The family and school play a vital role to help the girls gain confidence. Naturally, parents want the best for their children, both boys and girls.

The availability of family members is very important for girls especially when they face issues or difficulties. On the other hand, teachers can increase the confidence of Saudi girls by encouraging them to perform better by giving them rewards for their accomplishment. Saudi girls need respect as they are dependent on, and receive love, from their families and schools. Availability of these requirements with clarity of issues and discussion between teacher and parents will present a confident environment which helps the girl to improve her education level.

4) *Reduce anxiety of tests for Saudi students especially in the advanced stages.*

The goal of many Saudi girl students is just passing the examination with a high mark. This goal keeps the girls in a highly emotional and psychological state which occurs before and during the examinations; sometimes, this reduces their ability to study and they lose the focus on preparing for the examinations. There are many reasons for examination-related anxiety such as low confidence, subject difficulty, failure in the examination and punishment if one fails. Therefore, the family and school have a responsibility to help the girl to pass this stage by increasing her self-confidence, making earlier progress for studying and so on. Reducing the examination anxiety is helpful to the girl to improve her education and academic performance.

5) *Using technology.*

Technology can help the teacher to guide students through the acquisition of scientific knowledge. Technology can change the form of providing subjects to students in a manner that is easier to understand and increases the range of learning opportunities. The modern methods of learning, such as those with the use of computers, can help focus students' attention to the subject, or may assist teachers in guiding students by using computer programs and different functions relating to the science field. Moreover, technology can help students and teachers to search for more science information. Technology helps the teachers to find out more resources and helps the students to solve problems in doing their assignments and gain more science knowledge. Also, technology provides new communication between the school, the teacher, the student and her family. Teachers may need to be encouraged to make classroom activity more interactive in terms of using technology to facilitate students' learning and communication between parents, teachers and schools.

6) *Discover the talents of Saudi girls.*

Identifying a girl's talent is an important step towards the development of her skills, and if her talent is not discovered in appropriate time, it becomes hard for us (educators) to improve her talent and utilize it in the future especially those related to science. Caring about Saudi girls' talent could improve their participation in science and physics.

8.5 Suggestions for Future Research

For future research on a similar subject in Saudi Arabia, I would like to suggest two points. Firstly, this study concentrated on a particular geographical area in Saudi Arabia (Jeddah). There are different subcultures between Jeddah and other cities like Riyadh, Dammam, Arar and Al-Baha. There are differences between the big city and small town or the countryside. The priorities for girls change with respect to where they live. Therefore, I suggest for future studies that the research sample should involve a mix of different regions of Saudi Arabia. Secondly, this study concentrated on girl students. I think future research should care about the teachers' perspectives. An experienced and academically skilful teacher will help to make clear views about the research problem and the ways to solve it.

8.6 Limitations of the Study

There are three main limitations. All of the limitations are related to the interviews. Firstly the tradition and value of Saudi society is more restrictive about intermingling between different genders. Therefore, the researcher could not ask direct question on intermingling because of the possibility of misunderstanding from the girls, schools and families. Also, a direct question such as "What is your opinion about working with men?" could create problems for the researcher. Secondly, the responses to the interview questions by most of the participants were not extensive. Most of the interviewees' answers were "Yes" or "No" because they were afraid of passing their interview details to the principals and teachers or they were shy to present their beliefs. Thirdly, the administrative rules in girls' schools are very restrictive about taking photos and recording the voice of the girls. Therefore the school principals did not allow the researcher to record interviews with the participants.

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Appendix A

Your views about science and physics

Item 1: Demographic

Age:

Sex: o Male o Female

Grades:

Class:

Mother tongue:

Item 2: Reveal your profile choice, if still undecided please put first and second choice and why

Profile choice		Scientific		Literary
Why:	---------- ----------			

Item 3: View of science

	Strongly Disagree				Strongly Agree
I like science because it's interesting	1	2	3	4	5
I like science because it helps me to understand myself and the world	1	2	3	4	5
I like science because it's relevant to my life	1	2	3	4	5
I like science because it's relevant to the kind of work that I want to do	1	2	3	4	5
I like science because I get to discuss issues that are important	1	2	3	4	5

Item 4: How interesting do you find different science topics

	Not at all				Very much
How the heart works	1	2	3	4	5
Light waves: reflection and refraction	1	2	3	4	5
Rocks and metals	1	2	3	4	5
Genetics	1	2	3	4	5
Magnetic fields and electric motors	1	2	3	4	5
Plant structure	1	2	3	4	5
Chemical equations	1	2	3	4	5
The lifecycle of stars	1	2	3	4	5
Fighting disease	1	2	3	4	5
Polymers and plastics	1	2	3	4	5
Circuit symbols and devices	1	2	3	4	5
Respiration	1	2	3	4	5
The planets	1	2	3	4	5

Item 5: Experiences of science in school: indicate how much do you think your understand about different science topics

	Not at all				Very much
How the heart works	1	2	3	4	5
Light waves: reflection and refraction	1	2	3	4	5
Rocks and metals	1	2	3	4	5
Genetics	1	2	3	4	5
Magnetic fields and electric motors	1	2	3	4	5
Plant structure	1	2	3	4	5
Chemical equations	1	2	3	4	5
The lifecycle of stars	1	2	3	4	5
Fighting disease	1	2	3	4	5
Polymers and plastics	1	2	3	4	5
Circuit symbols and devices	1	2	3	4	5
Respiration	1	2	3	4	5
The planets	1	2	3	4	5

Item 6: What is physics?

	Strongly Disagree				Strongly Agree
Physics is very relevant to the work I want to do	1	2	3	4	5
I find physics very practical but it is boring	1	2	3	4	5
Physics is important to study because it helps me to understand the world	1	2	3	4	5
The laws and all of the maths makes physics difficult to learn and remember	1	2	3	4	5
Physics is interesting but not enjoyable	1	2	3	4	5
Physics is too difficult for me	1	2	3	4	5
Physics is remote compared with other subjects	1	2	3	4	5
I want to study physics because it's a good subject to have – it means you're clever	1	2	3	4	5
I'm not really sure what physics is	1	2	3	4	5
Physics is fascinating but I won't continue with it. What's the point?	1	2	3	4	5

Item 7: Describe the most four favourite subject in Math/ Arabic/ Science/ English

1) ----------
2) ----------
3) ----------
4) ----------

Item 8: Describe the least four favourite subject in Math/ Arabic/ Science/ English

1) ----------
2) ----------
3) ----------
4) ----------

Item 9: Rank the 11 school subjects according to their personal preference

	Subject	Grade
1)		
2)		
3)		
4)		
5)		
6)		
7)		
8)		
9)		
10)		
11)		

Item 10: Motivation

	Never				Always
I enjoy learning the science.	1	2	3	4	5
The science I learn relates to my personal goals.	1	2	3	4	5
I am nervous about how I will do on the science tests.	1	2	3	4	5
I become anxious when it is time to take a science test.	1	2	3	4	5
I think about how the science I learn will be helpful to me.	1	2	3	4	5
I worry about failing the science tests.	1	2	3	4	5
I am concerned that the other students are better in science.	1	2	3	4	5
The science I learn is more important to me than the grade I receive.	1	2	3	4	5
I hate taking the science tests.	1	2	3	4	5
I think about how I will use the science I learn.	1	2	3	4	5
I am confident I will do well on the science labs and projects.	1	2	3	4	5
I find learning the science interesting.	1	2	3	4	5
The science I learn is relevant to my life.	1	2	3	4	5
I believe I can master the knowledge and skills in the science course.	1	2	3	4	5
The science I learn has practical value for me.	1	2	3	4	5
I like science that challenges me.	1	2	3	4	5
I am confident I will do well on the science tests.	1	2	3	4	5
I believe I can earn a grade of “A” in the science course.	1	2	3	4	5
Understanding the science gives me a sense of accomplishment.	1	2	3	4	5

Item 11

Dear Student,

We are pleased that you are ready to participate on our survey. The survey is anonymous. That means we do not ask for your name. No one will know who filled out the questionnaires.

This is not a test/examination so there will be no right or wrong answers. It is exclusively to determine your opinion.

Please work for yourself and do not compare your answers with your classmate: Everyone has a different questionnaire!

This survey is about how you envisage/ imagine a 'particular' Person (who you will get to know). You should describe the general "Image" that you have in mind while thinking about such a person.

Examples:

We ask you what a typical Person is like who enjoys sport a lot. Try first to imagine such a person!
As soon as you have an Image of this person in your mind you should assess, how strongly these traits are represented on the questionnaire.
On the very left side of the paper you tick 3 if the traits match/apply very much to the person.
On the very right of the questionnaire you tick 3 if the traits do not fit at all to the person.
And the numbers in the middle you tick when the traits match more or less to the person.
This is how your answer could look like if you think that a typical person who likes sports a lot is very fast, quite fit and less unhurriedly.

- Work quickly without too much thinking!
- Answer everything in sequence!
- Make only one tick for each trait!
- Do not leave out a trait!
- Do not turn back to previous questions!
- Do not change anything subsequently!

Thank you and have fun while taking the questionnaire!!!

First you should describe the typical girl which likes the subject science the most!

Try to imagine such a girl for a moment and take some time to do so.

Do you have the image in your mind?

Than describe what is typical for her.

Use the following traits. Answer quickly and without hesitation:

		Totally agree						***Totally disagree***
1.	Respected	1	2	3	4	*5*	*6*	*7*
2.	Arrogant	1	2	3	4	*5*	*6*	*7*
3.	Attractive	1	2	3	4	*5*	*6*	*7*
4.	Open-mined	1	2	3	4	*5*	*6*	*7*
5.	Persistent	1	2	3	4	*5*	*6*	*7*
6.	Sought-after	1	2	3	4	*5*	*6*	*7*
7.	Popular	1	2	3	4	*5*	*6*	*7*
8.	To be “a known-it-all”	1	2	3	4	*5*	*6*	*7*
9.	Cool	1	2	3	4	*5*	*6*	*7*
10.	Talkative[1]	1	2	3	4	*5*	*6*	*7*
11.	Ambitious	1	2	3	4	*5*	*6*	*7*
12.	Empathetic	1	2	3	4	*5*	*6*	*7*
13.	Lonely	1	2	3	4	*5*	*6*	*7*
14.	One-sided	1	2	3	4	*5*	*6*	*7*
15.	Erotic	1	2	3	4	*5*	*6*	*7*
16.	Diligent	1	2	3	4	*5*	*6*	*7*
17.	Cheerful	1	2	3	4	*5*	*6*	*7*
18.	Educated (emotionally)	1	2	3	4	*5*	*6*	*7*
19.	Sensitive	1	2	3	4	*5*	*6*	*7*
20.	Brilliant	1	2	3	4	*5*	*6*	*7*
21.	Garrulous	1	2	3	4	*5*	*6*	*7*
22.	Talkative[2]	1	2	3	4	*5*	*6*	*7*
23.	Stylish	1	2	3	4	*5*	*6*	*7*
24.	Good-looking	1	2	3	4	*5*	*6*	*7*
25.	Intelligent	1	2	3	4	*5*	*6*	*7*
26.	Interested	1	2	3	4	*5*	*6*	*7*
27.	Isolated	1	2	3	4	*5*	*6*	*7*
28.	Clever	1	2	3	4	*5*	*6*	*7*
29.	Outgoing	1	2	3	4	*5*	*6*	*7*
30.	Body-aware	1	2	3	4	*5*	*6*	*7*
31.	Creative	1	2	3	4	*5*	*6*	*7*
32.	Boring	1	2	3	4	*5*	*6*	*7*
33.	Appreciates	1	2	3	4	*5*	*6*	*7*

34.	Easy-going	1	2	3	4	*5*	*6*	*7*
35.	Logical	1	2	3	4	*5*	*6*	*7*
36.	Fashion	1	2	3	4	*5*	*6*	*7*
37.	Smart-aleck	1	2	3	4	*5*	*6*	*7*
38.	Open	1	2	3	4	*5*	*6*	*7*
39.	Original	1	2	3	4	*5*	*6*	*7*
40.	Imaginative	1	2	3	4	*5*	*6*	*7*
41.	Eloquent	1	2	3	4	*5*	*6*	*7*
42.	Romantic	1	2	3	4	*5*	*6*	*7*
43.	Slim	1	2	3	4	*5*	*6*	*7*
44.	Smart	1	2	3	4	*5*	*6*	*7*
45.	Pretty	1	2	3	4	*5*	*6*	*7*
46.	Shy	1	2	3	4	*5*	*6*	*7*
47.	Self-confident	1	2	3	4	*5*	*6*	*7*
48.	Self-centred	1	2	3	4	*5*	*6*	*7*
49.	Sensual (Motivating)	1	2	3	4	*5*	*6*	*7*
50.	Spontaneous	1	2	3	4	*5*	*6*	*7*
51.	Athletic	1	2	3	4	*5*	*6*	*7*
52.	Sparkling	1	2	3	4	*5*	*6*	*7*
53.	Over-ambitious	1	2	3	4	*5*	*6*	*7*
54.	Dry	1	2	3	4	*5*	*6*	*7*
55.	Stubborn	1	2	3	4	*5*	*6*	*7*
56.	Inexperienced	1	2	3	4	*5*	*6*	*7*
57.	Courted	1	2	3	4	*5*	*6*	*7*
58.	Inhibited	1	2	3	4	*5*	*6*	*7*
59.	Opinionated	1	2	3	4	*5*	*6*	*7*
60.	Versatile	1	2	3	4	*5*	*6*	*7*
61.	Unworldly	1	2	3	4	*5*	*6*	*7*
62.	Pompous	1	2	3	4	*5*	*6*	*7*
63.	Eager to learn	1	2	3	4	*5*	*6*	*7*
64.	Witty	1	2	3	4	*5*	*6*	*7*
65.	Reserved	1	2	3	4	*5*	*6*	*7*

وجهة نظرك حول مادة العلوم والفيزياء

البند 1. **المعلومات الشخصيه العامه**

العمر:

الجنس: o **ذكر** o **انثى**

السنه:

الصف:

اللغه الأم:

البند 2. **وضحي ماهو التخصص الذي اخترتيه، اذا لم تختاري فماهو التخصص الذي ترغبين فيه مع توضيح السبب**

التخصص		**علمي**		**ادبي**
السبب	---------- ---------- ----			

البند 3. **النظره الى مادة العلوم**

	موافق بشده				**غير موافق بشده**
انا احب مادة العلوم لأنها ممتعه	١	٢	٣	٤	٥
انا احب مادة العلوم لأنها تساعدني على فهم نفسي والعالم	١	٢	٣	٤	٥
انا احب مادة العلوم لأنها ترتبط بحياتي	١	٢	٣	٤	٥
انا احب مادة العلوم لأنها ترتبط بنوع العمل الذي ارغب العمل فيه بالمستقبل	١	٢	٣	٤	٥
انا احب مادة العلوم لأنها تجعلني اناقش المشاكل المهمه	١	٢	٣	٤	٥

البند 4. كيف تجدين أهتمامك للموضوعات العلمية المختلفة

	بشده				ابداً
كيف يعمل القلب	١	٢	٣	٤	٥
موجات الضوء: الأنعكاس والأنكسار	١	٢	٣	٤	٥
الصخور والمعادن	١	٢	٣	٤	٥
الجينات	١	٢	٣	٤	٥
المجال المغناطيسي والماطور الكهربائي	١	٢	٣	٤	٥
تركيبة النبات	١	٢	٣	٤	٥
المعادلات الكيميائيه	١	٢	٣	٤	٥
دورة الحياه للنجوم	١	٢	٣	٤	٥
محاربة الأمراض	١	٢	٣	٤	٥
البولمرات والبلاستيكات	١	٢	٣	٤	٥
رموز وأجهزة الدوائر الكهربائيه	١	٢	٣	٤	٥
التنفس	١	٢	٣	٤	٥
الكواكب	١	٢	٣	٤	٥

البند 5. في تجارب العلوم في المدرسية: وضحي مدى استيعابكي مواضيع العلوم المختلفة

	بشده				ابداً
كيف يعمل القلب	١	٢	٣	٤	٥
موجات الضوء: الأنعكاس والأنكسار	١	٢	٣	٤	٥
الصخور والمعادن	١	٢	٣	٤	٥
الجينات	١	٢	٣	٤	٥
المجال المغناطيسي والماطور الكهربائي	١	٢	٣	٤	٥
تركيبة النبات	١	٢	٣	٤	٥
المعادلات الكيميائيه	١	٢	٣	٤	٥
دورة الحياه للنجوم	١	٢	٣	٤	٥
محاربة الأمراض	١	٢	٣	٤	٥
البولمرات والبلاستيكات	١	٢	٣	٤	٥
رموز وأجهزة الدوائر الكهربائيه	١	٢	٣	٤	٥
التنفس	١	٢	٣	٤	٥
الكواكب	١	٢	٣	٤	٥

البند 6. ماهي الفيزياء؟

	موافق بشده				غير موافق بشده
الفيزياء له علاقه قويه بالعمل الذي اطمح له في المستقبل	١	٢	٣	٤	٥
انا اجد ان الفيزياء عمليه جداً لاكنها مملة	١	٢	٣	٤	٥
الفيزياء مهمه للدراسه لأنها تساعدني على فهم العالم	١	٢	٣	٤	٥
القوانين والعمليات الرياضيه تجعل الفيزياء صعبة التعلم والتذكر	١	٢	٣	٤	٥
الفيزياء مثيره للأهتمام لاكنها ليست ممتعه	١	٢	٣	٤	٥
بالنسبه لي الفيزياء صعبه جداً	١	٢	٣	٤	٥
الفيزياء بعيدة المقارنه بالمواد الأخرى	١	٢	٣	٤	٥
انا اريد ان ادرس الفيزياء لأنها ماده جيده ولابد من دراستها – انها تعني انك ذكي	١	٢	٣	٤	٥
انا لست متأكد ماهي الفيزياء	١	٢	٣	٤	٥
الفيزياء رائعة ولكن أنا لن استمر معها. ما هي النقطة؟	١	٢	٣	٤	٥

البند 7. اي المواد التاليه تفضلين الرياضيات/ اللغه العربيه/ العلوم/ اللغه الأنقليزيه (اكثرها جذباً لكي تكون رقم "1" ثم التي تليها وهكذا)

1) ----------
2) ----------
3) ----------
4) ----------

البند 8. اي المواد التاليه لاتفضلين الرياضيات/ اللغه العربيه/ العلوم/ اللغه الأنقليزيه (اكثرها بعداً عنكي تكون رقم "1" ثم التي تليها وهكذا)

1) ----------
2) ----------
3) ----------
4) ----------

البند 9. رتب المواد الدراسيه حسب الرغبه الشخصيه مع ايضاح الدرجه الحاصل عليها

	المادة	الدرجه
1)		
2)		
3)		
4)		
5)		
6)		
7)		
8)		
9)		
10)		
11)		

البند 10. الدافع

	ابداً				دائماً
أنا أستمتع بتعلم مادة العلوم	١	٢	٣	٤	٥
أتعلم العلوم التي تتعلق بأهدافي الشخصية.	١	٢	٣	٤	٥
أنا قلق حول ماذا سأفعل في اختبارات العلوم.	١	٢	٣	٤	٥
عندما يحين وقت اختبار العلوم، انا اصبح قلق.	١	٢	٣	٤	٥
أفكر كيف العلوم التي أتعلمها تكون مفيدة لي.	١	٢	٣	٤	٥
أنا قلق بشأن الفشل في اختبارات العلوم.	١	٢	٣	٤	٥
أنا قلق من أن الطلاب الآخرين أفضل مني في العلوم.	١	٢	٣	٤	٥
تعلم العلوم اكثر اهميه من الدرجه التي سوف احصل عليها.	١	٢	٣	٤	٥
أنا أكره اختبارات العلوم.	١	٢	٣	٤	٥
أفكر كيف سأستخدم العلوم التي تعلمتها.	١	٢	٣	٤	٥
أنا واثق من أنني سوف أوأدي جيدا في المعمل والمشاريع العلمية.	١	٢	٣	٤	٥
أجد تعلم العلوم مثيرة للاهتمام	١	٢	٣	٤	٥
العلوم التي تعلمتها ذات صلة بحياتي.	١	٢	٣	٤	٥
أعتقد انه يمكنني أن إتقن المعارف والمهارات في درس العلوم.	١	٢	٣	٤	٥
العلوم التي اتعلمها لها قيمة عملية بالنسبة لي.	١	٢	٣	٤	٥
أنا أحب العلوم التي تتحداني.	١	٢	٣	٤	٥
أنا واثق من أنني سوف أووْدي جيداً في اختبارات العلوم.	١	٢	٣	٤	٥
أنا أعتقد أنني يمكنني الحصول على درجة أ" في مادة العلوم.	١	٢	٣	٤	٥
فهم العلوم يعطيني شعوراً بالإنجاز.	١	٢	٣	٤	٥

البند 11.

عزيزتي الطالبه،

يسرنا أنك على استعداد للمشاركة في الأستبيان. الأستبيان سوف يكون مجهول. وهذا يعني أننا لا نسأل عن اسمك ولا أحد سيعرف الذين ملئوا الاستبيانات.

هذا ليس اختباراً لذلك لن يكون هناك إجابات صحيحة أو خاطئة. وأنما ذلك لتحديد رأيكي.

رجاءً اجيبي على الأسئله لوحدك ولا تقارن إجاباتكي مع زميلتك: كل طالبه لديها استبيان مختلف!

هذا المسح هو حول كيفية تصور / تتخيل الشخص (الذي سوف نصل الى معرفة). يجب أن تصفي الصوره العامه التي لديك في الاعتبار أثناء التفكير في مثل هذا الشخص.

الأمثلة على ذلك:

نطلب منك تخيل شخص معين مثل الذي يتمتع بالرياضة كثيراً. أولاً حاولي تخيل مثل هذا الشخص!

بمجرد أن يكون لديك صورة لهذا الشخص في ذهنك يجب عليكي تعبية الأستبيان, قوة هذه الصفات سوف تتضح في الاستبيان.

على الجانب الأيسر جدا من الورق تضعين علامة على الرقم 3 إذا كانت الصفات تنطبق كثيراً جداً على الشخص.

على الجانب اليمين جدا من الاستبيان تضعين علامة على الرقم 3 إذا كانت الصفات لا تصلح على الإطلاق لهذا الشخص. والأرقام في منتصف وضع علامة عندما تطابق الصفات أكثر أو أقل إلى الشخص.

هذه هي الطريقة التي يمكن أن تبدو إجابتكي عليها إذا كنت تعتقد أن الشخص النموذجي الذي يحب الرياضة كثيرا سريع جدا، وتناسب تماما، وأقل بشكل متأني.

- العمل بسرعة دون التفكير كثيرا!
- جواب كل شيء في تسلسل!
- جعل علامة واحدة فقط لكل صفة!
- لا تترك خارج صفة!
- لا نعود إلى الأسئلة السابقة!
- لا تقم بتغيير أي شيء بعد ذلك!

شكراً لكن ووقتاً ممتعاً في حين أخذ الاستبيان!

أولا يجب أن تصفي الفتاة النموذجية التي تحب مادة العلوم كثيراً!

حاول أن تتخيلي مثل هذه الفتاة للحظة وقد يستغرق بعض الوقت للقيام بذلك.

هل لديكي صورة في عقلك؟

ثم صفي كيف حالها.

استخدام الصفات التالية. الإجابة بسرعة ودون تردد:.

		غيرموافق بشده						موافق بشده
.1	محترمه	٣	٢	١	٠	١	٢	٣
.2	متغطرسه	٣	٢	١	٠	١	٢	٣
.3	جذابه	٣	٢	١	٠	١	٢	٣
.4	عقليه متفتحه	٣	٢	١	٠	١	٢	٣
.5	مثابره	٣	٢	١	٠	١	٢	٣
.6	مطلوبة	٣	٢	١	٠	١	٢	٣
.7	معروفه	٣	٢	١	٠	١	٢	٣
.8	ان "تعرف بكل شي"	٣	٢	١	٠	١	٢	٣
.9	رائعه	٣	٢	١	٠	١	٢	٣
.10	ثرثاره	٣	٢	١	٠	١	٢	٣
.11	طموحه	٣	٢	١	٠	١	٢	٣
.12	تتفهم مشاعر الآخرين	٣	٢	١	٠	١	٢	٣
.13	منعزله	٣	٢	١	٠	١	٢	٣
.14	متحيزه	٣	٢	١	٠	١	٢	٣
.15	عاطفيه	٣	٢	١	٠	١	٢	٣
.16	مجتهده	٣	٢	١	٠	١	٢	٣
.17	مرحه	٣	٢	١	٠	١	٢	٣
.18	متعلمه (عاطفياً)	٣	٢	١	٠	١	٢	٣
.19	حساسة	٣	٢	١	٠	١	٢	٣
.20	رائعة	٣	٢	١	٠	١	٢	٣
.21	ثرثاره	٣	٢	١	٠	١	٢	٣
.22	ثرثاره	٣	٢	١	٠	١	٢	٣
.23	أنيقة	٣	٢	١	٠	١	٢	٣
.24	جميلة المظهر	٣	٢	١	٠	١	٢	٣
.25	ذكيه	٣	٢	١	٠	١	٢	٣
.26	مهتمه	٣	٢	١	٠	١	٢	٣
.27	منعزلة	٣	٢	١	٠	١	٢	٣
.28	ذكيه	٣	٢	١	٠	١	٢	٣
.29	منطلقه	٣	٢	١	٠	١	٢	٣
.30	مهتمه في جسمها	٣	٢	١	٠	١	٢	٣
.31	خلاقه	٣	٢	١	٠	١	٢	٣
.32	مملّه	٣	٢	١	٠	١	٢	٣

33.	تقدر	٣	٢	١	٠	١	٢	٣
34.	سهله	٣	٢	١	٠	١	٢	٣
35.	منطقية	٣	٢	١	٠	١	٢	٣
36.	على الموضه	٣	٢	١	٠	١	٢	٣
37.	مغروره	٣	٢	١	٠	١	٢	٣
38.	منفتحه	٣	٢	١	٠	١	٢	٣
39.	أصلية	٣	٢	١	٠	١	٢	٣
40.	تخيليه	٣	٢	١	٠	١	٢	٣
41.	فصيحة اللسان	٣	٢	١	٠	١	٢	٣
42.	رومانسية	٣	٢	١	٠	١	٢	٣
43.	رشيقة	٣	٢	١	٠	١	٢	٣
44.	ذكية	٣	٢	١	٠	١	٢	٣
45.	جميله	٣	٢	١	٠	١	٢	٣
46.	خجولة	٣	٢	١	٠	١	٢	٣
47.	واثقه من نفسها	٣	٢	١	٠	١	٢	٣
48.	أنانية	٣	٢	١	٠	١	٢	٣
49.	محفزه	٣	٢	١	٠	١	٢	٣
50.	عفوية	٣	٢	١	٠	١	٢	٣
51.	رياضية	٣	٢	١	٠	١	٢	٣
52.	متألقة	٣	٢	١	٠	١	٢	٣
53.	مفرطه في الطموح	٣	٢	١	٠	١	٢	٣
54.	جافه	٣	٢	١	٠	١	٢	٣
55.	عنيده	٣	٢	١	٠	١	٢	٣
56.	قليلة خبره	٣	٢	١	٠	١	٢	٣
57.	ودوده	٣	٢	١	٠	١	٢	٣
58.	مكبوته	٣	٢	١	٠	١	٢	٣
59.	متعنته برأيها	٣	٢	١	٠	١	٢	٣
60.	مرنة	٣	٢	١	٠	١	٢	٣
61.	ساذجه	٣	٢	١	٠	١	٢	٣
62.	مغروره	٣	٢	١	٠	١	٢	٣
63.	حريصة على التعلم	٣	٢	١	٠	١	٢	٣
64.	بارعه	٣	٢	١	٠	١	٢	٣
65.	متحفظه	٣	٢	١	٠	١	٢	٣

Appendix B

Interview Questions Protocol

1) Can you identify what you think are the most important factors that impacted on your learning of science/physics at primary or high school?
2) How would you describe the importance of science in the curriculum in the class/school?
3) How did the other students respond to science lessons in your class?
4) How does your mind map fit with your own experiences as a science learner?
5) How would you describe your overall feelings about science?
6) Could you describe in as much detail as possible any topics or strategies that were used in the classes that you found interesting?
7) Can you tell me about your experience of science when you were at primary or high school?
8) Have you experienced any changes in your feelings about science from primary school to high school? If so, can you explain this?
9) Do you think your parents and family encourage you to study science subjects as much as your brother? Why?
10) In detail, what are your hobbies?
11) What are your out of school activities and why did you choose them?
12) Please tell me in detail whether any girls in your class want to be physics scientist?
13) Is any member of your family a scientist or a science/ physics teacher?
14) What is the highest education level of your family members?
15) Does your family support you to work in a scientific field especially physics? Can you please elaborate
16) What is your plan to do in the future for study and work? Please explain why you take this direction?

بروتوكول أسئلة المقابلة

1) **هل يمكنك تحديد أهم العوامل التي أثرت على تعلمك مادة العلوم / الفيزياء في المدرسة من الابتدائية الى الثانوية؟**
2) **كيف تصفين أهمية العلوم في المنهج الدراسي؟**
3) **كيف استجابة الطلاب الآخرون لدروس العلوم في صفك؟**
4) **كيف تناسب خبراتك الخاصة بك كمتعلمه مع مادة العلوم؟**
5) **كيف تصفي مشاعرك العامة عن مادة العلوم ؟**
6) **اشرحي طريقة أو استراتيجية تم استخدامها في الفصل ووجدتى انها مثيرة للاهتمام و ممتعة؟**
7) **هل يمكن أن تخبرني عن تجربتك في مادة العلوم عندما كنت في المدرسة الابتدائية أو الثانوية؟**
8) **هل تغيرت مشاعرك نحو مادة العلوم من المدرسة الابتدائية إلى المدرسة الثانوية؟ إذا كان الأمر كذلك، يمكنك شرح هذا؟**
9) **هل تعتقد أن والديك وعائلتك تشجعانك على دراسة المواد العلمية بقدر ما يشجعان أخوانك الذكور؟ لماذا ا؟**
10) **بالتفصيل، ما هي هواياتك؟**
11) **ما هي نشاطاتك خارج المدرسة ولماذا اخترتها؟**
12) **من فضلك اشرحي بالتفصيل ما إذا كان أي الفتيات في صفك تريد أن تكون عالمة في الفيزياء؟**
13) **هل يوجد أي فرد من أفراد عائلتك له علاقه بمادة العلوم / الفيزياء؟**
14) **ما هو أعلى مستوى تعليمي لأفراد عائلتك؟**
15) **هل تدعم عائلتك العمل في المجال العلمي وخاصة الفيزياء؟ هل يمكن أن تشرحي بالتفصيل**
16) **ماهي خططك المستقبليه للدراسة اوالعمل؟ يرجى توضيح سبب اتخاذ هذا الاتجاه**

Appendix C

Curtin University

Science and Mathematics Education Centre

PARENT Information Sheet

My name is Reem AlGhamdi I am currently completing a piece of research for my Doctor of Science Education at Curtin University.

Purpose of Research

I am investigating the "Physics and Saudi Girls: Their Perceptions, Motivations and Career Perspectives"

Your Role

I will conduct research by asking for your child to take part in answering a short questionnaire. Your child's teachers and the school principal have already been contacted and have agreed in principle to the project.
The questions will not in any way affect the students reported grades.
This participation will be voluntary and of short duration (30-45 mins)

Consent to Participate

Your child's involvement in the research is entirely voluntary. You have the right to withdraw at any stage without it affecting your rights or my responsibilities. When you have signed the consent form I will assume that you have agreed to participate and allow me to use your data in this research.

Confidentiality

The information you provide will be kept separate from your personal details, and only myself and my supervisor will only have access to this. The interview transcript will not have your name or any other identifying information on it and in adherence to university policy, the interview tapes and transcribed information will be kept in a locked cabinet for at least five years, before a decision is made as to whether it should be destroyed.

Further Information

This research has been reviewed and given approval by Curtin University of Technology Human Research Ethics Committee (Approval Number SMEC-45-13). If you would like further information about the study, please feel free to contact me on 012-654-6242 or by email jurihala@gmail.com

Thank you very much for your involvement in this research.

Your participation is greatly appreciated.

PARENT CONSENT FORM

_

• I understand the purpose and procedures of the study.

• I have been provided with the participation information sheet.

• I understand that the procedure itself may not benefit my child.

• I understand that I and my child's involvement is voluntary and I can withdraw at any time without problem.

• I understand that no personal identifying information like my name and address will be used in any published materials.

• I understand that all information will be securely stored for at least 5 years before a decision is made as to whether it should be destroyed.

• I have been given the opportunity to ask questions about this research.

• I agree to allow my child to participate in the study outlined to me.

Name: _____

Student Name: _____

Signature: _____

Date: _____

جامعة كيرتين

مركز تعليم العلوم والرياضيات

ورقة معلومات ولي الأمر

انا ريم الغامدي وحالياً إكمل جزء من بحث الدكتوراة في تعليم مادة العلوم بجامعة كيرتين.

الغرض من البحث

أنا ابحث في "الفيزياء والفتيات السعوديات: تصوراتهم، ودوافعهم وطموحاتهم الوظيفية"

دور الأسره

سوف أجري بحثاً عن طريق طلب طفلك أن يشارك في الإجابة على استبيان قصير. وقد تم بالفعل الاتصال بمعلمي طفلك ومدير المدرسة ووافقوا من حيث المبدأ على المشروع.

لن تؤثر الأسئلة بأي شكل من الأشكال على درجات الطلاب.

وستكون هذه المشاركة طوعية وقصيرة المدة (30-45 دقيقة).

الموافقة على المشاركة

إن مشاركة طفلك في البحث طوعية تماماً. ولديك الحق في الانسحاب في أي مرحلة دون أن يؤثر ذلك على حقوقك أو مسؤولياتي. وعند التوقيع على استمارة الموافقة، سأفترض أنك وافقت على المشاركة وتسمح لي باستخدام بياناتك في هذا البحث.

السرية

سيتم الاحتفاظ بالمعلومات التي تقدمها منفصلة عن تفاصيلك الشخصية، ولن يتمكن من الوصول إلى هذا المعلومات إلا الباحث والمشرف. لن يحتوي نص المقابلة على اسم أو أي معلومات تعريفية أخرى عن الطالب، وفي إطار الالتزام بسياسة الجامعة، سيتم الاحتفاظ بأشرطة المقابلات والمعلومات المكتوبة في خزانة مغلقة لمدة خمس سنوات على الأقل، قبل اتخاذ قرار بشأن ما إذا كان يجب اتلافها.

معلومات اضافيه

لقد تم مراجعة هذا البحث وحصل على موافقة لجنة أخلاق البحوث التكنولوجيا البشرية في جامعة كيرتين (رقم الموافقة SMEC-45-13). إذا كنت ترغب في مزيد من المعلومات حول الدراسة، لا تتردد في الاتصال بي على 0126546242 أو عن طريق البريد الإلكتروني jurihala@gmail.com

شكرا جزيلا على مشاركتكم في هذا البحث.

نموذج موافقة ولي الأمر

- أنا ادرك الغرض وإجراءات الدراسة.
- تم تزويدي ب ورقة معلومات الأشتراك في البحث.
- أنا ادرك أن الإجراء نفسه قد لا يستفيد منه طفلي.
- أنا ادرك أن مشاركتي وطفلي طوعية وأستطيع الانسحاب في أي وقت دون مشكلة.
- أنا ادرك أنه لن يتم استخدام أي معلومات شخصية مثل اسمي وعنواني في أي مواد منشورة.
- أنا ادرك أن جميع المعلومات سيتم تخزينها بشكل آمن ولمدة 5 سنوات على الأقل قبل اتخاذ قرار بشأن ما إذا كان يجب إتلافها أم لا.
- أتيحت لي الفرصة لطرح أسئلة حول هذا البحث.
- أوافق على السماح لطفلي بالمشاركة في الدراسة المبينة لي.

الأسم:_____

أسم الطالب:_____

التوقيع:_____

التاريخ:_____

Appendix D
Curtin University
Science and Mathematics Education Centre
Participant Information Sheet

<<School>>
<<Principal>>
<<Address line 1>>
<<Address Line 2>> <<Post Code>>

Dear <<Name>>,

My name is Reem AlGhamd I am currently completing a piece of research for my Doctor of Science Education at Curtin University.

Purpose of Research
I am investigating the research topic "Physics and Saudi Girls: Their Perceptions, Motivations and Career Perspectives"

Your Role
I will conduct research by asking you to take part in answering a short questionnaire. Your teachers and the school principal have already been contacted and have agreed in principle to the project.
The questions will not in any way affect the students reported grades.
This participation will be voluntary and of short duration (30-45 mins)

Consent to Participate
The students and your school's involvement in the research is entirely voluntary. You have the right to withdraw at any stage without it affecting your rights or my responsibilities. When you have signed the consent form I will assume that you have agreed to participate and allow me to use the students' data in this research.

Confidentiality
The information provided will be kept separate from the students' personal details, and only myself and my supervisor will only have access to this. The interview transcripts will not have student names or any other identifying information on them and in adherence to university policy, the interview tapes and transcribed information will be kept in a locked cabinet for at least five years, before a decision is made as to whether they should be destroyed.

Further Information
This research has been reviewed and given approval by Curtin University of Technology Human Research Ethics Committee (Approval Number SMEC-45-13). If you would like further information about the study, please feel free to contact me on 012-654-6242 or by email jurihala@gmail.com. Alternatively, you can contact my supervisor Dr David Treagust on +61-8-9266-3711 or email D.Treagust@curtin.edu.au

جامعة كيرتين

مركز تعليم العلوم والرياضيات

ورقة معلومات المشارك

<<المدرسة>>

<<مدير المدرسة>>

<<العنوان 1>>

<<العنوان 2 >> << الرمز البريدي>>

عزيزي << الأسم >> ،

انا ريم الغامدي وحالياً إكمل جزء من بحث الدكتوراة في تعليم مادة العلوم بجامعة كيرتين.

الغرض من البحث

أنا ابحث في "الفيزياء والفتيات السعوديات: تصوراتهم، ودوافعهم وطموحاتهم الوظيفية"

دورك

سوف أجري بحثاً عن طريق طلبك للمشاركة في الإجابة على استبيان قصير. وقد تم بالفعل الاتصال بمعلمك ومدير المدرسة ووافقوا من حيث المبدأ على المشروع.

لن تؤثر الأسئلة بأي شكل من الأشكال على درجات الطلاب.

وستكون هذه المشاركة طوعية وقصيرة المدة (45-30 دقيقة).

موافقة على المشاركة

إن مشاركة الطلاب والمدرسة في البحث طوعية تماما. لديك الحق في الانسحاب في أي مرحلة دون أن يؤثر ذلك على حقوقك أو مسؤولياتي. وعند التوقيع على استمارة الموافقة سوف افترض أنك وافقت على المشاركة وتسمح لي باستخدام بياناتك في هذا البحث.

السرية

سيتم الاحتفاظ بالمعلومات التي تقدمها منفصلة عن تفاصيلك الشخصية، ولن يتمكن من الوصول إلى هذا المعلومات إلا الباحث والمشرف. لن يحتوي نص المقابلة على اسم أو أي معلومات تعريفية أخرى عن الطالب، وفي إطار الالتزام بسياسة الجامعة، سيتم الاحتفاظ بأشرطة المقابلات والمعلومات المكتوبة في خزانة مغلقة لمدة خمس سنوات على الأقل، قبل اتخاذ قرار بشأن ما إذا كان يجب اتلافها.

معلومات اضافيه

لقد تم مراجعة هذا البحث وحصل على موافقة لجنة أخلاق البحوث التكنولوجيا البشرية في جامعة كيرتين (رقم الموافقة SMEC-45-13). إذا كنت ترغب في مزيد من المعلومات حول الدراسة، لا تتردد في الاتصال بي على 0126546242 أو عن طريق البريد الإلكترونيjurihala@gmail.com

شكرا جزيلا على مشاركتكم في هذا البحث.

Thank you very much for your involvement in this research.
Your participation is greatly appreciated.

PRINCIPAL'S CONSENT FORM

_

• I understand the purpose and procedures of the study.

• I have been provided with the participation information sheet.

• I understand that the procedure itself may not benefit me.

• I understand that my schools involvement is voluntary and I can withdraw at any time without problem.

• I understand that no personal identifying information will be used in any published materials.

• I understand that all information will be securely stored for at least 5 years before a decision is made as to whether it should be destroyed.

• I have been given the opportunity to ask questions about this research.

• I agree to allow students form my school to participate in the study outlined to me.

_

Name: _____

Signature: _____

Date: _____

Appendix E
Curtin University

Science and Mathematics Education Centre

STUDENT Information Sheet

My name is Reem AlGhamd I am currently completing a piece of research for my Doctor of Science Education at Curtin University.

Purpose of Research

I am investigating the research topic "Physics and Saudi Girls: Their Perceptions, Motivations and Career Perspectives"

Your Role

I will conduct research by asking for you to take part in short diagnostic test on chemistry that will complement your learning. Your teachers and the College principal have already been contacted and have agreed in principle to the project. Students involved will undertake a number of short tests. The results of the tests will be given back to you after the completion of the test. The tests will not in any way affect your reported grades.
I may also ask for your participation in a short interview (group) about your attitudes and opinions about assessment in chemistry. Again this participation will be voluntary and of short duration (10-15 mins)

Consent to Participate

Your involvement in the research is entirely voluntary. You have the right to withdraw at any stage without it affecting your rights or my responsibilities. When you have signed the consent form I will assume that you have agreed to participate and allow me to use your data in this research.

Confidentiality

The information you provide will be kept separate from your personal details, and only myself and my supervisor will only have access to this. The interview transcript will not have your name or any other identifying information on it and in adherence to university policy, the interview tapes and transcribed information will be kept in a locked cabinet for at least five years, before a decision is made as to whether it should be destroyed.

Further Information

This research has been reviewed and given approval by Curtin University of Technology Human Research Ethics Committee (Approval Number SMEC-45-13). If you would like further information about the study, please feel free to contact me on 012-654-6242 or by email jurihala@gmail.com. Alternatively, you can contact my supervisor Dr David Treagust on +61-8-9266-3711 or email D.Treagust@curtin.edu.au

Thank you very much for your involvement in this research.
Your participation is greatly appreciated.

STUDENT CONSENT FORM

• I understand the purpose and procedures of the study.

• I have been provided with the participation information sheet.

• I understand that the procedure itself may not benefit me.

• I understand that my involvement is voluntary and I can withdraw at any time without problem.

• I understand that no personal identifying information like my name and address will be used in any published materials.

• I understand that all information will be securely stored for at least 5 years before a decision is made as to whether it should be destroyed.

• I have been given the opportunity to ask questions about this research.

• I agree to participate in the study outlined to me.

Name: _____

Signature: _____

Date: _____

Appendix F

Participants' interview responses

1st question	2nd question	3rd question	4th question
Year 10	1st	no body from my family has high education in science/ physics or scientist	both are high school and my elder sister is studying in first year at medical.
Year 10	2nd	no body from my family has high education in science/ physics or scientist	My father has engineering diploma, my mother has high school.
Year 10	3rd	there are some of my relative but no body from my close family has high education in science/ physics or scientist	My father has bachelor, my mother has high school and my elder brother is studying mathematics in university.
Year 10	1st	no body from my family has high education in science/ physics or scientist	My father has communication diploma and my mother has bachelor.
Year 11	5th	Yes there are two of my family are teachers. One of them is science teacher, while the other is physics teacher.	My father has high school and my mother has intermediate school.
Year 11	2nd	no body from my family has high education in science/ physics or scientist	My father has intermediate school, my mother has high school and my elder sister has psychologist degree.
Year 11	2nd	no body from my family has high education in science/ physics or scientist	Both have bachelor degree.
Year 9	2nd	Yes I have, my aunt is physics teacher.	both are high school
Year 9	1st	Yes I have, my aunt's daughter has doctorate in physics.	Both have bachelor degree.

Year 9	4th	Yes I have, my mother and my sister are medical doctors.	My father has high school and my mother has teaching bachelor.
Year 9	3rd	Yes I have, my aunt's daughter is science teacher. Also, in our family there are medical doctors.	My father has diploma and my mother has mathematics bachelor.
Year 9	6th	no body from my family has high education in science/ physics or scientist	My father has high school and my mother has primary school.
Year 9	1st	no body from my family has high education in science/ physics or scientist	My father has high school and my mother has primary school.
Year 9	2nd	no body from my family has high education in science/ physics or scientist	My father has high school and my mother has intermediate school.
Year 9	3rd	no body from my family has high education in science/ physics or scientist	My father has high school and my mother has intermediate school.
Year 11	4th	Yes I have, my aunt is biology teacher.	My father has high school and my mother has intermediate school. My elder brothers and sister have master of project administration.
Year 11	1st	Yes I have, in our family there and urologists and pharmacist.	Both have bachelor degree.
Year 11	1st	no body from my family has high education in science/ physics or scientist	Both are high school.
Year 11	2nd	no body from my family has high education in science/ physics or scientist	My father has primary school and my mother has intermediate school.

Year 10	3rd	no body from my family has high education in science/ physics or scientist	My father has high school and my mother has intermediate school.
Year 11	2nd	no body from my family has high education in science/ physics or scientist	My father has bachelor, my mother has high school.
Year 11	2nd	no body from my family has high education in science/ physics or scientist	Both have bachelor degree.
Year 11	2nd	Yes I have, my brother is studying civil engineering.	My father has primary school and my mother has intermediate school.
Year 11	4th	no body from my family has high education in science/ physics or scientist	Both have bachelor degree.
Year 11	4th	no body from my family has high education in science/ physics or scientist	My father has high school and my mother has intermediate school.
Year 11	7th	no body from my family has high education in science/ physics or scientist	Both have bachelor degree. My father is engineer.
Year 11	6th	no body from my family has high education in science/ physics or scientist	My father has intermediate school, my mother has high school.
Year 11	3rd	no body from my family has high education in science/ physics or scientist	My father has high school and my mother has primary school.
Year 11	1st	Yes I have, there is physics teacher.	My father has intermediate school and my mother has bachelor.

Year 11	1st	no body from my family has high education in science/ physics or scientist	My father has high school and my mother has teaching degree.
Year 11	1st	my father is specialist in mathematics	My father has master of mathematics and my mother has high school.
Year 10	5th	Yes I have, my uncle is studying doctorate in biology.	My father has high school and my mother has intermediate school.
Year 10	2nd	no body from my family has high education in science/ physics or scientist	My father has intermediate school and my mother has bachelor.
Year 10	3rd	no body from my family has high education in science/ physics or scientist	Both are high school.
Year 9	1st	no body from my family has high education in science/ physics or scientist	Both are high school.

5th question	**6th question**
there are support from my family because my impetus is studying medical and be a doctor	no idea because my brothers is not attend to school
I prefer literary especially English literary because I like it and find myself in it	Actually my parents didn't force me to select my way either be scientific or literary and they respect my choice and support me. Because I chose literary they support me.
They are supporting my studying depend on my objective and ambition. They don't force me to study the stream I don't like it.	They are supporting my studying depend on my objective and ambition. They don't force me to study the stream I don't like it.

They are supporting my studying because they would like me be a doctor.	They are supporting my studying depend on my objective and ambition. They don't force me to study the stream I don't like it.
They are supporting my studying because they would like me be a doctor.	They are supporting my studying depend on my objective and ambition. They don't force me to study the stream I don't like it.
They are supporting my studying because they would like me be a nurse.	They are supporting my studying depend on my objective and ambition. They don't force me to study the stream I don't like it.
They are supporting my studying because there is no different between boys and girls.	They are supporting my studying because there is no different between boys and girls.
They are supporting my studying depend on my objective and ambition. They don't force me to study the stream I don't like it.	They are supporting my studying because there is no different between boys and girls in my family.
They are supporting my studying because they would like me be a doctor.	They encourage us to approach our ambition.
They are supporting my studying because they would like me to be environmental scientist.	Sure they do to approach our ambition.
They are supporting my studying because they would like me be a doctor.	Sure because they believe that no different between boys and girls.
They are supporting my studying because there is no different between boys and girls.	Sure because they believe that no different between boys and girls.
They are supporting my studying because science stream can help me to enter the university department in the future.	yes there no difference between boys and girls.

They are supporting my studying depend on my objective and ambition. They don't force me to study the stream I don't like it.	Yes they support me because they think the girls more attention for their studying than boys.
They are supporting my studying depend on my objective and ambition. I would like to study special need teaching that related to our society.	yes there no difference between boys and girls.
They are supporting my studying and I would like to study scientific topics.	They encourage me to study the scientific topics.
They are supporting my studying to insure my future and approach my ambition (civil engineering)	They are supporting my studying depend on my objective and ambition. They don't force me to study the stream I don't like it.
They are supporting my studying depend on my objective and ambition. They don't force me to study the stream I don't like it.	yes there no difference between boys and girls.
They are supporting my studying depend on my objective and ambition. They don't force me to study the stream I don't like it.	They are supporting my studying depend on my objective and ambition. They don't force me to study the stream I don't like it.
They are supporting my studying depend on my objective and ambition. They don't force me to study the stream I don't like it.	yes there no difference between boys and girls.
They are supporting my studying depend on my objective and ambition. They don't force me to study the stream I don't like it.	yes there no difference between boys and girls.
They are supporting my studying to insure my future and approach my ambition (Electrical engineering)	yes there no difference between boys and girls.
They are supporting my studying depend on my objective and ambition. They don't force me to study the stream I don't like it.	They are supporting my studying depend on my objective and ambition. They don't force me to study the stream I don't like it.

They are supporting my studying depend on my objective and ambition. They don't force me to study the stream I don't like it.	They encourage me to study medical.
They are supporting my studying depend on my objective and ambition. They don't force me to study the stream I don't like it.	They are supporting my studying depend on my objective and ambition. They don't force me to study the stream I don't like it.
They are supporting my studying depend on my objective and ambition. They don't force me to study the stream I don't like it.	They are supporting my studying depend on my objective and ambition. They don't force me to study the stream I don't like it.
They are supporting my studying depend on my objective and ambition. They don't force me to study the stream I don't like it.	They are supporting my studying depend on my objective and ambition. They don't force me to study the stream I don't like it.
They are supporting my studying depend on my objective and ambition. They don't force me to study the stream I don't like it.	They are supporting my studying depend on my objective and ambition. They don't force me to study the stream I don't like it.
They are supporting my studying depend on my objective and ambition. They don't force me to study the stream I don't like it.	yes there no difference between boys and girls.
They are supporting my studying depend on my objective and ambition. They don't force me to study the stream I don't like it.	They encourage us to approach our ambition.
They are supporting my studying depend on my objective and ambition. They don't force me to study the stream I don't like it.	They encourage us to approach our ambition.
They are supporting my studying depend on my objective and ambition. They don't force me to study the stream I don't like it.	They encourage us to approach our ambition.
They are supporting my studying depend on my objective and ambition. They don't force me to study the stream I don't like it.	They are supporting my studying depend on my objective and ambition. They don't force me to study the stream I don't like it.

They are supporting my studying depend on my objective and ambition. They don't force me to study the stream I don't like it.	They are supporting my studying because there is no different between boys and girls.
They are supporting my studying because there is no different between boys and girls.	yes there no difference between boys and girls.

7th question	8th question	9th question
I like fashion design and I see myself in it	In my free time I help my parents, reading and spend some time on the Internet	I don't like to be a doctor. But my mum encourage me to study medicine. Therefore I work hard to get high marks to study medical in uni.
Painting and reading because they reveal internal sensations, release the stress, time consuming and improving the human.	In my free time I am reading, doing my homework, visiting relative and going out the house	I would like to be English teacher or business women because I like it.
I like swimming and sewing for time consuming.	In my free time I am reading, studying and Internet browsing.	I would like to study mathematics in university and be academic because I love teaching.
I like painting and learning English to get benefit and deal with people.	In my free time I am painting and translating English songs for learning English.	I would like to study medical in university because I love medical field.
I like traveling, scientific travels, learning English, acting and swimming to get self-confidant and experience.	In my free time I like to go a picnic for enjoyment.	I would like to learn English, computer programming and secretariat for studying business administration in university because I like office work and accounting.
I like writing thoughts, organising things and reading rarely to release stress.	In my free time I am Internet browsing, sitting with my family for contact them and reading books for time consume.	I would like to be decoration designer or attending to architecture (decoration) engineering at university because I love organisation.
I like reading, writing, picturing and painting to release stress.	In my free time I like to go a picnic and Internet browsing.	I would like to be a doctor because I like medical and help people and invention.

I like reading in psychology, anatomy and novels to develop the mind and expands perceptions.	In my free time I am reading, visiting relatives and sitting with my family.	I would like to study the anatomy to be a doctor because I like complex things and challenges.
I like reading and drawing to develop my mind and expand my perceptions.	In my free time I am studying, Internet browsing and painting for time consume.	I would like to study science in high school for attending to medical department in university because this is my ambition.
I like swimming and doing research, which is suitable to age.	In my free time I am walking and researching.	I would like to be academic staff and researcher because this is my ambition and I like invention.
I like swimming, painting, acting and leaning English to release stress.	In my free time I am watching TV.	I would like to attend to medical department in university because I would like help the people.
I like writing and painting to time consuming and enjoyment.	In my free time I am watching TV, reading novels and help my parents.	I would like to attend to medical department particularly special needs stream for helping them and affecting psychological positively on them.
I like computer games and cocking because they are interesting and I can get benefit.	In my free time I am studying and help my mother.	I would like to attend to medical in university to be surgeon.
I like reading to educate myself and swimming to care about my body.	In my free time I am studying and Internet browsing for improving my mind and time consuming.	I would like to attend to medical in university to be surgeon because this stream more feminine than masculine.
I like reading, Internet browsing, research and cocking to develop my mind and increase my confident.	In my free time I am reading, Internet browsing, research and cocking to develop my mind and increase my confident.	I would like to be specialist in special education for helping, contacting and communication with the society.
I like research and innovation for my future. I involved in innovation competition but I am not success. I will do it again.	In my free time I am sitting with my family, reading and watching TV.	I would like to be neurologists because the brain is the main part of human.
I like reading because it gives me information for important topics.	In my free time I am visiting relatives, watching TV for enjoyment.	I would like to be architectural engineer because I like it.

I like calculating and writing novels.	In my free time I am studying and teaching my brothers.	I would like to be Paediatrician because I like it.
I like swimming for my health, acting to deliver message and reading to improve my mind.	In my free time I am studying.	I would like to learn foreign languages and computer programming for myself.
I like computer, news either be national or international through newspaper, TV and the Internet.	In my free time I am studying, watching TV and helping my mother.	I would like to learn English languages because it is main language worldwide.
I like painting and sewing.	In my free time I am reading.	I would like to be special needs (like deaf and blind) teacher to understand their personality, and psychology to help them.
I like sewing for enjoying and time consuming.	In my long free time I organise sewing courses and beauty with my friends.	I would like to study in USA and work outside of Saudi Arabia.
I like organisation and attending courses.	In my free time I am attending courses.	I would like to achieve high academic education.
I like reading and sport exercises for time consuming.	In my free time I am helping my mother.	I would like to attend to medical in university because this stream more feminine than masculine.
I like rooms' organisation because it helps me to understand the colours and beauty of things.	In my free time I am studying.	I would like to achieve the highest level of education to be an academic in psychologist.
I like picturing and fashion design because they are interesting.	In my free time I am studying and Internet browsing.	I would like to work in designing and fashion.
I like painting, reading and writing.	In my free time I am studying.	I would like to complete my studying law.

I like Internet browsing.	In my free time I am studying and helping my mother.	I would like to complete my studying in management.
I like painting, and organisation for time consuming and hopefulness.	In my free time I am trying create and innovate things.	I would like to complete my studying in family educational.
I like reading because it gives me information for important topics.	In my free time I am studying, Internet browsing and helping my parents.	I would like to be engineer.
I like painting, reading for to improve my mind and time consuming.	In my free time I am studying, Internet browsing.	I would like to be a doctor.
I like writing my dairy for future.	In my free time I am watching TV.	I would like to complete my studying law.
I like picturing and fashion design because they are interesting.	In my free time I am reading, doing my homework, visiting relative and going out the house	I would like to be fashion designer because I can get a lot of money.
I like reading because it Increase my experience.	In my free time I like to go a picnic and Internet browsing.	I would like to be a teacher.
I like painting and reading.	In my free time I am reading, Internet browsing, research and cocking to develop my mind and increase my confident.	I would like to study art in university.

10th question	11th question	12th question
I don't think that because this subject is Masculine and the boys like it more	the teacher affects on public to like the physics. on the other hand, difficulty of mathematical equation in physics makes the student does not like it	I know many things related to life that I learn it from science unit

I think some girls can be physical scientist because some of them like physics	The teacher is impact on my physics and science learning. The teachers' ways of learning make different between them. Some of teachers made me love science and other not.	I find science is helpful and related to our life. Reading scientific books could help us but science school book is boring and more serious.
Yes because there are openness recently such as jobs was focused for men previously, while now women can work these jobs.	I think most important is explaining the topic concept and important and practical exercise in the class is very essential.	My knowledge increases every year. Science is expanding my perceptions.
Yes because the girl can work in any field recently.	I think most important is explaining the topic concept and encouraging the girls students to understand it.	Science is helpful, interesting and difficult.
Yes, no privacy in education.	I think most important is teacher, family and exercise.	Science is bored, uninteresting, depends on mathematics and equations.
Yes, there is no difference between boys and girls in ability.	I think most important is teacher, teacher's practise and family.	Science is helpful and related to life and environment.
Yes, some girls have ability to be scientist.	Teacher and class environmental are the most important.	Science expands the perceptions, new innovations and without it, we don't know a lot of things surround us.
Yes sure	Teacher is the most important.	My experience in science is vary and related to my life.
Yes, that depends on personal interest for the girl.	Home, books, teacher explanation and experiment are most important.	Science helped me to expand and increase my knowledge, made my understanding for surrounding actions better and observing the details better.
In my view, the girls students more attention and interest in this fields, therefor my answer is yes.	Science is essential and related to our life and our environment, therefor student surrounded environment is important factor on learning science.	In each next term the knowledge is increased and expanded.
Sure because the girls more attention than boys. While the boys like external fields like engineering and flying.	I think teacher, like the subject and life relation are important factor on learning science.	It is interesting subject, but physics is difficult because it contains laws.

Yes even the girls can adapt on the science studying.	Teacher, experiment and activities are most important.	Science could be interesting or boring and could be difficult or easy.
Yes, girls have ability to be scientist.	Teacher and experiment are most important.	It is related to life and environment.
Yes it can be because in my view that the girl has ability to work in this field.	Teacher, curriculum, tools and activities are most important.	It is interesting.
Yes because there are huge improvement in all fields recently.	Teacher, curriculum and pictures are most important.	Every studying year is preparing for next one. The difference is more knowledge.
Can be.	Teacher is most important.	Knowledge is expanded and more interesting.
Yes, some time for liking the field makes the human patient to learn it.	Teacher and experiment are most important.	Knowledge is expanded and more interesting.
Yes, if the human has ambition, why not.	Teacher is most important.	Every studying year is preparing for next one. The difference is more knowledge.
Yes because some girls more ability and initiative than boys.	Teacher is most important.	Every studying year is preparing for next one. The difference is more knowledge.
Yes depends on personal ambition.	Curriculum and teacher are most important.	Knowledge is expanded and raised but some information is useful and not changed.
Yes it can be because what the bay can do, girl can do also.	Curriculum and teacher are most important.	Knowledge is expanded and raised but some information is useful and not changed.

Sure because the girl has ambition and love of challenge.	Teacher and experiment are most important.	Curriculum is expanding.
Yes the girls can do.	Teacher, loving the subject and learn are most important.	It is interesting and the most important.
Yes to have role in community.	Teacher is most important.	Knowledge is expanded and raised but some information is useful and not changed.
Yes if she has encouragement and facilities.	Teacher and experiment are most important.	It is related to our life.
Yes because the girls have ability to do what the boy can do.	Teacher and her explanation are most important.	It is related to our life.
Yes	Teacher and experiment are most important.	It is related to our life.
Yes	Teacher and her explanation are most important.	It is board and related to our life.
Yes because the most of girls like physics.	Including entertainment games to lesson is one of the essential factors.	It is interesting and has a lot of information.
Yes	Teacher and experiment are most important.	It is related to our life.
Yes	It depends on understanding and improving the perception.	It is related to our life.

Yes, girls have ability to be scientist.	Teacher and experiment are most important.	Curriculum is expanding.
Yes because the girl can work in any field recently.	Teacher, curriculum and pictures are most important.	Curriculum is expanding.
Yes it can be because what the bay can do, girl can do also.	Teacher is most important.	It is interesting and the most important.
Yes even the girls can adapt on the science studying.	Teacher and experiment are most important.	Knowledge is expanded and raised but some information is useful and not changed.

13th question	**14th question**	**15th question**
There is change like more information and more knowledge belong many subjects	There are difficult and easy topics. Also, there are interesting and boring topics.	Science is very important. Science and most of its topics related to our life.
I got a lot knowledge, some of my previous knowledge was corrected and my thinking was improving.	I think science and physics are boring, I feel nervous during studying them and I don't contribute in the class exercises.	Science is one of the very important topics but also it is the most important topic because it is related to the life.
Yes it becomes more detail in each following year.	I think science and physics are difficult and need open mind and imaginative human.	It has topics related to human life and his environment.
Yes, my knowledge was growing and my perception was expanded.	It is interesting; it is active and related to our life.	Science is important, interesting and many subjects depend on it.
Yes, my knowledge was growing, my perception was expanded and practical exercise was increased.	Physics is bored depends on mathematics equations and imaginative.	It is important because it is related to life, environment and society.

My knowledge was growing, my perception was expanded	I like science classes that in the lab, it depends on the imaginative and it expands our perception. It depends on the teacher and her explanation.	It warns me about the diseases and learns me about phenomena that happen.
Yes my knowledge was raised.	It depends on type of lesson; it could be entertaining, interesting, not difficult and it depends on understand.	Science is one of the most important subjects.
Yes my knowledge was expanded.	I like it because it will deliver me to future's way.	It is one of the important science subjects because it related to our daily life, our environment and our community.
Yes changing happened is increasing the knowledge as expanding and details.	It is essential subject, everything in our life related to it.	It is essential subject related to our life.
In each year my knowledge is more than year before. Therefor my perception is raised.	I find science interesting, useful and related to our life.	Science is essential subject and many fields depend on it.
I feel change because the knowledge increasing and I like it more with knowledge rising.	I like science and I find it interesting, useful and related to our life.	It is the most important subject because it is strongly related to our life.
Yes, there is rising at knowledge and expanding at subjects.	Science is interesting subject, linking us with our life and worldwide.	It is the most important subject because it is related to our life and my body parts.
In each year subjects are improved and more information than previous year.	Science is interesting subject and it is from our real life.	It is considered the primary subject on the all of educational subjects.
Yes, there is rising at knowledge and expanding at subjects.	I like science and I find it interesting, useful and related to our life.	It is considered the primary subject on the all of educational subjects because it is related to our life and my body parts.
Curriculum is improved and more knowledge.	It is interesting and wonderful.	It is considered the primary subject on the all of educational subjects and it is related to all things surround us.

Yes, there is rising at knowledge.	I like science and I find it interesting and related strongly to our life.	It is essential subject because it is related to our daily life and it is important to learn it.
Yes, there is rising at knowledge.	I like science and I find it interesting and related strongly to our life.	It is essential subject because it is related to our daily life and it is important to learn it.
Curriculum is better and teachers also.	It is very wide cover all the life.	It is essential subject because it is related to our daily life and it is important to learn it.
Curriculum is better and teachers also.	It is very wide cover all the life.	It is essential subject because it is related to our daily life and it is important to learn it.
yes, sure I feel it.	It is very wide cover all the life.	It is essential subject because it is related to our daily life and it is important to learn it.
yes, sure I feel it.	It is very wide cover all the life.	It is essential subject because it is related to our daily life and it is important to learn it.
Yes, in primary school information was simple, but in the next stages the information was increased.	It is very wide cover all the life.	It is essential subject because it is related to our daily life and it is important to learn it.
Yes, in primary school information was simple, but in the next stages the information was increased.	It is very wide cover all the life.	It is essential subject because it is related to our daily life and it is important to learn it.
Curriculum is improved and more knowledge.	I like science and I find it interesting and related strongly to our life.	It is the most important subject because it is related to our life and my body parts.
Curriculum is improved and more knowledge.	I like science and I find it interesting, useful and related to our life.	It is the most important subject.

There are a lot of changes with increasing my knowledge.	It is interesting and has a lot of activity rather than other subjects.	It is the most important subject.
There are a lot of changes with increasing my knowledge.	It is interesting and has a lot of activity rather than other subjects.	It is the most important subject.
There are a lot of changes with increasing my knowledge.	It is interesting and has a lot of activity rather than other subjects.	It is the primary subject.
There are increasing in the knowledge.	My knowledge is increased.	It is the most important subject because it is related to our life and my body parts.
There are a lot of changes with increasing my knowledge.	It is interesting and has a lot of activity rather than other subjects.	It is the most important subject.
Yes, there is rising at knowledge.	I like science and I find it interesting, useful and related to our life.	It is the most important subject because it is related to our life and my body parts.
Yes, in primary school information was simple, but in the next stages the information was increased.	It is very wide cover all the life.	It is essential subject because it is related to our daily life and it is important to learn it.
Curriculum is improved and more knowledge.	I like science and I find it interesting and related strongly to our life.	It is the most important subject because it is related to our life and my body parts.
Yes, there is rising at knowledge.	It is cover all the life.	It is the most important subject because it is related to our life and my body parts.
Yes, there is rising at knowledge.	It is interesting and wonderful.	It is the most important subject because it is related to our life and my body parts.

16th question	17th question	18th question
I ware thinking about many science topics. During practical studying for these topics, I understand how these topics are done and relate them together.	I like practical exercise, working in groups and external practical that distribute by teacher and make competition among the class groups.	Some of my classmates believe that science is easy ant interesting and others believe is difficult and boring. I think that referring to the teacher and who she deals with the class.
Experience will increase consequence of studying of science, which is related to life daily.	I like practical exercise and working in groups make the class more interesting.	Some of my classmates are interesting and others are bored during the class.
Many things I didn't understand it before I study it in science. Science leads me to understand things around me.	Maybe is best way is explain the concept, make groups or practical exercise.	Many of them are feel bored, uninterested and worried.
My perceptions were expanded. I was misunderstanding many subjects. During the time and improving my knowledge lead my understanding to improve.	Make groups and make variety practical exercise.	Few of my classmates are like science subject.
My perceptions were expanded. I was misunderstanding many subjects. During the time and improving my knowledge lead my understanding to improve.	Maybe is best way is explain the concept, make groups or practical exercise.	Some of them look at it as interesting and easy subject, while others not.
I learn from previous science classes is always asking myself "how" and "why" that happened.	I think best way is encourage the student to use her imagination, play competition games, groups and practical exercise.	Depends on the class environment and depends on the teacher.
I learn from previous science classes is always asking myself "how" and "why" that happened.	I think best way is using laboratories, new tools, exercises and groups.	Some of them look at it as interesting because they like it and others look at it as bored subject.
My perceptions were expanded. I was misunderstanding many subjects. During the time and improving my knowledge lead my understanding to improve.	I think best way is using practical experiment.	They are bored and not concentrate for the lessons.
My perceptions were expanded. I was misunderstanding many subjects.	I think best way is using touchable material, experiments, lesson explanation.	Some of them look at it as interesting because they like it and others look at it as bored subject.

Many available phenomena in our life are explained by science and physics.	Maybe can use games, practise, example and exercises.	Some of them look at it as interesting and wonderful and others look at it as bored subject.
It is explaining many phenomena in our life.	I think using games and picture could help to more interest for lessons.	Some of them look at it as interesting and others look at it as bored subject.
It is explaining many phenomena in our life.	I think using touchable material is better way to deliver the science to student.	Some of them look at it as interesting and others look at it as bored subject.
My perceptions were expanded. I was misunderstanding many subjects.	I think maybe using materials, practical experiments in the lab and using power point for presentation is the best way.	Some of them look at it as useful and others look at it as bored subject.
It is explaining many phenomena in our life.	Using pictures and real material during lessons is very important in my opinion.	I think most of student like it and interesting, the lesson time is run away consequence of enjoyment.
My perceptions were expanded. I was misunderstanding many subjects.	Teacher needs to do more exercise, more focus on theories and more encourage us to read.	Some of them look at it as interesting and most of the student look at it as bored subject.
Many available phenomena in our life are explained by science and physics.	Using group competition and let students explain the lessons rather than teacher.	Some of them look at it as useful and others look at it as bored subject.
Many available phenomena in our life are explained by science and physics.	I think teacher summarises the lessons and using logical way to explain the lessons.	Some of them look at it as useful and others look at it as bored subject.
My perceptions were expanded. I was misunderstanding many subjects.	Using group competition and cards are one of the best ways.	Some of them look at it as useful and others look at it as bored subject.
My perceptions were expanded. I was misunderstanding many subjects.	Using group competition is one of the best ways.	They are bored and not concentrate for the lessons.

My perceptions were expanded. I was misunderstanding many subjects.	Using projector is one of the best ways.	Some of them look at it as useful and others look at it as bored subject.
My perceptions were expanded. I was misunderstanding many subjects.	I think using games and competition could help to more interest for lessons.	Some of them look at it as useful and others look at it as bored subject.
My perceptions were expanded. I was misunderstanding many subjects.	Using group competition and let students explain the lessons rather than teacher.	Some of them look at it as useful and others look at it as bored subject.
My perceptions were expanded. I was misunderstanding many subjects.	Using group competition and let students explain the lessons rather than teacher.	Some of them look at it as useful and others look at it as bored subject.
It is explaining many phenomena in our life.	Teacher needs to do more exercise, more focus on theories and more encourage us to read.	Some of them look at it as useful and others look at it as bored subject.
It is explaining many phenomena in our life.	I think best way is using experiments.	Some of them look at it as useful and others look at it as bored subject.
It is explaining many phenomena in our life.	I think best way is using experiments.	Some of them look at it as useful and others look at it as bored subject.
It is explaining many phenomena in our life.	Using group competition and the group win can go a trip.	I find student waiting the science lesson because the teacher using attractive teaching methods.
It is explaining many phenomena in our life.	Using group competition and the group win can go a trip.	I find student waiting the science lesson because the teacher using attractive teaching methods.
My perceptions were expanded. I was misunderstanding many subjects.	I think best way is using experiments.	Some of them look at it as useful and others look at it as bored subject.

It is explaining many phenomena in our life.	I think maybe using materials, practical experiments in the lab and using power point for presentation is the best way.	Some of them look at it as useful and others look at it as bored subject.
My perceptions were expanded. I was misunderstanding many subjects.	I think best way is using experiments.	Some of them look at it as useful and others look at it as bored subject.
My perceptions were expanded. I was misunderstanding many subjects.	Using group competition and let students explain the lessons rather than teacher.	Some of them look at it as useful and others look at it as bored subject.
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It is explaining many phenomena in our life.	Using group competition and the group win can go a trip.	Some of them look at it as useful and others look at it as bored subject.
It is explaining many phenomena in our life.	I think maybe using materials, practical experiments in the lab and using power point for presentation is the best way.	Some of them look at it as useful and others look at it as bored subject.