Cypriot Students' Attitudes towards School Science:

The transition from primary to secondary school

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To my family, whose love constantly encourage me to push myself out of my comfort zone. Particularly, to my husband Andreas whose support enabled me to carry on when I was ready to give up, my son Kyriacos whose arrival taught me what unconditional love is and to my daughter Nayia who is on her way -we can’t wait to meet her…

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Abstract

Understanding students' attitudes towards school science is an international endeavour, seen by researchers as a key part of improving students' science attainment, science career aspirations and their participation in science related studies. Research studies conducted previously in Cyprus highlight the association between positive attitudes towards school science and Cypriot students' science achievement. However, studies in Cyprus that provide insights into students' attitudes towards school science, what are they, what impacts them and how they change as students move from primary to secondary school have been sparse. This study employed mixed methods to investigate students' attitudes towards school science, if and how they change as students move from primary to secondary school and the factors that impact the formation of students' attitudes towards school science. The study is based on data collected from five primary and two secondary schools in Cyprus. It involved the collection of 539 questionnaires completed by primary and secondary school students (year 6 to year 8) as well as group interviews with smaller groups of students from the same cohort (9 group interviews with 34 participants). In line with certain studies in the reviewed literature, the findings suggest that students' attitudes towards school science are overall positive, and they do not change significantly as students move from primary to secondary school. There were no significant differences identified between the attitudes of girls and boys towards school science. Teacher and enjoyment of experiments were found to be key factors affecting students' attitudes towards school science. Other factors identified to affect students' attitudes were parents' attitudes towards science, science-related career aspirations and fathers' education level. Students in secondary school were found to have significantly more positive attitudes towards physics and chemistry than biology. Looking at the three attitude domains, students were found to have more positive affective and cognitive attitudes and less positive behavioural attitudes towards school science. This thesis has contributed to the theory and knowledge about the three attitude domains: the affective, cognitive and behavioural regarding students' attitudes towards school

science. It has also resulted in a validated instrument that can be used to collect data regarding students' attitudes towards school science in Cyprus and other countries. This study has implications for practice and policy makers such as the need to consider students' attitudes towards school science and the factors that impact them when planning for lessons, the national science curriculum and training opportunities for all the stakeholders. Its findings also suggest the need for more research that explores the attitudes towards school science of students from a range of school settings and considering factors such as the socio-economic backgrounds, parental education and income in a systematic way.

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List of abbreviations

ATSI	Attitude Towards Science Inventory
ATSSA	Attitude Towards Science in School Assessment
BERA	British Educational Research Association
D&T	Design and Technology
DfE	Department for Education
EECERA	European Early Childhood Education Research Association
GCSE	General Certificate of Secondary Education
GDPR	General Data Protection Regulation
ICT	Information and Computer Technology
KEEA	Educational Research and Evaluation Centre
MoEC	Ministry of Education and Culture (Cyprus)
NAEP	National Assessment for Educational Progress
NFER	National Foundation for Educational Research
OECD	Organisation for Economic Co-operation and Development
PISA	Program for International Student Assessment
STEM	Science Technology Engineering Mathematics
TIMSS	Trends in International Mathematics and Science Study
UNCR	United Nations Convention on the Rights of the Child
UNESCO	United Nations Educational, Scientific and Cultural Organization
VET	Vocational and Technical Education

Chapter 1: Introduction

1.1 Setting the scene – students' attainment, participation and attitudes to science

The attainment and participation of students in science related studies and later in science related careers has received increasing attention in developed countries over the last two decades (Hill et al., 2010; Tytler and Osborne, 2012; Bottia et al., 2015; Cooper et al., 2020). Even more so, in the last two years when the world has been fighting the COVID-19 pandemic and the contribution of scientists has been undoubtedly important (Moradian et al., 2020; Burden et al., 2021) with the current UK government placing science at the heart of the country's future prosperity (Jerrim, 2021). The concern regarding the low proportion of students who choose to study science at a 'post-compulsory' level and to follow a science related career is linked to the increasing industry demand for and the predicted shortage of science professionals following a STEM career (Hipkins, 2012; Bennett, Lubben, et al., 2013; STEM Learning, 2018; Science et al., 2020). However, there are studies (in the UK and around the world) that suggest that this view is overstated (Osborne and Dillon, 2008; Charette, 2013) or that there is a number of students who choose to study science but after they finish their degree they choose to follow a career that is not relevant to science, perhaps due to the fact that the demand for scientists trained in certain science areas is more than met at the moment (Smith and Gorard, 2011).

Studies conducted around the world have shown that positive attitudes towards school is a key predictor of students' achievement, participation and their future career aspirations (Moè, 2016; Veresova and Mala, 2016; Dagnew, 2017). The growing number of studies conducted in the last two decades report a relationship between the low participation in science after the period of compulsory school science and the poor attitudes of students towards school science (Collette Murphy and Beggs, 2001; Jenkins et al., 2010; Trowler, 2010; Sammons et al., 2012) suggesting that it is important to maintain students' positive attitudes towards school science in order to increase the number of students choosing science at a post-compulsory level. According to Linnenbrink-Garcia and Pekrun (2011), attitudes towards school science is potentially one of the factors that may impact students' course and career choices. However, it is important to note that not all students who hold positive attitudes towards school science choose to study science or a science related career (Bennett et al., 2006; DeWitt and Archer, 2015).

Research conducted in the last four decades also indicates a link between students' attitudes towards school science and the achievement of students in science (Hough and Piper, 1982; OECD, 2016; Mourshed et al., 2017; Liou, 2020; Jerrim, 2021). The ongoing research in the field of science education points out that students' attitudes towards school science and students' science career aspirations can depend on a range of factors including gender (Barmby, Per M. Kind, et al., 2008; DeWitt and Archer, 2015; Yamtinah et al., 2017), ethnic background (DeWitt and Archer, 2015) , teaching style, type of school, background of parents and social class (Dewitt et al., 2014; Mujtaba et al., 2018) and that individual students' attitudes towards school science may become less positive at different times throughout their school years. (Breakwell and Beardsell, 1992; Galton, 2002; Osborne et al., 2003; Braund and Driver, 2005; Logan and Skamp, 2008; Tytler et al., 2008). More specifically, the studies mentioned above, state that students' attitudes towards school science become less positive as they move through their secondary schooling. However, a significant number of studies (Speering and Rennie, 1996; Osborne et al., 2003; Logan and Skamp, 2008; Bennett and

Hogarth, 2009; Hutchinson and Bentley, 2011) indicate that the most dramatic decline in students' positive attitudes occurs as they move from primary to secondary school.

1.2 The purpose of the study

This study is an investigation into Cypriot students' attitudes towards school science; what they are, what impacts these attitudes, and how they change as students move from primary to secondary school. Previous studies have looked at Cypriot students' attitudes within the broader context of their attitudes to science (such as Papanastasiou and Zembylas, 2002; Papanastasiou, 2002; Mettas, 2006). The purpose of this research, in contrast to these studies, is to specifically investigate the extent to which students' attitudes towards science change in the primary – secondary interface and the factors that impact this change during the transition and in general. In doing so, the study aims to provide insight into the changing attitudes towards school science that will be of use to those involved with classroom teaching as well as amongst science policy makers in Cyprus and beyond.

Prokop et al. (2007) as well as the results from PISA 2018 (Jerrim, 2021) indicate that there is a close relationship between students' positive attitudes towards a subject and their achievement and interest within that particular subject. The findings of a research study in Cyprus, by Mettas et al., (2006) also show that there is a relationship between students' positive attitudes towards school science and a higher level of science achievement of Cypriot students. Thus, by researching into students' attitudes to school science and how these change as students move from primary to secondary school, this study hopes to give the tools to schools, science teachers and science policy makers to support students to achieve in their subject.

One of the limitations of previous studies that were conducted in Cyprus, has been the fact that although the results tend to show a relationship between positive attitudes and higher attainment in school science, there is little attempt to explore what students' attitudes towards secondary science are and whether there is a specific point in the schooling period at which students' attitudes tend to become less positive. Therefore, this area would benefit from further research that could be used to inform planning and teaching as well as the development of the science National Curriculum in Cyprus.

The reviewed literature (please see section 2.1.2), highlights that an 'attitude' can be seen as a complex, multidimensional concept that consists of three domains (the affective, cognitive and behavioural domain). This study will be the first attempt to explore the affective, cognitive and behavioural attitudes of Cypriot students towards school science separately and find out if there is an attitude domain for which students have more positive attitudes than others. Finally, this will be the first study in Cyprus that will consider attitudes towards separate science subjects in secondary school (biology, chemistry and physics) rather than just one single subject (science).

1.3 Reasons for the study

My interest in students' attitudes to science during transition arose initially as a consequence of my own experiences as a secondary school science teacher. During my first year as a secondary school teacher in a single-sex comprehensive school in outer London, I remember discussing with my colleagues following a science open evening, about how the year 6 students (who were in their last year of primary school) were so enthusiastic about school science and how their attitudes were so different from our year 7 students. Whilst I no longer remember the exact details of the conversations I had with my colleagues, what I do recollect quite clearly is the fact that other science teachers were certain that once year 6s joined year 7 they would become less and less enthusiastic about science. I did, indeed experienced this the following year when the new year 7s joined secondary school full of enthusiasm for secondary school science; however, I felt that their –initially- positive attitudes towards school science became less positive by the end of year 7.

Although all my teaching experience and training was in the UK, as a school student all my experiences were shaped in Cyprus, where I attended primary and secondary school. As I was recalling my own experiences as a student, in Cyprus, I started thinking about my own attitudes towards school science and I realised, that the reason that I kept positive attitudes towards science until the end of my school years was that I was certain that following a science related career would give me better career prospects. My parents also, chose to study science in the post-compulsory phase and they strongly encouraged me to choose science as well as they considered a science degree a useful qualification for future studies and a future career.

Therefore, I became very interested in studying Cypriot students' attitudes towards school science, what are they, if and how they change as students move from primary to secondary school and what influences these attitudes. As mentioned earlier, a number of studies show that there is a relationship between attitudes and achievement (Mettas et al., 2006; Prokop et al., 2007; Jerrim, 2021). Furthermore, the latest PISA (2015, 2018) results bring Cyprus to the last place among the European countries with the Cypriot students scoring the worst average in science compared to other European students. Having in mind the findings of such studies, I thought that it would be important to know more about Cypriot students' attitudes towards school science. Finding out what impacts students' attitudes towards school science, if and how they change as students move from primary to secondary school could potentially give us the tools to work on retaining more positive attitudes towards science throughout schooling.

1.4 Context of the investigation – Education in Cyprus

Cyprus is a country with a centralised public educational system. Cyprus' government sets out a vision of an educational system which 'ensures equal opportunities for all learners through an education policy informed by the principles of equality, participation, creativity and innovation and designed to achieve lifelong balanced and rounded development'. At the same time Cypriot education's purpose is to 'continuously strengthening culture, supporting cultural creativity and sport participation and empowering young people' (MoEC, 2022).

The function of the Cyprus Ministry of Education and Culture (MoEC) is to develop and implement the education policy in line with Cyprus government's vision and therefore, the MoEC is required to develop strategic goals and programmes to fulfil this vision, to formulate and develop the curriculum, to prescribe the syllabi and textbooks, to monitor and assess progress towards achieving the goals and to support schools in implementing the programmes. MoEC is also responsible for research related to education and culture, for the continuing professional development for teachers and school principals, and for the inspection of schools.

The educational system in Cyprus was gradually transformed through a series of reforms after the independence from the British in 1960 (Kimitris, 2018). These reforms included the establishment of a compulsory, nine-year comprehensive school legislated in 1981 (students aged 6-15), followed by a non-compulsory three year 'Lyceum' (students aged 15-18). The nine years of compulsory comprehensive school is divided into two levels: Primary Education (Primary School) which students join at the age of 6 and leave at the age of 12 and lower secondary (known in Cyprus as 'Gymnasium') which students join at the age of 12 and leave at the age of 15 (Zembylas and Papanastasiou, 2006). Once students finish 'Gymnasium' and obtain their school leaving certificate (after successfully passing the exams) they can choose to attend secondary Vocational and Technical Education (VET) instead of 'Lyceum'; VET provides students with knowledge and skills that will prepare them to enter the workforce or pursue further studies in their area of interest (Lettmayr and Hermann, 2012). Figure 1.4 below is a visual representation of the Cypriot educational system (borrowed from the website of the Ministry of Education and Culture, 2022).

Students in primary school are taught science as one subject (with the curriculum covering all the three sciences – biology, chemistry and physics). However, when they move to their first year in lower secondary school (year 7) they are only taught biology in their science lessons and they only have one science teacher -their biology teacher. Chemistry and physics are both introduced in year 8 where the students are taught all the three sciences (biology, chemistry and physics) as separate subjects. In year 8, students have a different teacher for each one of the separate sciences who is a specialist on their subject and they receive separate reports and assessments for each of the three sciences. Also, the students have a separate end-of-year formal exam on each subject. Therefore, the transition from primary to secondary school for science is, what I term, a 'two-phase' transition. The first phase is completed when students move to year 7 (and they are taught biology) and the second phase when students move to year 8 (and they are taught all the three sciences as separate subjects). This is important for the research design (section 3.4) and when considering data collection during transition.

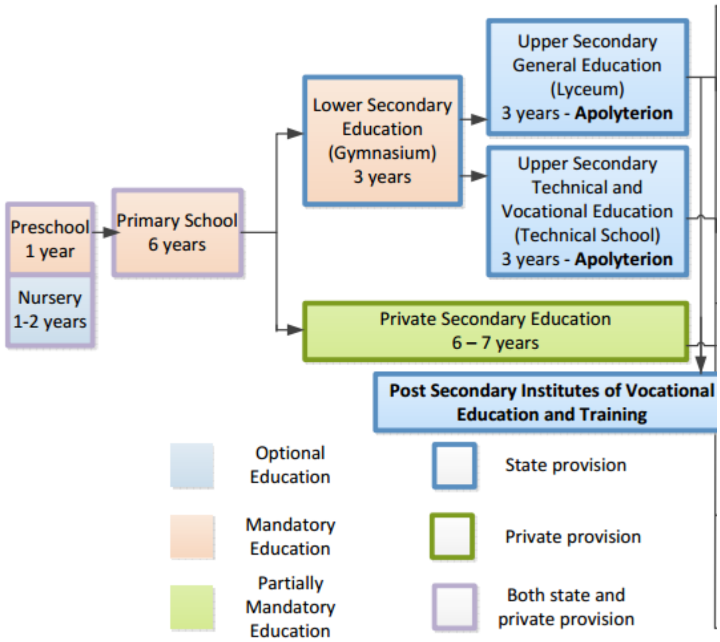


Figure 1.4-1 Diagram showing the Educational System in Cyprus (MoEC, 2022)

There are no tuition fees or charges for learning materials in state schools. However, there are also a number of private schools in Cyprus that follow the English National Curriculum and they are mostly attended by students who will follow further studies in the UK (Papanastasiou and Zembylas, 2004). In Cyprus, there are 30 private primary schools (with 10% of the primary student population studying there) and 39 secondary schools (with 19% of the secondary student population studying there) (Prokopiou, 2019). These numbers are just stated here for the reader to have a clearer idea of the educational profile of Cyprus; this study is focused entirely on state primary and secondary schools (justified more in section 3.4.3).

All students in state schools are taught the same subjects in the nine-year of compulsory comprehensive schooling. The primary school curriculum focuses on Modern Greek and Maths with the majority of teaching hours spent on these two subjects (MoEC, 2010). Table 1.4-1 below provides more information about which subjects are taught at primary and lower secondary level in Cypriot state schools.

Table 1.4-1 The subjects taught in compulsory education in Cypriot state schools

Lessons taught in primary school (ages 6-12)	**Lessons taught in lower secondary school (ages 12-15)**
Modern Greek	Greek Language and Literature
Maths	Maths
Religious Studies	Religious Studies
History	History
Geography	Geography
Science	Biology (introduced in year 7)
English Language	Chemistry (introduced in year 8)
Physical Education	Physics (introduced in year 8)
Health Education	Classical Greek
Design & Technology	Economics
Food Technology	English
	French
	ICT
	Music
	Art
	Physical Education
	Design and Food Technology
	Civics

The curriculum diversifies in the first year of upper secondary school ‘Lyceum’ into four distinct programme curricula, all leading to a school leaving certificate ‘Apolytirion’. In the first year of Lyceum, students will be taught 31 hours (out of 35) of core subjects and four hours of the subjects in their chosen curriculum direction (taught at advanced level -GCSE equivalent). In 2nd and 3rd year of ‘Lyceum’ students will follow one of the five available curriculum directions (taught at advanced level – A-level equivalent) based on their choice in the first year of Lyceum. Table 1.4-2 below shows the different curriculum directions that students can follow and the subjects taught in each direction.

Table 1.4-2 The subjects taught in Lyceum in Cyprus state schools

Subjects taught in 1st year of Lyceum (age 15-16)	Subjects taught in 2nd and 3rd year of Lyceum (age 16-18)
Core subjects Modern Greek Classical Greek Mathematics Physics Chemistry Biology English French ICT Art Music Physical Education Religious Education Design and Technology Economics	***Core subjects*** Modern Greek Classical Greek Mathematics Physics History English Physical Education Religious Education
Possible chosen curriculum options (students chose one of these) on top of their core subjects. These are taught at an advanced level (GCSE Equivalent). A. Classical Greek – History B. Mathematics – Physics C. Mathematics – Economics D. Economics -English	***Possible chosen curriculum options (students follow one of these) on top of their core subjects based on their initial choice in the 1st year of Lyceum. These are taught at an advanced level (A-Level equivalent).*** A. Classical studies and Humanities (Classical Greek, History and Latin) B. Modern and Foreign Languages (English, History and another chosen Language) C. Science and ICT (Mathematics, Physics and either Chemistry, Biology and ICT). D. Economics (Economics, Accounting and Mathematics) E. Business (Economics, English and either Accounting, ICT or D&T) F. Fine Arts (Art, Drama, History)

Both, primary and secondary schools, usually have a headteacher and two or three assistant headteachers depending on their size but, in contrast to England, there are no departments or heads of department for each subject. Therefore, the educational system is highly centralised (Menon and Christou, 2002) and it means that science teachers are rarely line managed by science specialists. Perhaps, in a country like Cyprus where students underachieve in science compared to other European countries (OECD, 2016; Martin et al., 2016; OECD, 2018; Mullis et al., 2020), it has its own significance that non-specialists are overseeing science curriculum implementation, and are responsible for science teachers' evaluation. Evidence suggests that teachers think that this centralised system with mostly non-specialist line managers, lacks vision and it leads to curricula that are extremely inflexible and boring (Zembylas and Papanastasiou, 2006).

The teaching profession is considered to be a high-status profession in Cyprus and there is a large number of graduates that apply for a teaching position (Menon and Christou, 2002; Zembylas and Papanastasiou, 2006). There is no specific teaching training that graduates are required to complete in order to be able to teach. Graduates can become primary school teachers if they have completed a 'Primary Education' degree and secondary school teachers if they have completed a university degree in a specific area (e.g a graduate of physics can become a physics teacher in secondary education without necessarily completing a teacher training degree). The appointment of teachers (as well as their promotion) is carried out by MoEC on the basis of a waiting list although now there is an opportunity for a small number of teachers (15% at the moment) to be appointed (whenever new positions arise in state schools) if they are successful in a series of exams they can take. The percentage of teachers appointed based on the examination result will keep increasing at stages until 100% (planned for 2027) of the teachers are appointed based on the examination results and the waiting list system will eventually cease. The appointment of teachers using the waiting list has been one of the major problems of the recruitment system as it does not consider the qualification and expertise of teacher; it only considers the amount of time that the person has been on the waiting list (Menon and Christou, 2002; Zembylas and Papanastasiou, 2006). However, another issue regarding teacher appointment and progression is that of teacher evaluation and promotion. Based on the current evaluation and promotion procedures, main pay scale teachers are promoted to assistant headteachers and headteachers based on a complicated system that primarily takes into consideration the numbers of years in teaching service (UNESCO, 1997; Committee for the Educational Reform, 2004; Zembylas and Papanastasiou, 2006). Teachers in Cyprus often complain that they are not evaluated based on their expertise and knowledge but based on their years in teaching (Zembylas and Papanastasiou, 2006). The report of the Committee for the Educational Reform (2004) state that this type of promotion system is outdated and counterproductive, an 'inseparable part of the centralised-bureaucratic system' (p.266) and that fails to reward excellence with promotion and to make the greatest use of the most able teachers. The findings of the present study (please see section 6.1) as well as the literature (please see section 2.3.2) place the teacher and the teaching among the main factors impacting students' attitudes and perhaps, the way the teacher appointment and promotion is currently carried out in Cyprus has a role to play in Cypriot students' attitudes towards school science.

1.5 Low attainment of Cypriot students in science

The results of the most recent PISA (Program for International Student Assessment, 2015 and 2018) as well as TIMSS (Trends in International Mathematics and Science Study 2015 and 2019) are quite concerning regarding the attainment of Cypriot students in science (University of Cyprus, 2016) although there was an improvement in the most recent TIMSS science results of primary school students (2019).

PISA (2015) results are characterised as 'appalling' and disappointing (Cyprus Mail, 2016; University of Cyprus, 2016) for Cyprus, showing that Cyprus has the worst performing students in the EU in science, maths and literacy. The 2015 results deteriorated in all the three subjects compared to 2012, the last time the survey had been conducted. Cypriot students were ranked in the 49th place for science out of the 72 countries that participated in PISA 2015, and in the last place among the European countries. Although there was a slight improvement in PISA 2018 results in which Cypriot students were ranked in the 47th place for science, the score was still below the OECD average (PhileNews, 2019; Financial Mirror, 2019).

The results for Cyprus in TIMSS were similar with Cypriot students scoring below the average in between 1995 and 2015 with a slight improvement in the latest TIMSS in which Cypriot primary students scored just above the average while Cypriot secondary students (whose performance was only slightly improved) scored below the average. This slight improvement of the Cypriot student averages might result from the fact that the Cypriot Ministry of Education and Culture has used the results of Cyprus in previous TIMSS cycles to form committees to prepare action plans and recommendations about improving learning outcomes (MoEC, 2019).

The following sub-sections 1.5.1 and 1.5.2, look into the PISA 2015 and 2018 as well as the TIMSS 2015 and 2019 results for Cyprus in more detail.

1.5.1 PISA 2015 and 2018 science results for Cyprus

PISA's aim is to evaluate the quality, equity and efficiency of school systems. Its goal is to identify the characteristics of high-performing education systems, and thus to enable governments and educators to identify effective policies that they can adapt to their local contexts (OECD, 2016). PISA assesses the extent to which 15-year-old students, near the end of their compulsory education, have acquired the key knowledge and skills that are essential for full participation in modern societies. Therefore, the assessment does not focus on whether students can reproduce knowledge; it focuses on examining how well students can apply what they have learned in unfamiliar settings in and outside of school. They test students in three key areas: maths, literacy and science. The 2015 PISA assessment focused on science, 'a discipline that plays an increasing role in our economic and social lives' (OECD, 2016, p.3). OECD explains the importance of making science the focus of PISA 2015, emphasising on the expected growth in science-related employment worldwide concern with students' declining interest in science as they progress through school. PISA 2015 measures students' engagement with and motivation for learning science and describe how different factors are associated with student performance in and attitudes towards learning science (OECD, 2016). Undoubtedly, the PISA project has steadily increased its influence on the educational discourse and educational policies in the participating countries in which the aim of improving PISA ranking has become high priority. However, PISA critiques, argue that there are ideological and political commitments underlying PISA and that there is a number of problems encountered in the process of the development of the PISA test, from intentions through framework to the actual test items. Commenting particularly for science education, critiques argue that the race to improve PISA science scores, is in conflict with basic views of what good science teaching and learning is (Sjøberg, 2015; Zhao, 2020).

PISA 2015 in Cyprus, was conducted by the Ministry of Education (MoEC) and Educational Research and Evaluation Centre (KEEA). Data collection took place between March – April 2015 and 5573 secondary school students (aged 15) took part (2762 girls and 2811 boys). This accounts for 45% of the 15-year-old student population.

The participation of Cyprus in PISA 2015 showed a 'stable' situation in students' results compared to the last time the country participated in the programme, in 2012. Although compared to 2012 the attainment of students showed a decline in all the three examined aspects (science, maths and literacy), this decline was not statistically significant and it was equivalent to the decline of the average of the OECD countries. More specifically, the average of Cypriot students in science was 433 on the PISA scale which was statistically lower than the OECD countries average (493). Table 1.5-1 summaries students' results in the latest PISA assessments (2012, 2015 and 2018).

PISA uses levels to indicate the skills which the students have developed and can use as well as the problems the students can solve in each level. Level 1 is the lowest they can achieve and level 6 the highest, with level 2 being the reference level for the basic skills. The students who achieve level 2 have developed some basic skills which are considered important for their future effective participation in social and economic life. A high proportion of Cypriot secondary school students (42%) achieved below level 2 in sciences. Only 1.6% of the Cypriot students achieved levels 5 and 6.

Another important finding from the analysis of PISA 2015 results for Cyprus is that girls have achieved better results in all three aspects (science, maths and literacy) with the difference in science and literacy being statistically significant. This is not in line with the results in other OECD countries in which boys have achieved better results than girls in maths and science (MoEC, 2016).

Analysis of the results of the student and school survey (questionnaires) reveal some of the factors that impact Cypriot students' attainment in science. Students with better socio-economic backgrounds and students who chose at least one of the sciences (biology, physics, chemistry) at advanced level (GCSE and A- level equivalent) as well as the ones with science related career aspirations achieved better results in science. Furthermore, Cypriot students' attitudes towards science as well as their attitudes towards their science lessons and their beliefs about their science experiences are related to their attainment. Students who hold more positive attitudes typically achieve better results. Teachers and teaching style were also found amongst the important factors affecting students' achievement in science. More specifically, students appeared to value a teacher that is able to guide them and support them, teaching strategies that are adapted to meet students' needs and abilities, the classroom environment and the consistent discipline strategies used in the classroom as opposed to teachers that are not supportive and inconsistent when it comes to discipline. (MoEC, 2016).

PISA 2018 was conducted in Cyprus by MoEC and KEEA. Data collection took place between March and May 2018 and involved 5503 students from 92 state and private schools in Cyprus (45% of the 15-year-old population) who completed an online test on the three knowledge areas (maths, science and literacy) and a questionnaire which collected information about their background (but no attitudinal data).

According to the survey results the average of Cypriot students was 439 in science which is statistically lower compared to the equivalent averages of other OECD countries (484 in science).

Compared to PISA 2015 results there was a statistically significant improvement of 6 units for the result for science. Similarly to PISA 2015 results, a significant percentage of students (39%) achieved below level 2 for science; only 1.7% achieved levels 5 and 6. However, there was a statistically significant decrease (of 3.2%) of the students who achieved below level 2 compared to 2015. Similarly to 2015, girls achieved better results in science compared to boys, this time in line with other OECD countries.

With the analysis of the questionnaire that collected data about students' background and the questionnaires completed by the schools, certain factors have emerged that seem to affect students' attainment on literacy which was the focus of PISA 2018 such as the background of students, the school environment, whether students are bullying victims, their teacher and their perceived quality of life (MoEC, 2019a).

Table 1.5-1 Cypriot students' PISA results for science compared to other OECD countries

	Cypriot students' average score in science	OECD average score in science
PISA 2012	438	501
PISA 2015	433	493
PISA 2018	439	489

1.5.2 TIMSS 2015 and 2018 science results for Cyprus

TIMSS is the longest running, large scale international assessment of Maths and Science education in the world that has taken place every four years since 1995 and it involves fourth and eighth grade students. In Cyprus, year 4 students (aged 9-10) and year 8 students (aged 13-14) take part every four years. TIMSS has a goal of monitoring the trends in educational achievement together with comprehensive data on students' contexts for learning mathematics and science in order to help countries make informed decisions about how to improve teaching and learning in mathematics and science. It also aims to be a valuable tool that countries can use to evaluate achievement goals and standards and monitor students' achievement trends in an international context (Mullis et al., 2020).

Cyprus has been participating with year 4 and year 8 students in TIMSS since 1995 (although not every time). Year 4 students participated in 1995, 2003, 2015 and 2019 TIMSS while year 8 students participated in 1995, 1999, 2003, 2007 and 2019 TIMSS. Data collection takes place between March and April and involves around 10% of the student population that attends year 4 and year 8 (MoEC, 2018).

TIMSS 1995, 2003 and 2015 results showed that Cypriot students were underachieving in science compared to the international average (Nicolaidou, 2015). In 2015 Cyprus was ranked last among the European countries in science; Cypriot students have scored well below (482) the average set in science by the OECD (500). However, in 2019 there was an improvement in Cypriot students' results in science with year 4 students scoring 511; this marks the first time that Cypriot students' average science score was significantly higher than the TIMSS centrepoint (500) (Mullis et al., 2020). Also, while in TIMSS 1995 and 2003 year 4 boys scored significantly higher than year 4 girls, in TIMSS 2015 and 2019 there was no significant difference between the scores of boys and girls. Table 1.5-2 below shows the TIMMS science results of year 4 students over the years.

Table 1.5-2 Table showing the science TIMSS results of Cypriot Year 4 students

	1995	2003	2015	2019
Science average	450 (500)*	480 (500)*	481 (500)*	511(500)*
()* TIMSS OECD Average				

TIMSS results between 1995 and 2019 show that Cypriot year 8 students are underachieving in science compared to the international average. Year 8 students have been scoring significantly below the TIMSS centrepoint (500) every time they participated in TIMSS since 1995. There was no significant difference between the achievement of boys and girls in 1995, 1999 and 2003. However, in the two latest TIMSS (2007 and 2019) girls have achieved significantly higher scores in science compared to points.

Table 1.5-3 Table showing the science TIMSS results of Cypriot Year 8 students

	1995	1999	2003	2007	2019
Science average	452 (500)*	460 (500)*	441 (500)*	452(500)*	484 (500)*
()* TIMSS OECD Average					

Looking at the data collected from the survey that students and parents completed for TIMSS 2019, we can see that Cypriot students' science achievement is related to factors such as the availability of home learning resources, the socioeconomic background and the school resources availability (Mullis et al., 2020). Cypriot students who had more home learning resources available achieved significantly higher science scores compared to students who had limited home learning resources available. Similarly, students from better socioeconomic backgrounds achieved significantly higher science scores compared to students from disadvantaged socioeconomic backgrounds. Students whose schools were not affected by learning resources availability achieved significantly higher science scores compared to students whose schools were affected by resource restriction (Mullis et al., 2020).

Looking at year 4 and year 8 TIMSS science results for Cyprus in comparison, we notice that year 4 students are performing relatively better compared to year 8 science students. Literature has a number of studies which show that students' attitudes decline as students progress from primary to secondary school and this has an impact on their science attainment (Breakwell and Beardsell, 1992; OECD, 2016; Mourshed et al., 2017; Liou, 2021; Jerrim, 2021). Therefore, we could ask the question if Cypriot primary school students perform relatively better in science than secondary school students, perhaps due to the fact that they hold more positive attitudes towards science compared to year 8 students.

Following the latest PISA and TIMSS results, the European Commission report (Chrysostomou, 2018) comments on the fact that Cyprus' high expenditure on education was not translating into improved learning for children. According to the report, the country's investment in education did not yield commensurate outcomes. Public expenditure on education in Cyprus is around 7.8 per cent of GDP, which is high by international and European standards. Annual public and private expenditure in Cyprus are €9,145 per pupil, which is higher than the EU average of €6,900. The report also found that the share of teachers aged 50 and over has been constantly growing to reach 40% in 2016, up from 29% in 2013, mainly due to the change of retirement age of teachers from 60 to 65. This is important to keep in mind as teachers have a significant role to play in the formation of attitudes towards science (and towards school in general) as indicated in a number of studies in literature (Anderman and Maehr, 1994; Speering and Rennie, 1996; Galton, 2002; Osborne et al., 2003; Griebel and Berwanger, 2006; Evangelou et al., 2008).

1.6 Summary and thesis overview

The results of PISA and TIMSS mentioned above, show that Cypriot students are typically underachieving in science. Also, studies conducted around the world and in Cyprus show that there is a link between students' attitudes and achievement in science. Having in mind these results, as well as the fact that there is only a limited number of studies that look into students' attitudes towards school science in Cypriot literature, this study aims to look into Cypriot students' attitudes towards school science. More specifically, this study aims to explore what Cypriot students' attitudes towards school science are, if and how they change as students move from primary to secondary school and the factors that might impact these attitudes towards school science. These questions will be explored in the chapters of this thesis that follow.

Chapter 2 will look at the literature review around attitudes and the three attitude domains (affective, cognitive and behavioural), students' attitudes towards school science, how they change throughout the school years and factors linked to the formation of these attitudes. At the end of chapter 2 the research questions that this study is hoping to answer are outlined.

Chapter 3 gives the rationale for the mixed method approach used to answer the research questions and describes the data collection and result analysis methods.

Chapter 4 focuses on the quantitative questionnaire data analysis.

Chapter 5 focuses on the analysis of the qualitative data collected from student group interviews.

Chapter 6 discusses the findings of the study with reference to the literature.

Chapter 7 uses the results and discussions to draw the final conclusions, to discuss the implications of the study, the limitations of the study and implications for future research.

Chapter 2: Literature Review

Having discussed the importance of understanding the attitudes of students towards school science and the impact they might have on students' attainment and career choices in the introduction, the relevant literature surrounding students' attitudes towards science is presented in this chapter. The following literature review will explore a brief history of the term 'attitudes' alongside current definitions of the term. Then, literature review focuses on defining 'attitudes towards science' for the purpose of the study followed by a summary of the literature available in Cyprus regarding students' attitudes towards school science. Finally, this chapter presents the literature regarding the dip in students' positive attitudes towards school science as students move from primary to secondary school in the UK and around the world and it examines different factors that affect students' attitudes towards school science.

2.1 Definition of 'attitudes'

2.1.1 History of the term 'attitudes' and the challenge in defining it

The term, 'attitude' was only used in a 'physiological' context until 1918 e.g. to describe the physical posture of movement among actors and dancers (Fleming 1967) or to describe the physical expression of an emotion in animals that were ready to fight (Koballa, 1988). Thomas and Znaniecki (1918) used the term for the first time as a 'psychological' concept to describe the acculturation of Polish peasants into American cities. Ajzen and Fishbein (1980) underline the importance of Thomas and Znaniecki's work as 'it stripped attitude from its physiological content in a period during which a more cognitive view of the attitude gained acceptance' (p.104). Koballa (1988) states that the term 'attitude' is used widely in daily life and thus, almost everyone has some idea of its meaning. However, he believes that 'science educators must define the term carefully for themselves if it is to be used to better understand and predict the science-related behaviours of students and teachers' (p.116). Reading through his article, by 'defining carefully', he means that although people often think of attitudes in general terms (e.g., A student has a bad attitude), science educators should always keep in mind that attitudes always refer to feelings about or towards an attitude object.

The term attitude object which is used in the section above as well as throughout this section, as defined by Crano and Prislin (2006), is something towards which our evaluative judgments are directed. Koballa (1988) in his work states that an attitude object could be, for instance, a person, a school subject, a situation or an abstract idea. For the purpose of the present study the attitude object is school science.

Researchers, studying attitudes towards science (e.g., Germann, 1988; Francis and Greer, 1999; Osborne et al., 2003; Aydeniz and Kotowski, 2014) have identified a challenge in what attitude means. Osborne et al. (2003), point out that attitudes are poorly articulated and not always clearly understood by researchers and science educators (both the explanation of the term 'attitudes' is poorly articulated and students poorly articulate their attitudes to school science). Kind et al. (2007) underline that 'there seem to be many concepts that relate to attitudes that may or may not be included in their definition; for example, feelings, motivation, enjoyment, affects, self-esteem, and so forth' (p.872). Earlier than this, Francis and Greer (1999) also raised the challenge of defining attitudes as Blosser (1984) who characterised the definition of science-related attitudes as vague and inconsistent.

Francis and Greer (1999) argue that there is an ongoing 'debate between two schools of theorists regarding the meaning of attitudes' (p.220). One school of theorists suggests a common definition that conceptualises attitudes as including three distinct components or dimensions: the cognitive, the affective and the behavioural (Ostrom, 1969; Hollander, 1976;

Breckler, 1984; Reid, 2006; Kind, Jones, Barmby, et al., 2007). The other school of theorists argues that attitude is a unidimensional concept (Allport, 1935; Ajzen and Fishbein, 1980; Germann, 1988; George, 2000; Ajzen, 2001; Crano and Prislin, 2006). More information about what the terms 'multi-dimensional' and 'unidimensional' mean (in relation to attitudes) is provided in the sections of the literature review that follow.

2.1.2 Attitudes as a multi-dimensional concept

Ostrom (1969) defined attitudes (in the most general sense) as a three-dimensional concept by giving explicit examples of the three constructs as represented through verbal statements. He explained that the first component represents favourable or unfavourable feelings, like or dislike feelings, emotional and physiological reactions. As he describes 'perhaps the phrase 'gut reaction' best conveys the spirit of this component. This component is called the affective domain' (p.16). For the second component, he used statements representing desirable and undesirable qualities which 'reflected values and attributes assigned to the attitude object and they included beliefs about the object, characteristics of the object and relationships of the object with other objects including itself. This component is called the cognitive component' (p.16). To explain the third component, Ostrom (1969) used statements that reflected personal action tendencies; they were 'statements of past action, future intentions and predicted behaviour in hypothetical situations. This component is called the behavioural component' (p.16). To put Ostrom's ideas in context, we can use the spider example. For instance, one would state: 'I am scared of spiders' (Affective), and that 'spiders are dangerous' (Cognitive) and so they would 'avoid spiders and scream' if they saw one (Behavioural).

Later, Hollander (1976) also described the three dimensions of attitudes using Plato's trilogy of the human condition (knowing, feeling and acting). He translated the trilogy as follows:

Knowing: a belief or unbelief about something (Cognition)

Feeling: like or dislike something (Affection) and

Acting: Conation (Behaviour).

Breckler (1984) suggested that these three dimensions of attitudes could be described using a 'tripartite model' (p.1191) in which affect refers to an emotional response or sympathetic nervous activity, the feelings or mood towards an object. According to Breckler (1984), behaviour includes overt actions and behavioural intentions. Beliefs, knowledge structures, perceptual responses and thoughts constitute the cognitive component. A similar definition was proposed by Hogg and Vaughan (2005) who defined an attitude as 'a relatively enduring organisation of beliefs, feelings, and behavioural tendencies towards socially significant objects, groups, events or symbols' (p. 150). Reid (2006) in agreement with the authors mentioned above (Ostrom, 1969; Hollander, 1976; Breckler, 1984; Hogg and Vaughan, 2005) also defined attitudes as a multidimensional concept. He defined the cognitive dimension as 'the knowledge about the object, the beliefs and ideas' (p.4), the affective as 'a feeling about the object, the like or dislike component' (p.4) and the behavioural one as the 'tendency-towards-action' (p.4). Commenting on Reid's definition, Kind et al, (2017) stated that 'this seems as a sensible view of attitudes. We know about science and therefore have a feeling or opinion about it that may cause us to take some actions' (p.872). Table 2.1-1 below summarises the work done on the definitions of the three dimensions of attitudes: cognitive, affective and behavioural.

Table 2.1-1 Summary of the definitions of the three attitude domains in the reviewed literature

Attitude domain	Definitions
Cognition	➢ Cognitions or thoughts may vary from favourable to unfavourable (e.g., supporting versus derogating arguments) (Allport, 1935). ➢ The cognitive dimension are the beliefs about the object, the characteristics of the object and the relationship of the object with other objects (Ostrom, 1969) ➢ Cognition is the belief or unbelief in something (Hollander, 1976) ➢ The cognitive component is the knowledge about the object, the beliefs and ideas (Reid, 2006)
Affection	➢ Affect can vary from pleasurable (feeling good, happy) to unpleasurable (feeling bad, unhappy) (Allport, 1935) ➢ The affective component represents favourable or unfavourable feelings, like or dislike feelings, emotional and physiological reactions (Ostrom, 1969) ➢ The affective component indicates the favourable or unfavourable feelings about an attitude object (Kothandapani, 1971) ➢ Affection is whether someone likes or dislikes something (Hollander, 1976) ➢ The affective component is related to someone's feelings; it is the like-dislike component (Reid, 2006)

Behaviour	➢ Behaviour can range from favourable and supportive (e.g., keeping, protecting) to unfavourable and hostile (e.g., discarding, destroying) (Allport, 1935) ➢ The behavioural domain reflects personal action tendencies; it predicts behaviour in certain situations (Ostrom, 1969) ➢ Behaviour is how we choose to act on a situation (Hollander, 1976) ➢ The behavioural component involves the tendency towards action in a certain situation (Reid, 2006)

2.1.3 Attitudes as a unidimensional concept

A number of researchers suggest that attitudes is a unidimensional concept and should be viewed in a narrower way, as the basis for evaluative judgements (Ajzen and Fishbein, 1980; Ajzen, 2001; Crano and Prislin, 2006). These authors therefore, suggest that attitude is how we judge an attitude object; it is our overall judgment about the object; it is a representation of the evaluation of a psychological object (Eagly and Chaiken, 1993; Petty et al., 1997; Ajzen, 2001). Other authors suggest that when we hold an attitude, we judge something along emotional dimensions, such as good or bad, harmful or beneficial, pleasant or unpleasant, important or unimportant and thus attitudes consist of only one dimension, the affective one (Germann, 1988; George, 2000).

Bogardus (1960), keeping the link of the term attitude with its physical past, stated that an attitude is similar to a trap waiting to be sprung by the right stimulus, while Allport (1968) characterised an attitude as 'a state of readiness for mental and physical activity' (p.60).

Fishbein and Ajzen (1975) described an attitude as 'a learned predisposition to respond to a consistently favourable or unfavourable manner with respect to a given object' (p.6). For these authors, attitude is a one-dimensional concept which is, however, very closely related to other concepts such as beliefs, behavioural intentions and behaviour itself. Fishbein and Ajzen (1975) consider that an attitude toward an attitude object is formed based on the beliefs about the object and in turn, yielding intentions and behaviour with respect to the object. While attitude is their central focus, belief serves as the most basic construct in their approach. Although a number of researchers have defined attitudes in terms solely of the affective component (George, 2000; Germann, 1988) as discussed later in this section, Fishbein and Ajzen (1975) state that attitudes are formed spontaneously and inevitably, as individuals form beliefs about the attributes of an object (p.873). Douglass (1977), reviewing Fishbein's and Ajzen's (1975) work states that the two authors assumed 'specific causal linkages and sequences among the four dimensions' (beliefs, attitudes, behavioural intentions and behaviour) (p.130).

Eagly and Chaiken (1993) defined attitudes as 'a psychological tendency that is expressed by evaluating a particular entity with some degree of favour or disfavour' (p.1). The authors have strategically chosen to refer to attitudes as tendencies instead of predispositions; their choice reflects that although attitudes can be more stable compared to fleeting thoughts, they are 'more malleable and temporary than a disposition' (Aydeniz and Kotowski, 2014, p. 3). Eagly's and Chaiken's (1993) definition also distinguishes attitudes from beliefs as they define beliefs as opinions that lack the necessary evaluation in order to be considered as attitudes. As the term 'beliefs' will be a part of the attitude definition for the purpose of this study, there will be a more detailed section on the work done on the term 'beliefs' later in section 2.1.5.

Ajzen (2001) explains that the term attitude has only one dimension and that it indicates how someone judges an object. His definition makes it clear that there is a distinction between attitudes and general affects such as moods, emotions as well as behaviour. According to Ajzen (2001) attitudes are dispositions to evaluate an attitude object; this implies 'that we hold one, and only one, attitude toward any given object or issue' (p.29). However, Wilson (2000) suggests that this view is quite simplistic and that a dual model of attitudes in which when attitudes change, the new attitude overrides but may not replace the old attitude would be perhaps a more appropriate model to explain attitudes. The dual attitude model suggests that people can hold two different attitudes towards a given object in the same context at the same time.

2.1.4 Defining attitudes towards science

Klopfer (1971) made an early, notable, contribution towards the elaboration of the term ***attitudes towards science*** in which he considered attitudes towards science as having mainly an affective construct. The researcher (Klopfer, 1971) categorised a set of affective behaviours in science education such as: the manifestation of favourable attitudes towards science and scientists, the enjoyment of science learning experiences, the development of interests in science and science-related activities. German (1988) too has chosen to focus on only one of the three attitudinal domains in his study. The focus of his study was on the students' general attitude towards science. This attitude for the purpose of his investigation was seen as consisting of a set of classroom affective factors such as attitudes towards teachers, towards the classroom, the classroom atmosphere and the subject. The author stated that there were other variables that could also influence general attitudes towards science such as students' beliefs, values and attitudes towards education, school and science and actions of other groups such as the as society, the family and peers. Although arguably quite old, German's work has been important for the present study as looking at the variables that affect attitudes towards school science is one of the foci of this research study.

Gardner (1975) made another important contribution towards defining attitudes towards science as his work formed the basis of the distinction between *scientific attitudes* and *attitudes towards science*. Scientific attitudes are linked to the features that characterise scientific thinking and are cognitive in nature; it is a process during which people question a statement, search for data to support or reject the statement and search for verification (Osborne et al., 2003). According to Gardner (1975), these scientific attitudes that are cognitive in nature are very different from the affective attitudes towards science which are the feelings, beliefs and values held about the attitude object (that may be the school science, scientists, and science teachers).

George (2006) drawing on Klopfer's (1971) work as well as on Gardner's (1975) ideas about the need to consider conceptually distinct attitudinal dimensions, also defines attitudes in terms only of the affective domain. More specifically, in the context of his study, attitudes towards science were defined as the positive or negative feelings about science, specifically to students' experiences in science classes.

Hillman et al. (2016), make a distinction between attitudes towards science and attitudes towards school science. They suggest that a students' attitude towards science consists of four main domains: attitude towards school science, attitude towards becoming a scientist, attitude towards the value of science to society and the perception of scientists. Therefore, they consider the attitude towards school science as part of a bigger concept- the attitude towards science. In their work, they describe the attitudes towards school science as a student's feelings towards participating in school science classes.

Reviewing the literature included in this section (2.1.4), it is noticed that most authors define attitudes towards science in terms of one dimension only. However, as discussed in section 2.1.2 attitudes is considered by a number of authors as a multi-dimensional concept. Therefore, I thought it was important to include elements of all the three dimensions in the definition of attitudes used for the purpose of this study (the definition of attitudes for the purpose of this study can be found in section 2.1.7). Another important contribution of this part of the literature to the definition of the attitudes used in this study is the distinction between scientific attitudes and attitudes towards science as well as the distinction between attitudes towards science and school science.

2.1.5 Attitudes and beliefs

Looking at the literature, there is a distinction between the terms 'attitude' and 'belief' (Fishbein and Ajzen, 1975; Eagly and Chaiken, 1993). Eagly and Chaiken (1993) state that beliefs are just opinions about an object while attitudes are opinions with an evaluative judgment. To put this to context, a student's belief would be that 'science is hard' (opinion without evaluation) while a student's attitude towards science would be 'science is hard and thus, I dislike it' (belief with evaluating statement). Similarly, Fishbein and Ajzen (1975) explain that: 'Whereas attitude refers to a person's favourable or unfavourable evaluation of the object, beliefs represent the information he has about the object. Specifically, a belief links an object to some attribute' (p. 12). To further explain the difference between attitudes and beliefs, the two authors state that a belief links a quality or characteristic to an object. If for example, we say that 'science is messy' we link the object (science) with the attribute (messy). Oskamp and Schultz (2005), however, support that beliefs can also have an evaluating component to them. They explain that while attitudes are strictly evaluative, beliefs can range from descriptive and factual to evaluative. Lindner et al. (2004) in agreement with Oskamp and Schultz support too, that beliefs can be factual or evaluative. They put this into context explaining that for instance the statement 'science careers are not just for males' is quite factual and descriptive (p.4) while the statement 'science is important' has an evaluative element; nevertheless, they are both beliefs held by students.

Fishbein and Ajzen (1975) also use the idea of a continuum or range when considering students' attitudes. The authors point out that beliefs can be held by students at different strength levels. They explain that beliefs link objects to qualities or attributes at some level between say 0 and 100. For instance, students might believe that 'science is difficult' but they might also know that this is not always the case as some science lessons are not that difficult. The two authors conclude that a set of beliefs form the basis of a students' attitude. Whether a student forms a positive or a negative attitude towards a subject depends on whether their beliefs about the specific subject are evaluated positively or negatively and on how strongly the beliefs are held. Koballa (1988) explains that it is not only the strength level of the belief that determines the formation of attitudes but also, the kind of people that hold the belief. He suggests that a belief linked to the same object can have different strength if it is held by different people. He states that students can hold the belief that acid rain is an environmental hazard; some of them might believe that acid rain is absolutely hazardous for the environment while others might believe that it is a possible environmental hazard. Koballa (1988) draws upon Fishbein's and Ajzen's (1975) work to explain how the dependency of attitudes upon beliefs operates. He explains that beliefs are the cognitive links between an object and an attribute and that links are made at a certain strength level to explain how beliefs form the basis of attitude formation. Using the same example of acid rain as above he suggests that when a person has a number of beliefs about acid rain (e.g., that acid rain disrupts the life cycle of plants and animals, affects humans by contaminating the food and water) and that person values environmental quality and good health they will form an attitude towards acid rain that will be 'strong and very negative' (p. 119).

2.1.6 Summary

In summary, a number of studies define attitudes as a unidimensional concept; Fishbein and Ajzen (1975) suggest that attitudes are formed spontaneously and inevitably as individuals form beliefs about the attributes of the object; Germann (1988), and George (2000 & 2006) define attitudes in terms of the affective component and Kind (2017) defines attitudes as the feelings that a person forms about an attitude object based on their beliefs about that object. Additionally, a number of studies suggest that attitudes is a multi-dimensional term including separate domains of 'cognition', which reflects what is known about the attitude object, 'affect' which reflects the emotional reaction to the attitude object and 'behaviour' which includes actual or intended behaviours towards the attitude object (Ostrom, 1969; Hollander, 1976; Breckler, 1984; Hogg and Vaughan, 2005 Reid, 2006).

Reviewing the literature, a distinction between the terms 'attitude' and 'belief' is noted. Eagly and Chaiken (1993) state that beliefs are just opinions about an object while attitudes are opinions with an evaluative judgment while Oskamp and Schultz (2005) explain that while attitudes are strictly evaluative, beliefs can range from descriptive and factual to evaluative.

Reviewing the work done around the definition of attitudes towards science, Gardner (1975) suggested the distinction between scientific attitudes and attitudes towards science while Hillman et al. (2016) suggested the distinction between attitudes towards science and school science.

The definition of attitudes for the purpose of the present study was formed drawing on all of the work reviewed above. The definition can be found in the next section (2.1.7).

2.1.7 Attitudes for the purpose of this study

For the purpose of the present study students' attitudes towards school science are defined as '***the feelings, beliefs and ideas of students towards school science, based on the impact of influence objects and the behaviour induced as a result of these feelings, beliefs and ideas'.*** The term 'influence objects' refers to any situation, experience, object or individual whose actions may influence students' attitudes towards school science.

2.2 Students' attitudes towards school science around the world

The literature reviewed in this section indicates that the investigation of students' attitudes towards school science has been a substantial part of the research done in the science education field. The mounting evidence highlights the significant decline in the positive attitudes of young people in school science as they progress through secondary education (Logan and Skamp, 2008; Barmby, Kind, et al., 2008; Christidou, 2011). Research in the UK and other developed countries such as Australia, Canada, New Zealand and USA has also underlined that the concerning low level of uptake of science by post – 16 students is a consequence of the fact that students' attitudes towards school science decline when they are quite young (Ferguson and Fraser, 1998; Osborne et al., 2003; Murphy and Beggs, 2003; Murphy and Beggs, 2008; Bennett, Braund, et al., 2013). Studies indicate that the largest decline in students' positive attitudes and engagement in school science occurs as students move from primary to secondary school (Braund and Driver, 2002; Braund and Driver, 2005) when they are about 11 years old. Several researchers agree that the erosion of students' attitudes towards science, which arises during the primary-secondary school transition, perhaps more than any other schooling period, can have long-term effects on their futures (Speering and Rennie, 1996; Galton, 2002; Braund and Driver, 2005). Braund and Driver (2005) found that not only the attitudes of students toward science became less positive during the primary-secondary transition but also their attainment declined. Galton (2002) suggested that one fifth of students failed to meet their expected targets at the end of KS3 (KS3 encompasses the first two or three years in secondary school, which students start when they are aged 11) for science, which is lower compared to English or mathematics. The same study highlighted that students' interest and positive attitudes decline more in science than any other subject (Galton, 2002).

The following sections look into research studies around students' attitudes towards school science conducted in Cyprus, the UK and other developed countries.

2.2.1 Students' attitudes towards school science in Cyprus

Papanastasiou (2002), investigated the effect of attitudes on science achievement among secondary school students in Cyprus using the Cypriot student data from TIMSS 1995. The study, developed a model to explain the TIMSS data. For the purpose of their study ten observed variables (related to students' attitudes towards science) were used from the student TIMSS database and were included in regression tests aiming to examine the attitude-achievement relationship in the data. The findings of the study, showed that students' science attitudes influence their science achievement. The same study investigated the factors that may impact students' attitudes towards school science but this is discussed later in section 2.3 where we look at the factors that impact students' attitudes in more detail.

Mettas (2006) also looked at the relationship between students' attitudes towards science and their science achievement based on TIMSS 1999 results concerning Cyprus. During the results analysis, a number of parameters concerning the effects of attitudes towards science on science achievement were identified and examined using variance estimation techniques. The results indicated that positive attitudes towards science were associated with higher levels of science achievement of the Cypriot students in the sample.

The focus of the 2015 PISA assessment was science, with the data collected used to analyse in detail students' engagement with and motivation for learning science and to describe how different factors are associated with student performance in and attitudes towards learning science (OECD, 2016). The analysis of the results of the Cypriot student questionnaires and the questionnaires completed by the leadership team in Cypriot schools revealed that Cypriot students' attitudes towards their science lessons and their beliefs about their science lesson experience are related to their attainment. Students who held more positive attitudes typically achieved better results (MoEC, 2016). More on Cypriot students' attainment in science and the results of the participation of Cypriot students in PISA and TIMSS can be found in section 1.5.

A substantial part of literature, in developed countries around the world, relates science achievement to the attitudes towards school science (Galton, 2002; Else-Quest et al., 2013) which are found to become less positive as students move from primary to secondary school (Breakwell and Beardsell, 1992; Braund and Driver, 2005; Logan and Skamp, 2008; Tytler et al., 2008). The limited Cyprus-specific literature in this area (Papanastasiou, 2002; Mettas, 2006) also show that Cypriot students' attitudes towards school science is associated with their science achievement. The review of this limited Cyprus-specific literature, underlines the importance of investigating whether Cypriot students' attitudes towards science change as they move from primary to secondary school as well as exploring the factors that impact the formation of these attitudes towards school science. This is important as understanding Cypriot students' attitudes towards school science, what impacts them, if and how they change during the transition from primary to secondary school could be useful in assisting the formation and maintenance of positive attitudes towards school science which could in turn lead to better science attainment and student participation after the post-compulsory stage.

Due to the lack of extended Cyprus-specific literature in this area, the section that follows reviews the literature on students' attitudes towards school science as students move from primary to secondary school in other developed countries around the world such as the UK, Australia and USA.

2.2.2 UK students' attitudes towards school science from primary to secondary school

The interest regarding students' engagement in science and the change of their attitude towards science as they move to older school years is not new. Newton (1974) collected and analysed a sample of 1066 questionnaires from state school students in the UK (age 11-15) investigating the relationship between attitude towards science and factors such as gender, age and ability. The findings of his study indicated that for the overall sample the attitudes of older students were less favourable compared to the ones of younger students. Although he does not specify what he considers as 'older' and 'younger' students and despite the fact that his study is arguably quite old, the results are in line with more recent research studies that show a decline in engagement in school science of a significant number of students as they progress to older years (Breakwell and Beardsell, 1992; Galton, 2002; Reiss, 2004; Barmby et al., 2008).

Breakwell and Beardsell (1992) also looked at transition and reached similar conclusions to Newton's study (1974); this shows a consistent attitude 'dip', after transition, in science across a thirty-year period. In their study the two authors explored the impact of a range of factors including gender, parental and peer influences on 11–14-year-old students in the UK. The sample consisted of 391 state school students; the data was collected by a questionnaire which was designed emphasising parental and peer influences on the respondents. Among the findings of the study, age appeared to play a major role in the engagement of students' in science. Younger students (11-year-old students) who had just joined secondary school appeared to enjoy science more compared to the older students (14-year-old students) that participated in the study. Another finding of the study was that students' science attainment declined with their declining attitudes in line with other, more recent studies which show a relationship between attitudes towards school science and science attainment (OECD, 2016; Mourshed et al., 2017; Liou, 2021; Jerrim, 2021).

As opposed to the studies reviewed above and for which quantitative data were collected, Galton (2002), used a range of qualitative and quantitative techniques to collect data to study students' attitudes towards school science. Their collected data included questionnaires completed by 138 boys and 144 girls, interviews with smaller groups of primary and secondary students and class observations from schools in different areas of the UK. According to the results of the study, boys and girls of a range of abilities and attainment in science were excited to join secondary school science with the majority of them reporting a high enjoyment of science lessons during their last primary school year (year 6). Furthermore, the results show that by the end of their first year in secondary school (year 7) a drop in enjoyment for both boys and girls has occurred. Both boys and girls reported that although the work in year 7 was easy to cope with they were less excited by it by the end of Year 7. Galton (2002), drawing on the ORACLE (Observational Research and Classroom Learning Evaluation) study (1975-1980) and the ORACLE replication study (1996-1998) findings, suggests that students arrive in secondary school with high expectations and excitement that science will be challenging and interesting and they become less excited by the end of the year when they feel that secondary science does not meet their expectations.

During the ORACLE (Galton and Willcocks, 1983) and the ORACLE replication study (Galton and Hargreaves, 2002) teachers and pupils were observed in the last year of primary school (year 6) and in the first year of secondary school (year 7). Students' attitudes were measured in June before their transfer to secondary school, in November and in June after their transfer. The ORACLE replication study shows that during their final year in primary school, a large proportion of students listed science among the subjects they look forward to doing in secondary school. Boys, including those with lower attainment, listed science as one of their favourite subjects (science was ranked second to only Physical Education). The authors (Galton and Hargreaves, 2002) support that 'such a positive result lies with the first encounter with the science laboratory on induction day, during the summer term, immediately before the move to secondary school' (p.256). However, by the end of year 7 there was a significant drop in enjoyment for both girls and boys. Among the findings of the ORACLE replication study was that both boys and girls reported that they found science easier as they progressed through primary and secondary school but their enthusiasm and interest declined year by year.

Barmby et al*.* (2008) also employed a combination of quantitative and qualitative data collection to conduct a study to examine the changing attitudes in secondary school science. The study was carried in the UK and involved 932 students who completed a questionnaire and took part in semi-structured interviews containing items looking at six separate attitude constructs. Although the study used a different approach in data collection (from the studies above), the results that emerged from the analysed data showed that students' attitudes towards science declined as they progressed through secondary school with the conclusion being in agreement with previous studies in the field (Newton, 1974; Breakwell and Beardsell, 1992; Galton, 2002). Osborne et al. (2003), composed a review study related to the attitudes of students towards science and how they change during different periods of students' schooling life. The review, suggests that independently of the data collection processes followed (quantitative, qualitative or mixed-methods), the declining positive attitudes of students towards science from year 6 onwards is well documented. The results of a number of studies that were included in the review, clearly point out that 'children's interest and attitude to science declines from the point of entry to secondary school' (p. 12).

Reviewing the work above, it is noticed that some authors used only quantitative tools to collect data (Newton, 1974; Breakwell and Beardsel; 1992) while others used a combination of quantitative and qualitative tools (Galton and Willock 1983; Galton, 2002; Barmby, 2008). This is quite important for the present study as it enabled me to think about the different tools that could be used in my data collection; with a combination of quantitative and qualitative tools seemingly as an appropriate strategy (more about the mixed – methods approach followed in this study can be found in section 3.3).

A four-year-project involving the development of the 'Attitudes to School Science' instrument was conducted by Bennett and Hogarth (2009). The developed instrument was used to collect descriptive and explanatory data from 280 students aged 11, 14 and 16 with the results analysis showing that positive attitudes to school science decline with age. The authors characterise the early years of secondary school as 'critical' (p.1) with attitudes to school science declining sharply between the ages of 11 and 16. Five attitudinal items (related to 'liking of science', 'teacher effects' and responses to individual disciplines within science) were statistically significant in terms of decreasingly positive responses by age. Also, a noticeable fall with age in the number of students reporting that science was one of their favourite subjects was identified with the proportion of students who positively responded to this statement dropping sharply between age 11 (39%) and age 14 (26%). In the study there were three attitude questions about biology, chemistry and physics separately with students in all years showing more positive attitudes towards biology and least positive attitudes towards physics. In the reviewed literature (although I am aware the literature included here is not an exhaustive list) this paper by Bennett and Hogarth (2009), is the only paper that differentiated between the three sciences and it had an important contribution in leading me to consider the distinction between biology, chemistry and physics when studying students' attitudes towards school science. Cypriot students in secondary school (as explained in section 1.4) are taught the three subjects separately so it would be quite important to treat the three sciences separately when collecting data from secondary school students rather than just using the umbrella term 'science'.

The studies reviewed above, show that students' attitudes towards school science decline as students move from primary to secondary school or throughout their secondary schooling. Murphy and Beggs (2001), however, pointed out that the positive attitude and engagement of students in science start to decline even earlier than the primary- secondary transition. The sample of their study was consisted of 1000 8- to 11-year-old primary students from Northern Ireland (50.1% female and 49.8% male) who completed a questionnaire regarding their perceptions of school science. Additionally, a smaller sample of students (32 students) took part in recorded, informal discussions with their teachers about their perceptions and feelings about science. The first part of the questionnaire required students to indicate whether they liked or disliked a range of different science topics. A larger number of younger students compared to older students liked every topic while for 12 out of 18 topics the difference between the number of younger and older students who liked the topic was statistically significant. The findings of the study show that younger students (8-year-old) were more enthusiastic about school science while students in their last year of primary school (year 6) had significantly less positive attitudes. Although the sample of the study suggests that the results are representative for Northern Ireland, it might not be the case for the rest of the UK as the procedures followed in Northern Ireland during the primary-secondary school transfer are not always similar to the ones in English schools. However, the findings of the research by Murphy and Beggs that show the decline of positive attitudes from primary school are in agreement with the findings of other research studies in the field (Simpson and Oliver, 1985; Pell and Jarvis, 2010).

A great part of literature reports the decline in students' positive attitudes as they move from primary to secondary school. However, a recent study by DeWitt et al. (2014) argues that the majority of students continue to enjoy secondary school science. The study was part of the ASPIRES project (Science Aspirations and Career Choice), a 5-year longitudinal study aiming to investigate the changes in students' interest in science between 10-14 years of age. The study involved a combination of qualitative and quantitative data collection. A quantitative online survey was used to collect data from 9000 children at three different points: in students' last year of primary school (year 6) and then in year 8 and year 9. The online questionnaires required the students to answer to questions including their aspirations in science and attitudes towards school science using a Likert-type scale. Additionally, longitudinal interview data was collected from 85 children. Contrary to the studies reviewed above, the study by DeWitt, et al. (2014) supports that the majority of students in the sample, enjoy school science in secondary school and they maintain positive attitudes towards school science. In an earlier study, Archer et al. (2010) highlight that one of the main factors contributing to the engagement of primary school students to school science is their expectation that school science will offer them the opportunity to do a lot of practical experiments, create explosions and that science will be 'dangerous and exciting' (Archer et al., 2010, p. 621).

The science education tracker, a large scale survey completed by the Department for Education, the UK Research and Innovation and the Royal Society (Hamlyn et al., 2020) also showed that students' attitudes towards school science are maintained positive as students move from primary to secondary school. More specifically, the participant students stated that they enjoyed their science lessons more in year 7 compared to year 6 but that there was a decline in their enjoyment between years 8-9. The project involved 6409 students attending UK state schools in years 7 to 13. The results showed that 76% of students in year 7 enjoyed secondary-level science more than primary-level science. However, the study found that there was a sharp fall in interest in school science over the first three years of secondary school. The proportion of students who were very interested in science lessons declined from 26% in year 7 to 23% in year 8 and 14% in year 9. Over the same period, students were found to increasingly reject science as a future pathway with the proportion of students stating that they are not planning to study science after GCSE increasing from 26% in year 7 to 41% in year 9. The authors explained that while there may be a range of factors underpinning this drop in engagement, the evidently reduced experience of practical work between year 7 and 9 (which was identified as the most motivating aspect of science lessons in their study) and the increase in the proportion of students who found science difficult were identified as the main factors leading to this change.

Reviewing the literature, it can be noticed that there is a number of studies examining the changing attitudes during the transition from primary to secondary school in the UK as well as in the rest of the world. Studies conducted in Australia, USA and Germany (Yager and Penick, 1986; Anderman and Maehr, 1994; Speering and Rennie, 1996; Sorge, 2007; Logan and Skamp, 2008) indicate that the concern for the decline in engagement of students to science as they move through their school years and especially during the primary-secondary transition is not confined to the UK. The section that follows reviews the studies that investigate the decline of positive attitudes of students with school science in Australia as they progress from primary to secondary school.

2.2.3 Australian students' attitudes towards school science from primary to secondary school

Logan and Skamp (2008) implemented an observational case study approach in a secondary school and its feeder primary school in Australia. The study involved 21 students of a range of abilities (10 boys and 11 girls) whose attitudes towards and interest in school science as they moved from primary to secondary school were measured. The data collected using a range of methods including observations, interviews and reviews of documents as year 6 students were moving from the feeder primary to the secondary school. Additionally, the sample included data collected from 70 'non- participant' students whose attitudes towards science in year 6 and 7 were measured using questionnaires. Using the results of the study the authors concluded that the positive attitudes towards science of the 'non- participant' sample declined as students moved from year 6 to year 7. Interestingly, as opposed to the findings for the 'non-participant' sample, the majority of the 21 student participants generally maintained positive attitudes towards science in year 7. The difference between the 21 participant students and the rest of the cohort could be due to the fact that the participant students perceived themselves as special 'science students' that were chosen for the research and this might have triggered their interest and engagement in science leading to biased results ('Hawthorne effect' -McCambrige et al, 2014). However, even within the 'participant' sample the attitudes of three students who were passionate about science in year 6 deteriorated by school science in year 7. The remaining students' attitudes were unaffected as they progressed in year 7 which is opposed to the findings of earlier studies and the results of the 'non-participant' students.

The results of the research study by Logan and Skamp (2008) reached similar conclusions to an earlier, longitudinal study aiming to increase the understanding of the effect of transition between primary and secondary school in Australia on the changing attitudes towards science (Speering and Rennie, 1996). During the study two groups of a total of 26 students (13 students each) in their final year of primary school were followed to their first year in secondary school. The study included both qualitative and quantitative data collection from the participant students as well as their peers. A total of 71 questionnaires were given to the peers of the primary school students. A great percentage of students (96%) enjoyed primary school science and 90% were looking forward to study science in secondary school while 78% of the primary school students expressed the idea that they would enjoy secondary school science. When the participant students moved to the secondary school a total of 147 questionnaires were distributed to their cohort; the analysis of the results showed a considerable change in the attitudes of students toward secondary science. The results which were particularly striking for girls indicated that while the majority of primary school students were enthusiastic about secondary school science, their positive attitudes decreased in their first year of secondary school. The results of the study by Speering and Rennie (1996) derive only from three schools of a specific type (state school) in a specific type of area (middle-class area). However, they confirm literature and previous work in this area of science education (Baird and Penna, 1992). The work by Speering and Rennie (1996) as well as the work by Logan and Skamp (2008) underline the importance of using both quantitative and qualitative data when trying to tap both the breadth and depth of students' attitudes towards school science and they definitely provided ‘food for thought’ in the decision process about the data collection methods that would be followed for the present study.

The issue of the primary-secondary transition engagement in science seems to be extensively examined and investigated in Australia; a report written by Tytler et al. (2008) aimed to review the literature and to draw upon Australian and global research in order to better understand the engagement of students in school science and if it is impacted by the school transition. The review led to the conclusion that engaging students in science ‘becomes increasingly difficult after the early secondary school years’ (p. 9) and it indicates that the biggest drop in students’ engagement in school science happens during the primary-secondary school transition. While the review discusses that the transfer to secondary school makes the attitudes of students toward school generally less positive, it is highlighted that STEM subjects experience the biggest decline of students’ positive attitudes. The review reports that the change in students’ attitudes and interest towards school science after they move to secondary school is also perceived by teachers.

2.2.4 US students’ attitudes towards school science from primary to secondary school

Kahle and Lakes (1983) using data from the NAEP (National Assessment for Educational Progress) survey in the U.S concluded that children leave primary school looking forward to join the secondary science classroom and having highly favourable attitudes and interest towards secondary science. However, their experience of secondary school science leads to a rather fast erosion of their interest in science and to less positive attitudes towards the subject compared to primary school. This study is quite old, however, more recent studies that were conducted in the U.S have reached similar conclusions and this shows that almost forty years on, the issue of the declining attitudes of students towards school science as they move from primary to secondary school is a persisting one.

Yager and Penick (1986) also used data from NAEP (1978) to assess the perceptions of four age groups (9, 13, 17-year-old and young adults) towards science classes, teachers and the value of science. The data collected during the NAEP project show that most (60%) of elementary school (primary school equivalent) students (9-year-old) find science classes fun. The number decreases to about 40% for junior-high school (lower secondary equivalent) students (13-year-old) and to 25% for high school (upper secondary equivalent) students (17-year-old). The table that follows (Table 2.2-3) summarises the information collected from three different projects and it shows the percentage of various age groups' perceptions of their science classes.

Table 2.2-1 Percentage frequency of various age groups' perceptions of their science classes (Yager and Penick, p. 359)

Statement	**Elementary**			**Junior School**			**High School**		
	1977	**1982**	**1984**	**1977**	**1982**	**1984**	**1977**	**1982**	**1984**
Science lessons are fun	62	57	64	33	41	40	27	28	25
Science classes are interesting	85	86	84	42	52	51	39	43	46
Science classes are exciting	50	56	51	43	44	43	48	49	40
Science classes make me feel uncomfortable	5	6	6	36	20	22	43	22	20
Science classes make	56	58	59	42	36	40	30	27	30

me feel successful									
Science classes make me feel curious	43	48	40	36	30	24	31	24	20
1977-Information from Third Assessment of Science, National Assessment of Educational progress (n=2500) 1982 – Information from National Science Supervisors Association Follow-up Study (n=1800) 1984- Information from Iowa study of Random Sample of Members of National Science Teachers Association (n=750)									

A study conducted more recently in the U.S (Sorge, 2007) examined the attitudes of 1008 students from rural New Mexico in primary and secondary schools from ages 9 through 14. Six primary and three secondary schools in two districts participated in the three-year study. The data were collected at the beginning of each fall semester using a Likert-style questionnaire with attitudinal statements. The analysis of the results showed a drop in positive attitudes towards science between primary and secondary school; the effect size for this change was large, representing a major drop in attitudes towards school science over the course of one year. The researcher, commenting on their results, express their concern about the result as the students have just joined secondary school (6 weeks before they took the instrument) when this significant drop of positive attitudes took place showing that 'unmistakably a precipitous drop in science attitudes takes place between primary and secondary school' (p. 35).

A review by Fredericks et al. (2011) reviewed twenty-one instruments used to measure student engagement to science in upper primary and secondary school in the U.S. According to the author the report focuses on this age range because of 'the documented decline in motivation and engagement across middle and high school' (p.3). The review suggests that student engagement with school science declines as students move through the upper primary and lower secondary school and it reaches its lowest levels in upper secondary.

2.2.5 Decline in attitudes towards science compared to other subjects in the UK

Although there is a wide range of studies looking into students' attitudes towards school science and how these change as students move from primary to secondary school, there is -interestingly- very limited research (in the reviewed literature) comparing the science attitude change to other school subjects. Osborne et al. (2003) in their review state that they find the fact, that there is only a limited number of studies comparing the attitudes towards different subjects, surprising. This is important to keep in mind as when students move from primary to secondary school their attitudes towards school and secondary school subjects might become less positive in general and not just towards science. Nevertheless, attempts to compare students' attitudes towards science to other subjects were done in the form of subject preference studies (Ormerod, 1971; Whitfield, 1980). The researchers suggest that some measure of attitudes towards subjects can be obtained by asking students to rank their liking of school subjects- their relative popularity can show what the students' attitudes towards each subject is. Whitfield's analysis of the data collected from year 9, year 10 and year 11 students, showed that students' attitudes towards science subjects (especially towards chemistry and physics) were less positive compared to other subjects such as English, geography, history and mathematics when students were in year 9. The results of the study also showed that there was a steeper decline in attitudes towards science subjects by the time students were in year 11 compared to any other subject. Figure 2.2-3 taken from

Whitfield (1980) shows students' attitudes towards secondary school subjects and how they change as students move through their schooling.

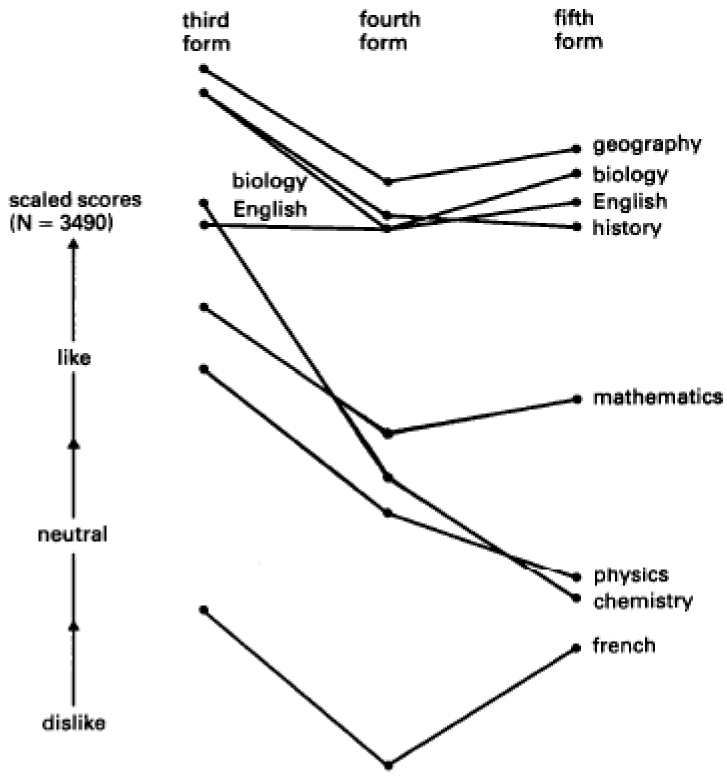


Figure 2.2-1 Attitudes towards secondary school subjects and how they change as students move through their schooling

Whitfield's study (1980) is arguably quite old and we can question the significance of its results because of the considerable changes that have occurred in the curriculum for science (and other subjects) since the study was conducted. Also, when thinking about the ranking system used by Whitefield, we need to keep in mind that such a scale is a relative scale. Therefore, a student that has very positive attitudes towards all school subjects can rank science the least popular but yet have a more positive attitude towards science compared to another student that ranks science as his favourite subject but they dislike all the school subjects. However, Osborne et al. (2003) state that this is a useful instrument that should not be discarded completely as it still provides information about the popularity of school science compared to other subjects; the authors suggest that such a scale should be used along with other data collection techniques rather than in isolation.

More recent studies looking at students' attitudes towards science in comparison (to some extent) to other subjects were conducted by Galton et al. (2003), Blenkinsop et al., (2006), Sjøberg and Schreiner, (2010) and Hutchinson and Bentley (2011).

For instance, Galton et al. (2003) demonstrated that students' attitudes towards school science, when compared to mathematics and English, decline most noticeably early in secondary school. Blenkinshop et al. (2006) compared the difficulty of secondary subjects (as perceived by the students) and concluded that mathematics and science were seen as harder than English but not as hard as languages. The findings of the Relevance of Science Education (ROSE) international study (Sjøberg and Schreiner, 2010), Mansell (2011) suggest that students find school science as the least interesting subject compared to other school subjects. Hutchinson and Bentley (2011) find that students' attitudes towards mathematics and science decline from age 11 to age 14, stating however, that it is mathematics that show the biggest decline than any school subject.

Finally, Hamlyn et al. (2020), in the UK, used a ranking system to measure students' attitudes towards learning science in secondary school compared to other subjects. In terms of enjoyment, science was ranked midway for students in year 7-9 (below art, design, maths and English and above history, computing, geography and languages). However, for years 10-13, when sciences are studied separately, biology was the most enjoyed science subject (ranked 3rd out of 10 subjects) and physics the least enjoyed science (ranked 8th out of 10 subjects).

Chemistry was ranked 6th. When it came to comparing the attitude change through the school years, science was only compared to computer science; 76% year 7-9 students stated that they found school science interesting as opposed to 60% who stated that they found computer science interesting with the percentages dropping for year 10-13 students to 68% and 40% respectively.

2.2.6 Summary

Literature suggests that there is a decline in students' attitudes towards and engagement in science as they move from primary to secondary school (Newton, 1974; Breakwell and Beardsell, 1992; Galton, 2002; Osborne et al., 2003; Braund and Driver, 2005; Bennett and Hogarth, 2009; Bennett, Braund, et al., 2013). The review of the literature indicates that the 'dip' in the positive attitudes towards school science as students move towards secondary school is not a problem that is only identified in the UK (Kahle and Lakes, 1983; Yager and Penick, 1986; Speering and Rennie, 1996; Logan and Skamp, 2008; Tytler et al., 2008). Certain studies have expressed the idea that this decline starts even earlier; during the last years of primary schooling (Murphy and Beggs, 2003) while other studies support that students generally maintain positive attitudes towards school science as they move from primary to secondary school (Logan and Skamp, 2008; Dewitt et al., 2014; Hamlyn et al, 2020). However, most of the research studies or reviews that were included in this section have looked at attitudes towards 'General science' (with the exception of Whitfield, 1980 and Bennett and Hogarth, 2009) and there was no distinction between the attitudes towards the three individual sciences. The nature and the content of the three sciences is rather different and it might worth considering them more often as different subjects when exploring students' attitudes towards them. The table that follows (table 2.2-4) summarises the findings of several studies in the field of student attitudes to school science.

Table 2.2-2 Summary of the literature relevant to the change of students' attitudes towards school science

Findings	**Author (s)**
Students' attitudes towards school science decline during primary years	Ayers and Price, 1975 (US) Simpson and Oliver, 1985 (US) Murphy and Beggs, 2003 (UK) Pell and Jarvis, 2010 (UK)
Students' attitudes towards school science decline in the primary – secondary interface	Newton, 1974 (UK) Kahle and Lakes, 1983 (US) Yager and Penick, 1986 (US) Breakwell and Brearsdell, 1992 (UK) Speering and Rennie, 1996 (AUS) Galton and Hargreaves, 2002 (UK) Osborne et al, 2003 (UK) Braund and Driver , 2002 (UK) Reiss, 2004 (UK) Braund and Driver, 2005 (UK) Teaching and Learning Programme, 2006 (UK) Barmby et al, 2008 (UK)

	Logan & Skamp, 2008 (AUS) Tytler et al ,2008 (AUS) Fredricks et al, 2011 (US)
Students' attitudes towards school science decline during secondary years	Newton, 1974 (UK) Yager and Penick, 1986 (US) Breakwell and Brearsdell, 1992 (UK) Tytler et al, 2008 (AUS) Barmby et al, 2008 (UK) Fredericks et al, 2011 (US) Bennett and Hoggarth, 2009 (UK) Bennett et al., 2013 (UK) Hamlyn et al., 2020 (UK)
Students' attitudes towards school science **do not** decline during secondary years	Hobbs and Erickson, 1980 (CA) Logan and Skamp, 2008 (AUS) Dewitt et al., 2014 (UK)
Students' attitudes towards science decline more than other subjects	Whitfield, 1980 (UK) Hadden and Johnstone, 1984 (UK) Galton, 2002 (UK) Tytler et al., 2008 (AUS)

2.3 Factors affecting students' attitudes towards school science

This part of the literature review focuses on the literature surrounding the factors that impact the formation of students' attitudes towards school science (in general) and the attitude change as students move from primary to secondary school. More specifically, the review that follows explores the impact of students' expectations of secondary school science (section 2.3.1), the impact of the teacher and teaching (section 2.3.2), the impact of practical work (section 2.3.3), the impact of the primary-secondary transition and the change in school setting (section 2.3.4), the impact of career aspirations and science utility (section 2.3.5), the impact of family and friends (section 2.3.6) and the impact of gender (section 2.3.6).

2.3.1 The impact of students' expectations of secondary school science on students' attitudes towards secondary school science.

A number of studies that were conducted in developed countries such as the UK, USA, Australia and Canada indicate that one of the most significant factors leading to the decline in engagement with secondary school science is the great expectations of secondary science which students have when they are in primary school. Once students move to secondary school they feel that these expectations are not always met (Baird et al., 1990; Baird and Penna, 1992; Griffiths and Jones, 1994; Speering and Rennie, 1996; Braund and Driver, 2005).

Baird et al. (1990) conducted a three-year research study in Australia which included 25 different investigations into aspects of science teaching and learning. During one of their investigations, they used questionnaires to collect data for year 6 and year 7 students' perceptions of secondary school science. A large percentage of the 208 year 6 students (93%) were found to be looking forward to continuing science in secondary school as they believed that secondary school science would be taught by specialised science teachers, using a wider range of resources compared to the primary school. According to the results of the research by Baird et al. (1990) students also expected that they would be following a more challenging curriculum which would be 'active, interesting and fun' and that they would be 'doing experiments, dissections, investigations and projects' (p.12-13). However, many of the students (50% of girls and 33% of boys) were considerably disappointed by year 7 science. Some of the students did not hesitate to use strong statements such as 'I hate science. All we do is sit there and watch' or 'We hardly do anything. We are not given any real work and a lot of people are getting low marks because they are bored' (Baird et al, 1990, p.130). Such results underline that the reality of secondary school science appears not to meet the expectations of students moving from primary to secondary school.

Griffiths and Jones (1994) have also investigated the expectations of year 6 students of the science work they would encounter in secondary school. The project involved qualitative data collection from eight year 6 students from four different English primary schools who took part in a focus group discussing about their primary science experience and their expectations of secondary school science. The discussion in the focus group indicated that the year 6 students in different classes or schools had very different science experiences; some of them had more practical experience while others had science experiences that developed through TV programmes or text-book work. Although the different students have encountered a varying range of teaching methods, they all expressed the idea that primary school science was a very positive experience for them and came high on the list of the 'best' lesson they have done in year 6. The students that participated in the focus group were also asked about their expectations of secondary school science. The majority of the students were very positive about secondary school science and they clearly had high expectations of secondary school science: ‘Can’t wait to get there. You have to dissect frogs…and bull’s eyes’(Griffiths and Jones, 1994, p 83). The authors collected data only from year 6 students and therefore we cannot use the results of the study to determine whether secondary school science met the expectations of the students once they moved in year 7 but we can use the results to draw the conclusion that students expected that secondary school science would offer them new and interesting experiences such as dissection- although frog dissection has no place in the contemporary science classroom due to its ethically problematic nature. Furthermore, although qualitative data has, undoubtedly, provided richer details and an in-depth view of year 6 students attitudes towards school science, the sample (8 students) is arguably quite small and this is something that will be taken into consideration when designing the data collection for the present study (as well as the need to collect data from year 7 if the study is to compare how the attitudes of students change as they move from primary to secondary school). Nevertheless, the question that is raised, considering that dissecting frogs is not the case in secondary school, is how this ‘false’ image of secondary school science is created. Jarman (1993) suggests that a reason that possibly leads to high students’ expectations of secondary school science is that they do not consider primary school ‘real’ compared to secondary school. As Jarman (1993) explains secondary school with its laboratories, the science equipment available and the ‘use of real scientist’s words’ create very high expectations of secondary school science to the point that the perceptions are not realistic. Abrahams (2007) using the results of twenty-five multi-site case studies in English schools, suggests that a factor that leads to the formation of high expectations of secondary science and the portray of secondary science as fun, exciting and mainly practical is, perhaps, the way science is presented in Open Evenings. According to Abrahams (2007) in Open Days, members of other departments use textbooks and examples of students' work around the classroom while science teachers use such events as an opportunity to show prospective students that science is not conceptually demanding (as traditionally viewed) but promote an image of science as fun, exciting, enjoyable and full of practical opportunities.

Similar results with Baird et al. (1990) and Griffiths and Jones (1994) were reported by, Speering and Rennie (1996) who used, however, a longitudinal study to collect their data. The authors, followed a group of year 6 students in Australia to their first year in secondary school as discussed in section 2.3.2. The results of their study show that 96% of the 78 year 6 students who participated in the study said that they 'enjoyed' primary science and nearly all students (90%) were looking forward to study science in secondary school. The students who responded said that they would enjoy science (78%) were asked why they thought so and the most common response (22%) was that 'it would be enjoyable and fun', followed (15%) by 'better equipment would be used' and 'there would be lots of experiments' (13%). Interestingly, only five students of the sample have actually 'heard from others that secondary school science is interesting' (p. 290) which might confirm the findings of the literature which suggest a 'dip' in engagement with science in secondary school. Speering and Rennie (1996) used qualitative data from interviews to explain that 'students expect science to become more exciting at secondary school because of the specialised knowledge of teachers, the sophisticated resources available and the prospect of a more challenging curriculum' (1996, p. 286) and that they were disappointed when they realised that secondary school science did not meet their expectations and that the 'enthusiasm for science with which students have entered secondary school seems to have been somewhat dampened by the unexpected boredom'(p.295). During the interviews it appeared that the students who did not enjoy secondary science expressed the idea that their secondary science lessons were boring: 'It is probably because we do mostly lecturing, and it's pretty boring', 'We've been doing for the last three weeks, just notes and we haven't done, like all the other classes, an experiment...' (p.292). The comment 'like all the other classes' could mean that students have higher expectations of secondary school science compared to 'all the other classes' and it could be one of the reasons that the 'dip' in their attitudes towards secondary school science is steeper than any other secondary school subject (Whitfield, 1980; Galton et al, 2003).

Using a combination of quantitative (questionnaire administered to 36 students in year 6 and 32 students in year 7) and qualitative (6 students were interviewed following their responses to the questionnaire in each year) methods, Campbell (2002), confirms previous findings that students' expectations of secondary school science are not met. In year 6, students were very enthusiastic about secondary school science as they were expecting to be using specialist facilities and apparatus, to do a lot of experiments and encounter more challenging content in secondary school. Once the students moved to secondary school, they expressed less positive views regarding their secondary science experience and they felt that their expectations of secondary school science were not met. Specifically, the responses of 25 out of 32 students in year 7 (78%) indicated unfulfilled expectations of secondary school science as the students felt that the perception of learning science by performing a lot of experiments with new and exciting equipment in secondary school was not realistic: 'I thought that we would do a lot more experiments than we have done so far' (p.588). According to Campbell (2002) what makes the students feel less positively for secondary school science once they join secondary school is the expectation that secondary school science will be a predominantly practical lesson with very small amount of theoretical content and the disappointment once they realise that this is not the case. Although the combination of quantitative and qualitative methods used in Campbell's (2002) study were intended to provide a better understanding of the research problem (Cresswell and Clark, 2011), the quantitative data collected from each year might not considered to be large enough to allow generalisations and again, this is something to keep in mind when planning the data collection for the present study.

Similar conclusions were drawn by Braund and Driver (2005) who found that students expected secondary school science to be a mainly practical subject with better, sophisticated equipment and great opportunities for fun and interesting experiments. A total of 117 year 6 students (76 girls and 41 boys) and 105 year 7 students (52 girls and 53 boys) took part in the study. The students responded to a questionnaire with open-ended questions; a small sample (11 students) were also involved in interviews. The following table (2.3-1) summarises the responses of year 6 students and year 7 students and it shows that students in year 6 arrived in secondary school with high expectations of science while their responses in year 7 indicate that most of their expectations were not met.

Table 2.3-1 Analysis of Year 6 and Year 7 students' responses to: What might be/is different about science in primary and secondary school?

	Year 6		Year 7	
Response to the open – ended question: **'What might be/is different about science in primary and secondary school?'**	Boys (%) (n=41)	Girls (%) (n=76)	Boys (%) (n=53)	Girls (%) (n=52)
Use different/better/more equipment	32	35	21	25
Work is/will be harder/ more advanced	39	41	6	17
Do more/some experiments	5	5	25	33
Do more dangerous work (use more dangerous chemicals)	34	25	8	37
Work in a laboratory or specialist area	12	14	0	1

The table shows that more year 6 students expected to use better and more equipment compared to the number of students that actually felt that they were using better equipment in year 7. Also, a higher percentage of year 6 believed that the science work in year 7 would be harder or more advanced than the percentage of year 7 students reporting that year 7 work was actually harder than year 6 work. More students in year 6 expected that they would be working in a laboratory or a specialist area in year 7 than the number of year 7 students reporting that they were actually working in a laboratory or specialist area. In terms of the number of experiments done in year 7 it seems that the expectations of year 6 students were fulfilled and exceeded.

Contrary to the research studies that support the idea that students were disappointed once they realised that there was not sufficient challenge in secondary school science compared to primary school (Baird et al, 1990; Speering and Rennie, 1996), Jarman (1993), Osborn and Collins (2000) and Lindahl (2012) suggest that when students find science difficult they perceive that they have a low ability in science and this tends to impact students' attitude towards science. Logan and Skamp (2008) also found that when science is perceived by students to be more difficult, students' interest declines and they found this to be particularly the case for the primary – secondary transition. In their study (described in detail in section 2.2.3), all participant students whose science interest scores declined markedly over the primary -secondary school transition, had an increase in science difficulty scores. More specifically, 61% of the participant students perceived secondary school science to be more difficult than primary and they all had declining attitudes towards secondary school science.

2.3.2 The impact of the teacher and teaching on students' attitudes towards school science

Many of the reviewed papers which are part of this literature review, show that science teacher plays an important role in the development of students' attitudes towards school subjects and school in general (Keller et al., 2016; Moè, 2016; Lazarides et al., 2019) and school science (George, 2000; Papanastasiou, 2002; Frenzel et al., 2009; Bennett, Braund, et al., 2013; Hadzigeorgiou et al., 2019). According to Frenzel et al. (2009), teachers have a major impact on students' attitudes towards school science. The authors suggest that students' attitudes are affected by teachers' comments about a subject and by teachers' enjoyment while teaching their topic. Hadzigeorgiou et al. (2019), state that students' attitudes and engagement with school science can be affected by teaching style and teacher personality. Research also points out that teacher feedback, expectations and encouragement influence students' positive attitudes towards science (George, 2000; Stake and Mares, 2001) and that students' attitudes are impacted by classroom experiences (Papanastasiou, 2002). Finally, teacher specialism was also found to impact students' attitudes and post-compulsory participation in science (Reid and Skryabina, 2002; Cerini et al., 2004; Bennett, Lubben, et al., 2013; Bennett, Braund, et al., 2013).

Denessen et al (2015), also suggest that a positive teacher attitude seems to be very important in the development of positive student attitudes. Their study investigated the development of Dutch primary student attitudes towards science and technology in relation to teachers' enjoyment in teaching these subjects. The sample of their one-year longitudinal study consisted of 91 teachers and their 1822 primary school students (aged 8 - 12); the results showed that student attitudes towards science become less positive as students grow older and that teacher attitudes towards science affect student attitudes. Students in the study showed a stronger decrease in their attitudes when teachers were less enthusiastic about science.

One of the challenges in engaging students with science in primary – secondary interface appears to be the teaching and learning practices used in secondary school science (Osborne and Collins, 2001; Lyons, 2006; Lindahl, 2012). Collected data coming from countries around the world such as the UK (Osborne and Collins, 2001), U.S (Haladyna et al., 1982; Keeves, 1992), Sweden (Lindahl, 2012) and Australia (Ferguson and Fraser, 1998; Lyons, 2006) show that students are turned away from science due to the transmissive pedagogy that characterises secondary school science, the decontextualised content that does not engage students' interest and the difficulty of secondary school science (Lindahl, 2012; Lyons, 2006; Osborne and Collins, 2001; Tytler et at, 2008). Other studies such as Van Langen and Dekker (2005) emphasise on the fact that although the majority of literature identifies teachers as having a positive effect on students' attitudes towards school science, there are some science teachers who, either deliberately or subconsciously discourage students by giving them the impression that science is too hard and thus, science is only for the brighter elite students.

Lindahl (2012) followed 80 students from primary to secondary school studying the factors that affect students' engagement to secondary school science. The results of her study suggest that students are given fewer opportunities for discussion and expression of their personal opinion in secondary school science and that the teaching in the secondary science classroom is very teacher-led while most of the times the teaching involves students copying texts that include facts which are not often made relevant to students' everyday experiences. Lindahl (2012) describes the disappointment of the students during the first encounter with secondary school science as they spent time sitting still, listening and copying. While students in the study recognised the value of transmissive pedagogy, which is the process during which a specific body of knowledge is transmitted from the teacher to the student who is a passive absorber of information (Freire, 1993), in some modes they were 'overwhelmingly critical of its use as the default teaching option' (Lyons, 2006, p.595). Another important finding of her study is that a number of students developed an interest in science outside school but they were finding school science not as interesting and they felt that they did not really know what kind of career opportunities school science could give them. Lyons also characterises the transmissive pedagogy as one of the reasons that students become disengaged from science as they move from primary to secondary school, while some students who participated in the study found science 'important – but not for me' (Lyons, 2006, p.600).

Similar findings by Osborne and Collins (2001) indicate that students in secondary science were not given the opportunity to discuss or reflect on their own learning and they conclude that the overfull content- driven curriculum infrequently links school science to everyday life. Students who participated in the interviews characteristically underlined that: 'Some teachers just read off a page and you 've got to copy it down and they don't say anything about it, and you 've got a page of writing in your book and you don't know what you're doing' (p. 27).

The positive impact on the science attainment and attitudes of pupils when the emphasis is on talking rather than writing is also noted by Hanley et al. (2020). Their study investigated the impact of a professional development programme for teachers that encourages more practical and interactive science lessons. Students aged 9-10 at 42 primary schools in England were randomised to receive either the programme or to be in the control group. The attainment outcomes were measured with an age-appropriate paper science test covering a range of topics and question types and attitudes were measured by attitudes surveys completed by students. The analysis of the results showed that the intervention had a statistically significant effect on attainment and that it had also improved their attitudes to science.

However, research by Sheldrake et al. (2019) shows that wider applications of science is the only teaching approach to consistently and positively associate with students' attitudes. The analysis of the results for their study considered nationally-representative samples of year 11 students in England, collected for PISA, from 2006 (4935 students from 171 schools) and 2015 (5194 students from 206 schools) and showed that the perceived utility of science was the main factor that impacted the development of positive attitudes towards school science, with students reporting that teaching approach and style have smaller or no impact on their attitudes. Despite the differences between PISA 2006 and PISA 2015 which suggest that some results may be sample-dependent (as it does not consider how different cohorts might systematically change –or be similar- in their thinking, experiences and beliefs) it does suggest that teaching style or approach has small or no impact on students' attitudes towards school science.

2.3.3 The impact of practical work in primary- secondary interface on students' attitudes towards school science

Work by Jarman (1993), Griffiths and Jones (1994) and Braund and Driver (2005) which is already described in section 2.3.1 as part of students' expectations of secondary school, suggests that one aspect of science that primary school students look forward to in secondary school is practical work. Practical work in science is very popular with students and it is the aspect of science they believe they will enjoy the most when they move to secondary school (Cleaves, 2005; Braund and Driver, 2005). Once in secondary school, however, they characterise much of the practical work in secondary school as teacher – directed (Fraser, 1994; Goodrum et al., 2001) which can detract from interest. Adding to this, Lindahl (2012) suggests that there is a lack of understanding of what is expected in science laboratory work in secondary school and that once students arrive in the secondary science classroom, they find that there is no challenge during science practicals which means students are 'doubting their own capabilities and losing interest' (Lindahl, 2012, p.16).

Students in year 6 are looking forward to spend time in the secondary science laboratory using more sophisticated equipment and doing 'dangerous' experiments (Jarman, 1993; Griffiths and Jones, 1994). However, when they get to year 7 most of them express their disappointment as they feel that year 7 practical work is the same as in year 6 just using different equipment: 'You are always experimenting about the same things as in primary school, only in secondary school you just have better equipment', 'You just do the same experiments all the time but you may do it with different equipment or because in primary school you didn't have the stuff to do it properly' (Braund and Driver, 2005, p.88). The high expectations that students have regarding secondary science practical activities and the disappointment the feel once they get to secondary school and they realise that there is no advancement in terms of experiments in year 7 is often translated to student disengagement from secondary school science.

Research studies by the National Foundation for Educational Research (Mansell, 2011) in the UK also highlight the importance of continuing active involvement of students in science lessons in secondary school in order to avoid potential negative perceptions of science as boring. The research involved case studies in 20 schools in the UK during which evidence was collected from interviews and focus groups of a total of 240 students. The results of the study note that young people had enjoyed science more in primary school as it was fun, it involved a lot of practical activities and trips and more connection of the science themes with everyday life experiences.

Hands on activities and practical work are not always considered as developing science skills and knowledge as compared to content -driven or textbook based science learning (Pine et al., 2006) but they are considered as a factor sustaining students' engagement with science (Foley and Mcphee, 2008). Foley and McPhee in their study investigated the attitudes of 955 primary school students in the US towards science in classes using a hands-on (480 students) or textbook based (475 students) curriculum. The findings of the study showed that the students who experienced hands- on activities in primary school enjoyed science more and had more positive attitudes towards secondary school science compared to those who were learning in textbook – based science classes. Furthermore, the results of the study suggest that without improvements in teacher preparation it seems unlikely that switching to a hands – on curriculum will result in science learning gains. However, the motivational aspect of hands-on curriculum may be an important component in increasing the number of students who are more engaged and have more positive attitudes towards secondary school science.

Research studies claim that practical work has an essential role in shaping students' attitudes towards school science (Osborne et al., 1998). Research by Sharpe (2015) shows that students positive attitudes towards secondary school science are formed during primary school as students are looking forward to moving to secondary school and to performing 'interesting' (p.29) science experiments. However, the positive attitudes towards practical work and secondary school science decline significantly as students move to secondary school and the practical work moves 'away from a focus on the enjoyment of science towards one that is examination oriented' (Sharpe, 2015, p. 25).

Logan and Skamp (2008), in line with all the studies mentioned above, also emphasise on the importance of practical work and hands on activities in the primary-secondary school transition. Students who participated in their research study (as described in section 2.2.3) expressed the idea that in primary school they had the opportunity to participate in a lot of 'fun' activities', 'hands on' experiences and 'practical investigations' (p.14). The students had scored a high science interest score. After their transition most students started describing their science lessons as 'teacher centred', based on 'copying notes' (p.16), and they stated that the practical activities were not only minimised but they were also 'recipe-like' (p.17) experiments in which most of the times they were told the expected results. Logan and Skamp

(2008) identified this as one of the factors affecting students' engagement to science in primary-secondary interface.

2.3.4 The impact of primary – secondary school transition and the change in school setting on students' engagement with school science

Although attitudes towards school become less positive in general (Anderman and Maehr, 1994; Griebel and Berwanger, 2006; Evangelou et al., 2008; Hanewald, 2013), studies show that the decline in positive attitudes is sharper for science (Galton et al., 2003; Tytler, 2007; Tytler et al., 2008; Sjøberg and Schreiner, 2010; Mansell, 2011). A longitudinal study in Australia (Speering and Rennie, 1996 -described in section 2.2.3) uses qualitative and quantitative methods to study the attitudes of students towards science during transition. The findings of the study show that the considerable change in the organisation of the school, the rigid timetable, the curriculum and the different teacher-student relationship (compared to primary school) negatively affects students' attitudes towards secondary school science. Although this is the case for other subjects too (Galton et al., 2003; Blenkinshop, 2006; Hutchinson and Bentley, 2011), Speering and Rennie (1996) suggest that the implementation of curriculum in secondary school seems to affect to a significant extent students' engagement with science as in primary school years the curriculum is more activity based and student-centred 'providing a strong contrast with science lessons which are teacher-centred and content-driven in secondary school' (p. 285). Another finding of the research is that positive attitudes of girls towards science in the primary-secondary interface decline more compared to boys. However, in the studies, only one out of six pupils in 1993 and three out of ten pupils in 1994 were boys. Thus, the reliability of the gender -related findings can be questioned. When looking at comparing the attitudes of boys and girls towards science, it is important to ensure approximately equal number of boys and girls participating in the study, especially if the process involves group interviews or focus groups; this will be taken into consideration as planning for the group interviews for the present study. The impact of gender on students' attitudes towards science in the primary – secondary interface is discussed further section 2.3.7.

Another piece of research conducted in Tasmania points out that school size and student gender are influencing factors for the change in perceptions and attitudes towards science. The longitudinal research included qualitative and quantitative data collection from the same students in year 6 and in year 7 (Ferguson and Fraser, 1998). This study investigated students' perceptions of the generalist learning environment of the primary school compared to their perceptions of the specialist science learning environment of secondary school. The data collected were related to classroom and school environment as well as the teaching style and student-teacher relationships. Students found that the environment of secondary school science was less favourable compared to the primary school one and that teacher-student relationships were not as personal as in primary school and this found to be affecting students' perception of secondary science. That was particularly the case for girls who were found to miss the close relationship they had with their primary school teachers.

A review of the UK literature (Whitfield, 1980; Galton, 2002; Galton et al., 2003) confirms that also in the UK the 'dip' in attitude is steepest for mathematics and science. The review of the UK literature suggests that students become disengaged from science as they move to secondary school because they feel that they have adaptability problems as they are the youngest students in the school, they are afraid of the size of the new school and they are worried that they will get lost, they are afraid that they will not be able to adjust to the teaching style of different teachers and that they will find it difficult to move around in the new school and learn the rules.

Although such results (indicating that moving to a bigger, different school can cause a 'dip' in the positive attitudes of students towards school science) are certainly important, they raise the question if it is the transition itself and the difficulty in adjusting to the new environment that leads to a declining engagement then why this decline is steepest in science compared to other subjects? (This is based on the limited literature available). This, would definitely worth exploring in more detail.

A research study conducted by Power (1979), aimed to investigate whether one of the main factors affecting students' engagement with science is the movement from primary to secondary school and the difficulty that many students find in adjusting to the new environment and setting. Power (1979) found out that there were no major problems confronting students in transition (in the schools sampled) in terms of science. The research pointed out that students enjoy science both in primary and secondary school and it found no 'sharp drop off in students' attitudes towards science as years wear off' (p.83). The study by Power (1979) is quite old, however it is in agreement with the study by Dewitt et al. (2014) which is described in detail in section 2.2.2, and which argues that the majority of students continue to enjoy secondary school science.

2.3.5 The impact of career aspirations and science utility on students' attitudes towards school science

The literature suggests that attitudes towards science remain more positive for students who perceive science as useful or important for their future career. Although a number of students do not find secondary school science as interesting, or they perceive it as less fun or more difficult (Ogunkola and Samuel, 2011) in secondary school they might maintain their positive attitudes towards the subject as they recognise its importance in their future career aspirations. Blatchford (1992) noted that a number of students started developing ideas and concerns about their future careers before leaving primary school. Bennett et al. (2013), too, concluded that a number of students who appeared to have positive attitudes towards secondary school science began to shape their future career directions in the primary – secondary school interface and they expressed the idea that future employers would value science – related skills. Bennett et al, reviewing the available UK literature reached the conclusion that the majority of students perceive school science as an important subject which, regardless of their views about their school science experiences, has a 'strategic' (p.26) importance. Furthermore, the early secondary school students who participated in the NFER study (NFER, 2011) and who had generally positive attitudes towards science recognised the value of studying science for accessing University as it was seen as a 'good' (p.26) subject for University entry and as 'opening doors' (p.26) to a wider range of career options: 'Science gets you far in life. There are hundreds of jobs out there for science degree but if you do drama you can only become a theatre or movie star (Year 7 interviewee, p. 26).' Similar findings were derived from Dewitt et al (2014), Osborne and Collins (2010) as well as Jenkins and Nelson (2005) who suggest that students perceive science lessons as important because of the future career benefits that science has to offer them.

Mujtaba et al. (2018) also found that students' aspirations to study non-compulsory science in the future were strongly associated with their positive attitudes towards science. Their study involved a survey of 4780 students in year 7 and in year 8 from 25 schools in England with high proportions of those from disadvantaged backgrounds (eligible for free school meals, a measure intended to reflect low family income). Students completed a four-point scale questionnaire that measured a range of aspects such as students' backgrounds, their attitudes and beliefs about science and their learning at school. The associations between students' reported aspirations to study science further and other factors were considered through correlations and multi-level predictive modelling. The analysis of the results shows that on average, students generally reported positive attitudes towards the perceived utility of science and the extrinsic motivation for science (their perception that science can help them in their future lives). On average, the students reported a mean of 2.95 for that particular question (about the utility of science) which is closest to 'agree' on the 1-4 scale. However, their research study, as many of the studies cited in this literature review, have treated 'science' as a single subject as students in year 7 and 8 in English schools are not studying the three subjects separately and that was one of the limitations of their study. Another methodological limitation was that they measured the socio-economic background of students by asking them about the numbers of books they have at home (in order to avoid asking sensitive questions); however, the number of books does not always accurately reflect the socio-economic status of families (Sieben and Lechner, 2019).

Most studies reviewed in this section find that students who believe that science will be useful in their future lives and careers maintain positive attitudes towards science as they progress through their school years. However, Speering and Rennie (1996) found that not only the positive attitudes towards science declined after students joined secondary school but also the future career plans of students were unlikely to include science after they have joined secondary school. Similar findings were reached by a more recent study in the UK (Hamlyn et al., 2020); the study found that between years 7 and 9 students increasingly rejected science as a future pathway.

Aschbacher et al. (2014), in line with Speering and Rennie (1996) found too, that the deterioration of positive attitudes towards science can cause students who were once very interested in science careers to decide to leave the 'science pipeline' (the educational qualifications and training experiences necessary for students to consider a career in science) in high school. Their longitudinal study which included interviews and surveys, followed an ethnically and economically diverse sample of 33 high school students in California as they were moving from grade 10 (age 15) to grade 12 (age 17) to find out the reasons that caused this change. 45% of the participant students left the pipeline and although they were once interested in a science career, they claimed that they were no longer interested in one. The study found that the main reasons for it were that school science experiences failed to support or encourage their science interests. The study also showed a correlation between the perseverance of some students (these students were still interested in a science related career) and their positive attitudes towards school science.

Finally, George (2006), also examined the changes in students' attitudes towards science and attitudes about the utility of science over the middle school and high school years. The results of the longitudinal study which involved 444 students showed that the overall trend for students' attitudes about the utility of science is positive; however, attitudes towards school science decline over the middle school and high years.

2.3.6 The impact of significant individuals on students' attitudes towards science

Another factor influencing students' attitudes towards school science is the impact of significant individuals (such as parents, teachers and peers) and their perceived importance of secondary science (Osborne et al., 1998; Archer et al., 2011; Aschbacher et al., 2014; Hanley et al., 2020). Studies suggest that families play an important role in encouraging students' interest, positive attitudes and decision to follow science careers (Ferry et al., 2000; Gilmartin et al., 2006). Some studies have shown that parental effects differ by ethnicity for science attitude and interest (Huang et al., 2000). Peer attitudes towards science (George, 2000) as well as having friends to share science interests with (Stake and Nickens, 2005) are also found to be important factors that affect students' attitude towards school science. According to Stake and Nickens (2005), one of the reasons that girls might have less favourable attitudes towards science could be that they tend to have less peer support for their interests than do boys.

In the study conducted by Aschbacher et al. (2014), which is described in section 2.3.5 students expressed positive attitudes towards science where they experienced support from important people in their life such as their teachers and families. Andre et al. (1999) also support that apart from curriculum and pedagogical factors, students' attitudes towards science can be influenced by parental perceptions of their children's abilities. This is because parental perceptions of students' abilities can have a strong effect in how students perceive their own abilities and this can in turn influence their expectations for success, achievement and engagement with secondary school science. Hulleman and Harackiewicz (2012), found that promoting the relevance and utility of science to parents was associated with higher science interest for students.

Cleaves (2005) states that young students' attitudes towards science are influenced by parents who place a higher value on science subjects. In agreement with Cleaves (2005), nearly all young students who maintained positive attitudes towards secondary school science in the Wellcome Trust Monitor (Butt et al., 2010) expressed the idea that it was important for their parents that they do well in science at school. The study also reached the conclusion that students' level of engagement with secondary school science overlaps with parents' interest or engagement with science. Breakwell and Bearsdell (1992) also found a relationship between maintaining positive attitudes towards school science as students' progress to secondary school and the influence of parents. 'A positive attitude to science was strongly related to having a father and mother who supports science' (Breakwell and Breasdell, 1992, p.182). The paper also refers to the formation of positive attitudes towards school science when students do science related 'out-of-school' activities together with their parents. For these students, the engagement with school science as they move from primary to secondary school is maintained. However, in later secondary school years it is noticed that the attitudes towards school science become less positive. This was explained by authors on the basis of the fact that as students move through secondary school, they spend less time doing extracurricular activities with their parents but it could simply be due to the fact that as students move through secondary school other factors possibly impact their engagement and attitudes towards science.

Research (Karagiorges 1986; Papanastasiou and Papanastasiou, 2004; Papanastasiou and Zembylas) has shown that Cypriot parents are a great influence on their children's attitudes towards school science and career choices with Papanastasiou and Zembylas (2002) stating that 'Cypriot families tend to favour longer-term advantages that stem from being well educated (p.471)'. Their study intended to examine the attitude- achievement relationship in Cyprus using data from TIMSS which collected (among other information) data regarding students' perceptions of the sciences (e.g., students' beliefs about the importance of science for self, for parents and for friends). The analysis of the results showed that there was a correlation between students' attitudes towards science and their parents' attitudes towards school science. Papanastasiou and Papanastasiou (2004) also researched with Cypriot students and found out that one of the strongest influences towards school science attitudes was that of the students' families and peers. Particularly the involvement of parents in the form of interest taken by parents to discuss their children's class and school experiences was found to influence the attitudes of students towards school science. Their study found parental involvement and peers to have direct and indirect effects on students' science attitudes mediated through science activities, i.e., by encouraging the students to participate in science activities which in turn was found to help the development of positive attitudes towards school science and science in general.

Archer et al. (2015) have explained this using the term 'higher science capital' building on the work of the sociologist Bourdieu's concept of capital (Bourdieu, 1986).

Archer et al. (2015) explain that students with 'higher science capital' are students coming from socially advantaged families with higher parental education, number of books at home, number of museum visits, families with positive parental attitudes towards science, valuing science and scientists and having future science career aspirations. In their study, 5% of students were found to have ‘high science capital’ (p. 936), meaning they had a good level of scientific literacy and access to a range of high quality, science-related cultural and social resources. The students that had ‘high science capital’ were confident in their scientific skills, they had parents, family or friends that worked in science-related jobs and they were involved in science-related activities in their free time.

These students according to the researchers appeared to have significantly more positive attitudes, career aspirations towards and attainment in STEM subjects.

In an earlier project, the ASPIRES project (Archer et al., 2012) it was found that students (aged 10-14) who had more science-related resources at home (including parents with scientific qualifications or careers) were more likely to hold more positive attitudes towards science and to aspire a science-related career or to follow science post-16.

As opposed to the studies reviewed above, Logan and Skamp (2008) found no pattern for students’ attitudes towards school science and their parents’ views although a parental survey when the students were in year six (n=15; 75% response rate for one or both parents) indicated that most parents said that they liked science with seven stating that they particularly liked the practical aspects of science. However, it is important to keep in mind that only 15 parents have completed the survey and thus, it can be challenging to draw conclusions and find associations based on this sample.

Talton and Simpson (1985) found that the attitudes of peers towards science can impact on an individual’s attitude towards science. The authors suggest that a peer-influenced attitude towards science may increase during the transition from primary to secondary school and that this can have a ‘snow balling effect’ resulting in a ‘negative group attitude’ towards science although there is no attempt to justify their conclusions. A number of studies support the conclusions drawn by Talton and Simpson (1985) and Papanastasiou and Papanastasiou (2004) which were the positive correlations between peer and individual attitudes towards school science (Keeves, 1975; Simpson and Oliver, 1990; George 2000; George 2006). However, other studies, such as the ones conducted by Atwater et al. (1995) and Schibeci (1989) found no impact of the peer group on the attitudes towards school science of individuals.

2.3.7 The impact of gender on students' attitudes towards science

The impact of gender on students' attitudes towards school science has been the focus of a number of studies in the literature (Weinburgh, 1995b; Galton, 2002; Francis and Greer, 2006; Krapp and Prenzel, 2011; Sofiani et al., 2017; DfE, 2019; Hamlyn et al., 2020). The interest around how the gender may impact attitudes towards science is not new with Schibeci (1984) stating that of all the variables that may influence attitudes towards science, gender has generally been shown to have a consistent influence. Although that one would argue that the work by Schibeci is quite old and things might have changed since 1984, more recently, some researchers have argued that gender difference in attitudes towards school science may be the explanation behind the underrepresentation of women in STEM fields (Smeding, 2012; Else-Quest et al., 2013).

Weinburgh (1995) conducted a meta-analysis covering the U.S literature between 1970 and 1991 examining gender differences in students' attitudes towards school science. For their meta-analysis they used thirty-one studies representing the testing of 6753 students. The results of the analysis of gender differences in attitude indicated that boys showed a more positive attitude towards science than girls. Using the results of the included studies, it was also shown that when considering individual sciences, boys showed more positive attitudes towards all types of science than girls although, interestingly, there were no studies found in the field of chemistry and therefore, 'all types of sciences' for Weinburgh's study meant biology and physics. The effect of gender on attitudes was found to be stronger in physics than in biology.

Gail Jones et al. (2000) examined the attitudes towards school science of 437 students (from five schools) in their first year of secondary school in the U.S. The analysis of the results of the survey that students had to complete showed that there continued to be significant gender differences in attitudes and perceptions towards school science, science courses and careers with boys showing more positive attitudes than girls. Also, more girls than boys reported that science was difficult to understand and more boys reported that science was more suitable for boys. Similar findings were reported by Miller et al.(2006) who examined gender differences in 79 U.S high-school students' attitudes towards science classes, their perceptions of science and scientists and their views about majoring in science. Girls generally found science uninteresting and the scientific lifestyle (as perceived by them) unattractive.

Another study that was conducted in the U.S by Desy et al. (2011) showed that boys have more positive attitudes towards school science than girls with boys reporting greater enjoyment and motivation in school science although the difference was statistically significant only for the upper secondary students. The participants in the study consisted of 1299 students in lower and upper secondary school taking science classes at six different school districts in Minnesota. The participant students completed a questionnaire with 50 items measuring attitudes towards school science taken from the Attitudes Towards Science

Inventory (ATSI) and Attitude Towards Science in School Assessment (ATSSA). In addition to the difference in positive attitudes towards school science between boys and girls, girls reported a significantly higher level of anxiety towards school science than males; girls reported a significantly higher perception of the science teacher, while boys reported a significantly higher self-concept in science.

However, as opposed to the studies reviewed above, Sorge's study (2007) which was also conducted in the U.S showed that there is a large decrease in attitudes towards school science as students move from primary to secondary school with the descent in positive attitudes occurring for both boys and girls at an equal rate. The results of Sorge's study were in line with a study conducted quite recently in the U.S (Schpakow et al., 2021) which involved a sample of 450 participants from thirty-six classes from two different lower secondary schools in a suburban school district; the results indicated that boys' attitudes towards school science were not statistically significantly different from girls' attitudes. Also, boys desire to become scientists was found to be no different statistically from that of girls.

The difference in attitudes of boys and girls towards school science was also extensively studied in the UK. The study conducted in England by Barmby et al. (2008) examining students changing attitudes towards school science in secondary school indicated two main patterns emerging; students' attitudes towards school science sharply decline as students move through their secondary schooling and that this decline is more pronounced for girls than boys. More recently, Hampden-Thompson and Bennett, (2011) used the UK data from the 2006 PISA to explore the associations between student engagement with science and a range of factors (such as gender, teaching and learning activities and other school factors). Boys were found to have more positive attitudes to science than girls. Also, Bennett and Hogarth

(2009) analysing students' responses to attitudinal statements drew the conclusion that girls' attitudes towards school science were less positive than those of boys. Bennett and Hogarth's study was one of the few in the reviewed literature that explored students' attitudes towards separate sciences (biology, chemistry and physics). They found significant gender differences in the attitudes towards biology, chemistry and particularly physics, with girls showing more positive attitudes towards biology and boys showing more positive attitudes towards physics and, to a lesser extent, chemistry.

Looking at attitudes of students during the primary – secondary transition in the UK, Hamlyn et al. (2020) stated that most students in year 7-9 reported that they enjoyed science more at secondary school than they did at primary with more males students (72%) reporting that they found science interesting and that they enjoyed science at secondary school than girls (66%). When looking at the attitudes of students towards learning science at school, girls reported more barriers than males and were especially likely to say that they had been 'put off science' by factors related to difficulty, achieving good grades and the quantity of work involved. Boys, on the other hand, were twice as likely as girls to state that nothing had 'put them off learning science'. From year 10, girls and boys reported the same level of interest in science, however, girls were much less likely than males to think of themselves as 'good' in sciences.

The issue of gender inequality in attitudes towards school science between the genders, is not confined to the U.S and U.K. Reilly et al. (2019), reported the results from the 2011 TIMSS of year 8 students' achievement, attitudes and beliefs among 45 participating nations (261,738 students with a mean age of 14.60 years). The study used the data from the survey that the students had to complete in addition to the mathematics and science achievement test; the survey included a range of 4-point Likert-type items (agree a lot to disagree a lot without midpoint) measuring students' attitudes and self-efficacy beliefs towards mathematics and science. The items that were relevant to students attitudes towards science included statements that reflected students' interest and enjoyment of learning school science (such as: 'I learn many interesting things in science') while science self-efficacy items included statements that reflected students' perceptions of their competency in science (such as: 'I learn things quickly in science'). Generally, boys reported more positive attitudes towards learning science than girls with Japan, Taiwan, England and Oman showing the largest gender differences in attitudes towards learning science. Boys also reported higher self-efficacy in science than girls across nations despite there being no significant difference in global science achievement scores.

2.3.8 Summary

Research has shown that a range of factors affect the formation of students' attitudes towards school science and the decline of students' science attitudes in the primary-secondary transition. Studies have shown that students have high expectations of secondary science (Baird et al, 1990; Griffiths & Jones, 1994; Campbell, 2002; Braund & Driver, 2005), expecting to do more experiments, follow a more challenging curriculum and use more sophisticated equipment than in primary school. Where these expectations are not met, this may result to a decline in the positive attitudes towards school science. Teacher, teaching style and student-teacher relationship were also found to have a major impact on students' attitudes towards school science (George, 2000; Papanastasiou, 2002; Frenzel et al., 2009; Bennett, Braund, et al., 2013; Hadzigeorgiou et al., 2019). Research studies have also shown that practical work has a vital role in shaping students' attitudes towards school science with the majority of primary school students having generally positive attitudes towards practical work in the secondary science classroom (Jarman, 1993; Griffiths and Jones, 1994; Braund and Driver, 2005; Sharpe, 2015). Other factors affecting students' attitudes towards school science were found to be the transition from primary to secondary school (Galton et al., 2003; Tytler, 2007; Tytler et al., 2008; Sjøberg and Schreiner, 2010; Mansell, 2011), the science career aspirations and the importance of science for students' future careers (Galton et al., 2003; Tytler, 2007; Tytler et al., 2008; Sjøberg and Schreiner, 2010; Mansell, 2011; Bennett et al, 2013; Dewitt et al, 2014), the impact of family and friends (Osborne et al., 1998; Archer et al., 2011; Aschbacher et al., 2014; Archer et al, 2015; Hanley et al., 2020) and the impact of gender (Gail Jones et al., 2000; Sorge, 2007; Kind, Jones, Barmby, et al., 2007; Desy et al., 2011; Hampden-Thompson and Bennett, 2011; Reilly et al., 2019; Hanley et al., 2020).

2.3.9 Summary of the gap in literature

In line with research around the world (Galton, 2002; Else-Quest et al., 2013), Cyprus-specific literature (Papanastasiou, 2002; Mettas, 2006) shows that Cypriot students' attitudes towards school science is associated with their science achievement. Studies in Cyprus have also shown that students' attitudes towards school science are affected by teacher and teaching style and parents' attitudes towards science (Karagiorges 1986; Papanastasiou and Papanastasiou, 2004; Papanastasiou and Zembylas). However, this limited Cyprus-specific literature, has not explored whether Cypriot students' attitudes towards science change as they move from primary to secondary school or other factors (with the exception of parental and teacher influence) that impact the formation of these attitudes towards school science. Therefore, more research work in this area would be important in understanding Cypriot students' attitudes towards school science, what impacts them, if and how they change during the transition from primary to secondary school. The findings of such research could be utilised in developing and maintaining positive attitudes towards school science which could in turn lead to better science attainment and student participation after the post-compulsory stage. Additionally, looking at the Cyprus specific literature, all the work on attitudes is based on secondary data (such as using TIMSS data). In gaining a better understanding of Cypriot students' attitudes towards school science, it would be important to conduct research collecting primary data from students in Cyprus, both quantitative and qualitative to enable us to tap the depth and breadth of students' attitudes towards school science.

Furthermore, most of the research studies or reviews that were included in this literature review have looked at attitudes towards 'General science' (with the exception of Whitfield, 1980 and Bennett and Hogarth, 2009) and there was no distinction between the attitudes towards the three individual sciences. The difference in the nature and the content of the three sciences suggests that it might worth considering them more often as different subjects when exploring students' attitudes towards them. In Cyprus secondary schools (as explained in more detail in section 1.4), biology, chemistry and physics are taught as three different subjects and students have three different specialist teachers for each of the sciences as well as separate exams for each science subject. Therefore, we can presume that students can answer questions about separate sciences with confidence; examining attitudes towards separate sciences rather than towards 'science' would give us a better understanding of students' attitudes towards biology, chemistry and physics and allow for comparisons between the attitudes towards individual sciences.

Finally, as discussed in section 2.1.2 attitudes are considered by a number of authors as a multi-dimensional concept. However, in the reviewed literature (although I am aware that this is not an exhaustive list) there were no studies identified that were looking at the affective, cognitive and behavioural attitude components separately (with the exception of very few studies that either looked at only one of the components, usually the affective- these can be found in section 6.2). In understanding students' attitudes towards school science and how they change, it would be important to identify if students' attitudes differ by component (e.g. if they hold more positive affective attitudes than cognitive or behavioural attitudes for instance) and how these change (if they do) as students move from primary to secondary school. This would enable us to gain a better understanding of which attitude component the students are more positive about at different points in their academic journey (e.g. could it be that primary school students have more positive affective attitudes towards science because they enjoy doing experiments but as they move to secondary school they have more positive cognitive attitudes because science is perceived as important for their future and career?) The findings of such research could be taken into consideration when planning a curriculum aiming at maintaining students' positive attitudes towards school science.

Chapter 3: Methodology

This chapter includes eight sections, respectively introducing my research aims and research questions, research paradigm, methods, research design, development of the questionnaire and interview schedule, data analysis procedures, and ethical considerations.

3.1 Research aims and research questions

The purpose of this study is to examine Cypriot students' attitudes towards school science, whether they change as they move from primary to secondary school and what impacts the formation of these attitudes (in general) and the change in these attitudes (assuming the attitudes are changing as students move from primary to secondary school). The four research questions that guide this study are the following:

1. **What are Cypriot students' attitudes towards primary school science when they are in their final year of primary school (year 6)?**

Studies conducted around the world have shown that students have positive attitudes towards school science when they are in their final year of primary school and that a decline in students' positive attitudes towards science happens when students move from primary to secondary school (Galton, 2002; Logan and Skamp, 2008; Cézar and Pinto, 2017; Chrappán and Bencze, 2017b; Cermik, 2020). As this study aims to explore if Cypriot students' attitudes towards school science change when students move from primary to secondary school, this first research question will investigate what are Cypriot students' attitudes towards school science when they are still in primary school.

2. **What are Cypriot students' attitudes towards secondary school science when they are in their final year of primary school (year 6)?**

Research results (Murphy and Beggs, 2003; Linnenbrink-Garcia and Pekrun, 2011; Sammons et al., 2012; Liou, 2021; Jerrim, 2021) provide evidence that positive attitudes towards school science is a key predictor of students' science achievement, participation and their future career aspirations. Furthermore, studies indicate that if students enter secondary school with positive attitudes towards science, they will be more likely to study science post – compulsory or additional science courses (Papanastasiou and Zembylas, 2002). This second question aims to investigate what are the attitudes of primary school students towards secondary school science. More information about the reasons and motivation for the study which led to this second research question can be found in sections 1.1, 1.3 and 2.2.

3. **How do Cypriot students' attitudes towards school science change as they move from primary to secondary school?**

An extensive part of literature in developed countries such as the UK (Galton, 2002; Osborne, 2003; Jenkins and Nelson, 2005), USA (Fredricks et al., 2011) and Australia (Logan and Skamp, 2008), indicates that positive attitudes towards school science change in the primary – secondary transition. However, there is limited research in Cyprus in this area. The latest PISA (2015 and 2018) as well as the latest TIMSS (2015 and 2019) results bring Cyprus to the position of the worst performing European country in science. The existing research in Cyprus, relates positive attitudes to achievement (Mettas et al., 2006; Papanastasiou and Zembylas, 2004) but there is no attempt to investigate what these attitudes towards school science are or if there is a specific point during schooling when attitudes towards school science become increasingly less positive. Therefore, this third research question aims to find out if Cypriot students' attitudes towards school science change when they move from primary to secondary school and if they do, how? More on the existing literature -although limited- around Cypriot students' attitudes towards school science and the reasons that led to this research question can be found in section 1.5.

4. **What are the factors influencing Cypriot students' attitudes towards school science?**

Research studies reveal that a range of factors influence students' attitudes towards school science (in general) such as the amount and frequency of experiments, the teacher and teaching, students' career aspirations and importance of science in students' everyday life and their future, gender and the impact of family and friends (Logan and Skamp, 2008, Papanastasiou and Zembylas, 2002). Also, a range of factors was found in the literature to impact the change of the attitudes towards school science as students move from primary to secondary school. These factors include the high expectations that students have from secondary school science and the fact that they can be disappointed when these expectations are not met (Abrahams, 2007; Braund and Driver, 2005), the impact of the teacher and the teaching style (Frenzel et al, 2009; Hadjigeorgiou, 2019), the expectations of practical work in secondary school (Cleaves 2005; Logan and Skamp, 2006) and science career aspirations (Aschbacher, 2014; Mujtaba, 2018). Thus, this final research question aims to provide more information about the factors that affect Cypriot students' attitudes towards school science in general, and during the transition from primary to secondary school. More on the factors affecting students' attitudes towards school science in general and during the transition (such as the enjoyment of experiments, the importance of science for students' everyday life and their future studies and careers, the science teacher and science teaching, students' expectations of secondary science, parental attitudes towards science, parental education, peer attitudes towards science, gender) can be found in section 2.3.

3.2 Research paradigm

A paradigm can be viewed as an 'accepted model or pattern' (Kuhn, 1962, p.23), a deeper philosophical position linked to the nature of social phenomena and social structures. Morgan (2014) states that the latter directly relates a paradigm to research, as an epistemological stance.

Pragmatism is the theoretical framework that underpins this study; that is, the view that the most important determinant of the underlying research philosophy is the research question (Tashakkori and Teddlie, 2003; Biesta, 2015; Saunders et al., 2019). Pragmatism recognises that relationships that follow patterns can be altered and affected upon by human elements (Feilzer, 2010) while Collis and Hussey (2003) state that pragmatist researchers use whatever combination of methods necessary to find answers to the research questions.

Morgan (2014), explains that although the possibility of pursuing pragmatism as a paradigm in social research is not new (Gage, 1989) it has gained attention in the last years due to its frequent linkage with mixed methods research (Tashakkori and Teddlie, 2003; Bryman, 2006; Biesta, 2015). As Hall (2013) states, pragmatism offers 'an alternative epistemological paradigm' (p. 19) between the two opposing viewpoints: positivism and interpretivism.

Positivism and interpretivism are two extreme mutually exclusive paradigms. Positivism is the view that 'all genuine knowledge is based on sense experience and can be advanced only by means of observation and experiment' (Cohen et al., 2007, p.9). Researchers that adopt the positivistic approach believe that law-like generalities exist for human action and they suggest that findings would be generalisable to all similar situations and settings. Interpretivism requires researchers to interpret elements of the study and thus, interpretivism integrates human interest into a study. Accordingly, Myers (2008) suggests that interpretive researchers assume that access to reality (given or socially constructed) is only through social constructions such as language, consciousness, shared meanings, and instruments.

As a result, researchers such as Saunders et al. (2019), believe that choosing between one of the two opposing theoretical frameworks is somewhat unrealistic in practice. They also suggest that if the research question does not clearly indicate that either a positivist or interpretivist philosophy should be adopted, this confirms the pragmatist's view that it is appropriate to work with both philosophies and therefore both qualitative and quantitative methods are possible within one study.

Tashakkori and Teddlie (2003) state that pragmatism is a paradigm that advocates the use of mixed methods in research and encourages the researcher to consider both qualitative and quantitative viewpoints in their research; this paradigm focuses on 'what works' (p.713) as the truth regarding the research questions under investigation. Therefore, pragmatism 'rejects' (p.713) a position between positivism and interpretivism in the paradigm 'wars' (p.713). Morgan (2014) adding to this, explains that pragmatism presents a 'coherent philosophy that goes beyond 'what works'' (p. 1051) and which underlines the importance of combining beliefs and actions in a process of inquiry that underlies any search for knowledge such as research.

Tashakkori and Teddlie (1998) suggest that it is more appropriate for the researcher in a particular study to think of the philosophy adopted as a continuum rather than opposite positions. The authors, suggest that within a study, sometimes the researcher and the participants must be interactive, while others, the researcher can stand apart from what they are studying. In a research that has a pragmatist approach as a theoretical framework, a researcher can focus instead on what interest them and is of value to them, combine methods to answer their research question in a way they consider appropriate and use the results of their study to bring positive consequences and implications to their research area.

Therefore, pragmatism is in accordance with my research aims and my personal philosophical stance; in adopting a pragmatist framework, this research uses a mixed method approach combining qualitative and quantitative tools to collect data and it draws on ideas from qualitative and quantitative data and different groups of participants to give a better understanding of Cypriot students' attitudes towards school science.

3.3 Mixed-method approach in this study

According to Babbie (2010), quantitative methods emphasise objective measurements and the statistical, mathematical or numerical analysis of data collected using computational techniques. Quantitative research focuses on gathering numerical data and generalising it across groups of people to explain a particular phenomenon. In contrast to quantitative methods, the word qualitative implies an emphasis on the qualities of entities and on processes and meanings that are not experimentally examined or measured in terms of quantity, amount, and intensity or frequency.

Denzin and Licoln (2005), define qualitative research as a multimethod in focus which involves an interpretative approach to its subject matter; qualitative researchers, according to the two authors, study things in their natural settings, trying to understand or interpret phenomena from the perspective that people bring to them. This type of research involves data collection using a range of empirical materials that 'describe routine and problematic moments and meanings in individuals' lives' (Denzin and Licoln, 2005, p.2).

These two research methods (qualitative and quantitative) were historically distinguished and used separately, even though reports mention the use of combined qualitative and quantitative data within the same study by the Chicago School since 1963 (Fine, 1995). However, in the recent years, an alternative approach that proposes the use of qualitative and quantitative research methods in combination has been developed within social sciences research (Mcevoy and Richards, 2006; Freshwater, 2007; Denzin, 2010).

According to Tashakkori and Creswell (2007), since the use of mixed methods in research studies has become more widespread within social sciences various researchers have debated the concepts, methods and standards of quality of studies that use a combination of both qualitative and quantitative approaches in their research (Miles and Huberman, 1994; Caracelli and Greene, 1997; Tashakkori and Teddlie, 2003).

A number of researchers and authors expressed the concern that mixed methods approach is becoming a dominant approach in the methodological literature and they argue that the emergence of mixed methods has been so explosive that it is becoming synonymous of best practice and this might undermine the importance and quality of deep methodological expertise, especially in quantitative research methods (Ahmed and Sil, 2012; Freshwater, 2015). Commenting on quality, Hasse-Biber (2010) claims that mixed methods produce a quality that is unique beyond its qualitative and quantitative aspects and this can potentially lead to new, innovative approaches to mixed methods research.

However, Creamer (2020) believes that a growing number of studies utilise mixed methods, not because this practice is becoming the 'gold standard' (p.7) but because new researcher generations have pursued training that makes it possible for them to be open to more approaches apart from positivism and interpretivism; this new era of researchers find the idea of mixed methods appealing and logical as an increasing number of innovative examples of mixed methods has begun to become part of the published literature.

Sandelowski (2014) also states that mixed methods and mixed data is essential in many research approaches as the logic of mixing methods is central to understanding the conclusions of a study. Greene (2007) too, suggests that using mixed methods is 'fascinating', not with data consistency but with paradoxes that often arise when data from various sources are compared.

Creamer (2020) argues that a controversy in the topic of paradigms concerns that qualitative and quantitative approaches are incompatible. Creswell and Plano Clark (2011) and Tashakkori and Teddlie (2003) too, recognise the paradigm controversy as an ongoing one while Maxwell and Mittapalli (2010) characterise mixed methods as a 'philosophical oxymoron' (p.146) because it ignores the epistemologies behind quantitative and qualitative research which are said to be mutually exclusive. At the other extreme, researchers argue that the two approaches and paradigms can be combined because they share the same goal which is understanding the world in which we live and that they are compatible as they share the commitment of understanding and improving the world (Haase and Myers, 1988; King et al., 1994; Reichardt and Rallis, 1994). Moreover, several researchers suggest that qualitative and quantitative methods should be viewed as part of a continuum research which aims to answer a research question (Creswell, 2009; Johnson and Christensen, 2012; Daniel, 2016).

However, it appears that the debate and controversies do not only exist regarding the use of mixed methods in research but also within the definition of mixed methods itself. When reviewing the literature about mixed methods, Tashakkori and Creswell (2007) highlight that there are inconsistencies in the way that mixed methods are defined and they suggest that it is necessary to distinguish between mixed methods as a collection and analysis of qualitative and quantitative data (method) and mixed methods as the integration of qualitative and quantitative approaches to research (methodology). The authors review numerous studies and they define mixed methods as research in which **'the researcher collects and analyses data, integrates the findings and draws inferences using both qualitative and quantitative approaches or methods in a single study or a program of inquiry'** (p.4).

Paraphrasing the research questions (see section 3.1), this study aims to:

a) Identify what the Cypriot students' attitudes towards school science are
b) Find out if the attitudes of Cypriot students towards school science change as students move from primary to secondary school and
c) To probe deeper into why these attitudes are formed (in general) and why they change (if they do) as students move to secondary school.

It is, in my view, important to use a combination of quantitative and qualitative research methods to collect data for this research study. The quantitative method (questionnaires) will be used to get a general idea about what Cypriot students' attitudes towards secondary school science are and how they change as they move from primary school to lower secondary school. The qualitative methods (group interviews) will be used to gain an in-depth understanding about why these attitudes are formed and why they change (if they do) or maintained (if they do not change) as students move from primary to secondary school.

As my study involves data collection using both qualitative and quantitative tools (questionnaires and group interviews), data is analysed and results are integrated using both qualitative and quantitative approaches, it is in line with Tashakkori and Creswell (2007) definition of mixed methods.

3.3.1 A comparative cross – sectional study

Cohen, Manion and Morrison (2007), state that a cross-sectional study is one that produces a 'snapshot' (p. 213) of a population at a particular point in time. This type of study uses different groups of people who differ in the variable of interest but who share other characteristics (Wang and Cheng, 2020).

Comparative research essentially compares two or more groups in an attempt to draw a conclusion about them. Researchers identify and analyse similarities and differences between these groups (Esser and Vliegenthart, 2017). At any rate, comparative research is a research design with the use of which data from these groups is collected and compared (Allardt, 1990).

As explained later, in the research design section (3.4), the data collected for this study is collected from three different year groups (year 6, 7 and 8) at the same point in time with the aim of identifying their attitudes towards school science as well as comparing the attitudes towards school science between groups (e.g., Between year groups, boys and girls etc).

Therefore, the present study is a ***cross – sectional, comparative study*** as per the definitions included above (Allardt, 1990; Cohen, Manion and Morrisons, 2007; Esser and Vliegenthart, 2017; Wang and Cheng, 2020).

According to Cohen, Manion and Morrison (2007) a cross-sectional study can 'bear several hallmarks of a longitudinal study of parallel groups (e.g., year groups) which are drawn simultaneously from the population' (p. 213). Therefore, collecting data from year 6, 7 and 8 students at a single point in time would bear some characteristics of a longitudinal study in that change in attitudes over year groups could be identified, although of course, it would not have the same weight as if conducted on the same year group over time (e.g., by following the year 6 students in year 7 and year 8 to explore the attitude change). As mentioned earlier, cross-sectional studies 'capture' the attitudes at a specific point and this could be considered as a limitation in studies, like this one, that aim to study change. However, the 'two-phase' science transition in Cyprus (as explained in section 1.4 and 3.4.1), means that a longitudinal study would involve collecting data over a period of about three years (following a year 6 student to year 7 and then year 8); this would be very challenging due to the time pressure in analysing the collected data and in producing the work and the thesis. To ensure that the data collected would enable the researcher to study the change in attitudes in the primary – secondary transition, the number of students involved and the number and type of schools involved were carefully considered to allow generalisations (Lietz and Keeves, 1997).

Cross-sectional research was chosen not only because it is less 'time-costly' but also because it can allow a large-scale data collection and representative sampling (Cohen, Manion and Morrison, 2007). Another important advantage of cross-sectional research is that it can limit the control effects (such as environmental factors, personal bias, unpredicted changes such as the COVID pandemic which changed, for instance, how lessons were taught) as students participate in the study only once. According to Gorard (2001) this is one of the main limitations of longitudinal studies that face a thread to internal validity which arises from the need to 'test and re-test the same individuals' (p. 86). A cross-sectional study also minimises the possibility of changing attitudes as a result of taking part in the research. For instance, in the case of a longitudinal study, students that will take part in the first interview might change their attitudes to school science because they feel that they must have positive attitudes if they were especially chosen to take part in the interview process (Hawthorn effect- Mccambridge et al., 2014). Additionally, cross –sectional data collection increases the likelihood of participation as it only occurs once (Wang and Cheng, 2020).

Spector (2019), states that there is perhaps no research design more used than the cross-sectional design; he notes that researchers using this design typically note how their conclusions are limited and it is common for them to discount the conclusions of their own study. However, he supports that although a longitudinal study is accepted as the 'superior' (p. 125) research design, its ability to reflect causality has been overstated and that it offers limited advantages over the cross-sectional design in most cases in which it is used. As the author explains, from a philosophy of science perspective, cross-sectional designs can provide evidence for relationships among variables and can be used to eliminate many potential alternatives for these relationships. Additionally, they suggest that if the cross-sectional process is optimised by including variables carefully controlled to rule out spurious relationships, incorporating experimental methods and adding alternative sources of data, it can tell us as much that is of value as the longitudinal study which is not necessarily superior in providing evidence for causation.

3.3.2 Rationale for using questionnaires

Questionnaires are defined by Brown (2001) as an instrument that gives participants a series of questions to answer or statements to respond to. This response could be in the form of writing a number, checking a box, marking a page on paper or online. Questionnaires are frequently used to collect data related to participant's background and demographic information, to report their behaviours, express their attitudes, opinions or factual knowledge, their future intentions or aspirations and to determine their psychometric properties (Young, 2016). In educational research, questionnaires are valued as tools in collecting data to measure students' attitudes, beliefs and practices and they enable the researcher to collect information that students can report about themselves such as their attitudes, beliefs and motivations about learning or their reactions to learning and classroom activities (Denscombe, 2003; Mackey and Grass, 2005; Young, 2016; Xerri, 2017).

Questionnaires with closed-ended questions (such as the ones used in this study) where the respondent is answering the researcher's formulation (assuming that the respondent is engaged and answering all the questions) can help us explore the attitudes towards school science when students are in primary school compared to when they move in secondary school. It can also enable us to collect data about what factors impact the formation of students' attitudes towards school science or lead to an attitude change during the transition from primary to secondary school (for example the enjoyment of experiments, the importance of science for students' everyday life and their future studies and careers, the science teacher and science teaching, students' expectations of secondary science, parental attitudes towards science, parental education, peer attitudes towards science, gender).

Using a questionnaire as a research instrument also provides potential for anonymity and a high return rate (Denscombe, 2003), a general freedom from bias on the part of the researcher and the possibility of directly linking the research question and the results from the questionnaire analysis (Geisinger, 2010). Judd, Smith and Kidde (1991) add to the above, the ease of data coding and analysis for interpretation of the results with Munn and Drever (2004) adding that questionnaires with close-ended questions can make analysis 'reasonably straightforward' (p.5) Many authors seem to agree with this argument as they support the view that questionnaires are easily converted into statistical databases and they can be used to draw conclusions with statistical support, compare the differences between groups (such as the difference in attitudes between boys and girls or between the different year groups), to create scales and sub-scales for statistical analysis and collect a larger sample (Munn and Drever, 1990; Denscombe, 2003; Munn and Drever, 2004; Archenti, 2007; Spooren et al., 2007; Pozzo et al., 2019).

However, some researchers believe that questionnaires tend to provide a thin description of whatever is being investigated and they have a rather restricted scope of the collected data as well as a limited response flexibility (Cohen, Manion and Morrison, 2007). Reid (2006) suggests that rich detail is lost in such methods and warns, that questionnaire data could possibly lead to a superficial understanding of complex ideas while Knight (2002) emphasises that while questionnaires are good at providing information about attitudes, motivation and accounts of behaviour, interviews are 'far better at exploring these things in depth, learning about the informants' perspectives and about what matters to them' (p.89).

As the many advantages of using questionnaires in data collection (such as the potential for a higher sample to be collected, the generalisability of the results and the range of possibilities of analysing the data to draw conclusions) is recognised by a number of researchers (Munn and Drever, 1990; Judd et al., 1991; Denscombe, 2003; Munn and Drever, 2004; Archenti, 2007; Spooren et al., 2007; Pozzo et al., 2019), the present study will use questionnaires to collect data in regards to students' attitudes towards school science. However, as this comparative, cross – sectional study attempts to tap both the breadth and depth of participants' attitudes towards secondary school science, if, how and ***why*** they change as they move from primary to secondary school, it employs both a quantitative questionnaire as well as qualitative group interviews with a small group of students from each school alongside the questionnaires. The reason that group interviews are chosen as a qualitative tool to collect data is discussed in the next section.

3.3.3 Rationale for using student group interviews

As discussed above, the use of questionnaires can allow a larger sample to be analysed and this enables the generalisation of the results of a study while the number of participants in interviews is restricted due to the time cost of interviewing. This makes interview a method better for in-depth work with fewer people (Arksey and Knight, 1999).

Drever (1995) explains the reasons that interviewing is one of the most common methods used in small-scale educational research. According to the author (Drever, 1995), interviewing is a flexible technique, suited to a wide range of purposes that can be a helpful tool in gathering 'high-quality data' (p.2) about people's circumstances and in exploring in depth their experiences, attitudes, motivations and reasoning. Cohen, Manion and Morrisons (2007) also describe interview as a 'flexible tool for data collection' (p. 349) which allows verbal, non-verbal, spoken and heard sensory channels to be used.

To collect qualitative data, group interviews with students were conducted in this study. Watts and Ebbutt (1987) explain that group interviews are very useful in cases when a group of people have a common purpose and they suggest that this type of interview can lead to discussions that can result to a wide range of responses. Arksey and Knight (1999) point out that a group interview can provide the opportunity to the participants to complement each other, add points and thus, create a more complete and reliable record. According to Cohen, Manion and Morrison (2007), group interviews are particularly useful, when interviewing children as it enables a child to interact with other children during the interview rather than simply respond to an adult's questions. Furthermore, Eder and Fingerson (2003) suggest that children, in an one-to-one interview might feel that they have less power compared to the adult and this might make them feel less confident and less comfortable. The authors suggest that group interviews help overcoming this, as children might be less intimated than in individual interviews, they feel they are given a voice and they feel more comfortable. This view is also supported by Morrison (2013) and Irwin and Johnson (2005). Lewis (1992) also found that group interviewing children provides the potential of them challenging each other and encourages them to extend each other's ideas and introduce new ideas in a way that may not happen in an individual adult-child interview. Other advantages of group interviewing students, which are particularly important for the present research bearing in mind the time pressures mentioned earlier, include: practical and organisational advantages as group interviews can be timesaving compared to the individual ones which often take more time (Cohen, Manion and Morrison, 2007).

A number of authors however, highlight the limitations of group interviews. Arksey and Knight (1999) state that a group interview may result in one respondent dominating over the others and that some respondents might be quieter compared to others. Watts and Ebbutt (1987) too, believe that group interviews can lead to participants withholding information as this type of interview can create a group dynamic that may discourage an individual with a different opinion from speaking out in front of the other participants. Eder and Figerson (2003) provide evidence that indicates that individual interviews may be more valuable than group ones if the research focus involves sensitive matters such as relationships, family, body issues. However, as the research focus of the present study is students' attitudes towards science, the interview questions will concern students' ideas, beliefs and opinions about school science, how they feel about school science, which are not considered as too sensitive. Also, to overcome the limitations mentioned above, I (the researcher) carefully considered the characteristics of the students brought together for the purposes of the group interview. For instance, I ensured approximately equal numbers of boys and girls in each group, as research indicates that girls might feel less confident to share their views and ideas if there are more boys in the group and that boys might have the tendency to dominate over girls in a group discussion (Arksey and Knight, 1999). I also ensured that I was vigilant during the group interview, picking up on people who were trying to speak and giving all the students the chance to speak. Finally, I made sure that the students were put at their ease – always started the group interview process with a chat and less challenging questions so the participants feel more comfortable. The number of participants per group interview (more on sampling and data collection to be found in section 3.4.2), allowed me to remember the participant names; using the participant names helped with ensuring participation from everyone as well as made the participants feeling more comfortable.

3.4 Data collection and sample

The present study investigates Cypriot students' attitudes towards school science; what are they, if and how they change as they move from primary to secondary school. It also explores the factors that impact the formation or change of these attitudes in general and during the transition. To answer the research questions a comparative, cross- sectional study was conducted in which data was collected from a group of year 6 students (summer term of their final year in primary school), a group of year 7 students (summer term of their first year in secondary school) and a group of year 8 students (summer term of their second year in secondary school). At this point it is quite important to remind the reader that the main reason the 'secondary student' data is collected from both year 7 and 8 is that the science transition in Cyprus is a 'two-phase transition'. In primary school, students are taught 'science' (all the three sciences: biology, chemistry and physics) while in the first year of secondary school (year 7) they are only taught biology. Chemistry and physics are both introduced in year 8 (this is explained in section 1.4 in more detail). This is the main reason that data is collected from year 8 students as well; to capture the attitude change towards secondary science (if there is an attitude change) as collecting data only from year 7 would potentially consider only students' attitudes towards biology and not all the three sciences.

The data collection included questionnaires completed by all the students in each year (whose parents have consent) and semi-structured group interviews with a smaller group of students in each year. Questionnaires were collected from 161 year 6 students that attended 5 different primary schools (rationale for school choice can be found in section 3.4.3), and 378 secondary school students (192 in year 7 and 186 in year 8) that attended two different secondary schools (for which the primary schools were feeder schools). More information about the data collection using questionnaires can be found in section 3.4.1 below. On the same day that questionnaires were completed by the year 6, 7 and 8 cohort, a smaller group of students (34 students) were chosen to participate in group interviews with the researcher (18 year 6 students from the five primary schools, eight year 7 students and eight year 8 students from the two secondary schools). More information about the data collection using group interviews can be found in section 3.4.2 below. Data were collected at the end of summer term (June 2019) for all the three year groups and it involved students between 11-13 years old.

3.4.1 Data collection using questionnaires

The data collected using questionnaires occurred by the simultaneous distribution of a questionnaire to three different groups of students (year 6, year 7 and year 8 students). The table below gives information about the data collected by questionnaires from each year group and school. The response rate was excellent in most schools with most of the parents consenting for their children to participate in the study. Schools PA, PB and PC were fully subscribed (with 75 children in year 6) and therefore, the response rate was more than 50%. PD had 25 students in year 6 so for this school too, more than 50% of the students have completed the questionnaire. Primary school PE had 45 students on roll in year 6 but only 8 students returned their consent forms.

The participants had to complete a paper questionnaire during their normal science lessons. It took around 15 minutes for the participants to complete the questionnaire; I was there for the duration of filling in the questionnaire to answer any questions that emerged. The distribution of the questionnaire occurred in the summer term of year 6, 7 and 8 students.

All the five primary schools were feeders to the two secondary ones and therefore, student characteristics were similar (to allow comparisons).

Table 3.4-1 The number of questionnaires collected from each primary and secondary school

School	Number of questionnaires collected
Primary	
PA	46
PB	60
PC	40
PD	15
PE	8
Total	161
Secondary	
SA	
Year 7	80
Year 8	74
SB	
Year 7	82
Year 8	84
Total	378

3.4.2 Data collection using student group interviews

The same day that the questionnaires were administered to the year 6, 7 and 8 students in each school a smaller number of students were invited to participate in a group interview. The selection of students for the group interviews was decided with the contribution of class teachers in each primary school and science teachers in each secondary school. The researcher has asked the class teachers/science teachers to choose a number of students (based on the number of questionnaires completed in each school) that have different views of science (some that liked science, some that did not, some that have a neutral opinion), a range of abilities (higher, lower, medium ability in science), range of SEN status, range of backgrounds and equal number of boys and girls. As class teachers knew their students better than the researcher, this enabled the participation of students with a range of views, abilities and equal participation of boys and girls. Also, teachers' contribution enabled the participation of students of different backgrounds, SEN, ethnicity (as far as possible as most students in Cyprus are Greek Cypriots).

Initially, it was planned for the researcher to choose students that would be invited to the group interviews based on their questionnaire responses. However, this would require a preliminary analysis of the questionnaires to identify the students that would be invited to the group interviews and this would mean that there should be a time space of three weeks to one month between the questionnaire collection and the group interviews. Due to time constraints this was not possible as the summer term in secondary schools is a very short one (Easter 2019 was in April and schools closed in early May with loads of revision for the final exams in between) so it was not possible to visit the secondary schools more than once.

The 34 students (18 year 6 students, eight year 7 students and eight year 8 students) were interviewed in groups (as explained in section 3.3.3). Each interview was audio-taped (with permission), transcribed, and then analysed to find the emergent themes (section 3.7.2). The following table (3.4-2) provides information about the number of students interviewed in each school per year group while table 3.4-3 summarises the data collection methods used to answer each of the research questions of this study.

Table 3.4-2 The number of interviews conducted in each participant school

Year Group	Number of interviewees per school	Total number of group interviews conducted	Total number of interviewees
Year 6	PA- 6 PB - 4 PC - 4 PD - 2 PE- 2	5	18
Year 7	SA – 4 SB –4	2	8
Year 8	SA – 4 SB – 4	2	8

Table 3.4.2 Summary of the data collection methods used to answer the research questions

Data collection method		
Research Question	**Student Questionnaires**	**Student Interviews**
1. What are Cypriot students' attitudes towards primary school science when they are in their final year of primary school (year 6)? **2. What are Cypriot students' attitudes towards secondary school science when they are in their final year of primary school (year 6)?**	Used to identify the attitudes of students towards school science and to collect data ***about the number*** of students that have certain attitudes.	Used to identify the attitudes of students towards school science and to collect data ***about why*** students have certain attitudes towards .school science.
3. How do Cypriot students' attitudes towards school science change as they move from primary to secondary school?	Used to determine if attitudes towards secondary school change and ***to find out the percentage*** of students whose attitudes change as they move from primary to secondary school. Also, used to compare the attitudes of primary and secondary school students towards secondary school science.	Used to determine if attitudes towards secondary school change and to ***provide a better understanding*** of ***why*** these attitudes change.
4. What are the factors influencing Cypriot students' attitudes towards school science?	Used to identify the factors that impact the formation of students' attitudes towards school science and the change in attitudes as students move from primary to secondary school.	Used to identify the factors that impact the formation of students' attitudes towards school science and the change in attitudes as students move from primary to secondary school and ***to provide a better, deeper understanding*** of ***how and why*** each factor contributes to the attitude formation or attitude change.

3.4.3 Rationale for school choice and students' ages

An important consideration in deciding the type of schools to be selected for inclusion in the study was, to ensure that they are 'typical' representatives of state schools in Cyprus. By the term 'typical' we mean they have around the average number of students attending and they are comprehensive state schools so private schools were avoided. The main reason to include comprehensive state schools for the study is that the majority of students in Cyprus are taught in comprehensive schools and using such schools in the study would allow generalisations that could apply to most students in comprehensive schools throughout Cyprus. More specifically, there are 314 state comprehensive primary schools and 70 lower secondaries in Cyprus whereas there are only 29 private schools that offer both primary and secondary education (MoEC, 2016); 82.2% of the Cypriot students are taught in state comprehensive schools and only 17.8% are in private schools (Adamou, 2013). Also, for this study, my interest is only in state schools as private schools are different in character (e.g., they follow a curriculum that is different to the Cyprus curriculum).

The data were collected from five primary comprehensive state schools, three in urban areas and two in rural areas and two lower secondary schools, one in an urban area and one in a rural area. This school sampling was to ensure that students from different areas and different socioeconomic backgrounds were involved in the study. The reason for choosing three urban primary schools compared to two rural primary schools is that there is a greater number of primary students in urban areas and fewer in rural areas. According to Adamou (2013) who describes the educational profile of Cyprus, 69.2% of primary school students attend an 'urban' primary school and 30.8% attend a 'rural' primary school and therefore, by choosing three urban and two rural primary schools we would potentially be able to generalise the results of this study. All the schools that were included in the study were mixed schools as there are no single-sex schools in Cyprus.

One of the aims of this study was to examine attitudes of students towards school science in the primary-secondary school transition. Thus, the study involved collecting data from year 6, year 7 and year 8 students (students of 11-13 years of age).

3.5 Development of questionnaire items

The questionnaire developed for this study was used to collect background and categorical and ordinal data (e.g gender, ethnicity, parental education) via multiple-choice questions and involved Likert-type items on topics related to attitudes towards school science, attitudes towards science experiments, parental influence, parental and peer attitudes towards science, science aspirations, expectations of secondary school science. The response option for the attitude items was on a five –point scale from 'strongly disagree' to 'strongly agree' with 'neither agree nor disagree' as a midpoint.

Gardner (1996), states that when thinking about creating an attitude scale, one should keep in mind that a set of questions intended to measure the same construct should be used in order to greatly increase the reliability of the scale. Furthermore, having a limited set of meaningful (to the pupils) statements is regarded as crucial (Kind et al, 2007). Therefore, some statements in the questionnaire developed for this study, were adopted from existing, previously tested and validated questionnaires that have been proven to work with pupils (Kind, Jones, Barmby, et al., 2007; Sjøberg and Schreiner, 2010; DeWitt et al., 2011). These instruments are 'What do you think of science?' (Kind et al., 2007); the Relevance of Science

Education (ROSE) questionnaire (Sjøberg and Schreiner, 2010); 'High aspirations but low progression' (DeWitt et al., 2011). The developed questionnaire was piloted with 16 primary and secondary school students and appropriate changes were made (more information about the questionnaire piloting can be found in section 3.5.1, 3.5.2 and Appendix XV).

When selecting the items to include in the developed questionnaire from the previously tested and validated instruments mentioned above, the following were taken into consideration.

- There has been a lack of clarity over the term attitude (Osborne et al., 2003; Kind et al., 2007). As discussed in the literature review chapter (see section 2.1), attitudes are considered by a number of researchers, as a multi-dimensional concept, consisting of the affective, cognitive and behavioural dimension. Therefore, when selecting items, from the instruments mentioned above, it was ensured that a combination of affective, cognitive and behavioural items was included, to ensure that the scale was suitable to measure all three attitude dimensions adequately.
- The need to clearly define 'science' for the purpose of the present study as, looking at, for example students' attitudes towards school science is different to looking at students' attitudes towards science outside school, or students' attitudes towards scientists (Ramsden, 1998). As the purpose of the developed questionnaire was to measure students' attitudes towards school science, the selected items were carefully chosen to include items that explicitly referred to students' attitudes towards school science.
- The need to develop an instrument that would provide data which would allow the research questions to be answered. The research questions (please see section 3.1)

focus on identifying students' attitudes towards primary and secondary school science and how they change and on the factors that affect these attitudes. Therefore, the items selected from the validated instruments were the ones, based on the literature review (see chapter 2), that were useful in answering the research questions.

Additional scales or items were developed for the constructs and items of interest for which existing instruments were not sufficient, drawing on the literature (Galton and Hargreaves, 2002; Osborne et al., 2003; Murphy and Beggs, 2003; Barmby, Per M. Kind, et al., 2008; Bennett and Hogarth, 2009) and the discussions with students following the piloting of our questionnaire. The additional items covered mainly questions relevant to students' expectations of science in secondary school when students were in year 6 (such as 'I think I will like science in year 7', 'I think science will be more exciting in year 7' etc) and comparative items when students were in year 7 and 8 ('I like science more this year than in year…', 'Science is more interesting this year than in year…' etc).

Table 3.5-1 gives a visual breakdown of the year 6 questionnaire showing the validated source for each of the questionnaire items, the attitude domain, the research question that it is relevant to and other original literature source. Most of the questions in year 7 and year 8 questionnaires were very similar to the year 6 items, taken from the validated sources mentioned earlier (with the year 8 attitude items slightly altered to measure attitudes towards the individual sciences – please see appendix XI for more information).

Table 3.5-1 The development of the questionnaire -the example of the year 6 questionnaire

	Attitude Domain	Research Question	Source
1. I really enjoy science this year	Affective	RQ1	Wider literature
2. Science lessons are fun	Affective	RQ1	Kind et al., (2007)
3. Science lessons are interesting	Affective	RQ1	Kind et al., (2007)
4. I look forward to my science lessons	Affective	RQ1	Kind et al., (2007)
5. I would like to do more science at school.	Behavioural	RQ1	Kind et al., (2007)
6. Science lessons are boring	Affective	RQ1	Kind et al., (2007)
7. Science lessons are hard	Cognitive	RQ1	Sjøberg and Schreiner (2010)
8. I am good at science	Cognitive	RQ1	Kind et al., (2007)
9. I get good marks in my science tests	Cognitive	RQ1	DeWitt et al., (2011)
10. Science is one of my best subjects	Affective	RQ1	Sjøberg and Schreiner (2010)
11. Practical work in science lessons is exciting	Affective	RQ1	Kind et al., (2007)
12. I look forward to doing experiments in my science lessons	Affective	RQ1	Kind et al., (2007)
13. I like watching TV programmes about science.	Behavioural	RQ1	DeWitt et al., (2011)
14. I would like to study science at University	Behavioural	RQ4	DeWitt et al., (2011)
15. I think that science is an important subject.	Cognitive	RQ4	Sjøberg and Schreiner (2010)
16. I would like to have a job working with science	Behavioural	RQ4	DeWitt et al., (2011)
17. My parents like science	Sig. others	RQ4	DeWitt et al., (2011)
18. My parents think that science is important	Sig. others	RQ4	DeWitt et al., (2011)
19. My parents think that I should study science at University	Sig. others	RQ4	DeWitt et al., (2011)
20. My friends like science	Sig. others	RQ4	DeWitt et al., (2011)
21. I am really looking forward to doing science in Year 7	Affective	RQ2	Wider literature
22. I think science in secondary school will be more interesting than primary school	Affective (Comparative)	RQ2	Wider literature
23. I think science in secondary school will be more fun than this year	Affective (Comparative)	RQ2	Wider literature
24. I think that we will be doing more interesting experiments in secondary school than this year	Affective (Comparative)	RQ2	Wider literature
25. I think that we will be using better equipment in our science experiments in secondary school than this year	Cognitive (Comparative)	RQ2	Wider literature
26. I think that my science teacher in year 7 will have better knowledge of science than my year 6 teacher	Cognitive (Comparative)	RQ2	Wider literature
27. I think we will learn science in more detail in year 7 than in year 6	Cognitive (Comparative)	RQ2	Wider literature
28. I think I will really like science lessons in year 7	Affective (Comparative)	RQ2	Wider literature
29. I don't think I will enjoy science lessons in year 7	Affective (Comparative)	RQ2	Wider literature

3.5.1 Piloting the questionnaires

Although the current study did not make use of self- designed questionnaires, piloting of the questionnaires was necessary as some items were added to the tested and validated instruments used to develop the questionnaire for this study (see section 3.5 above). Also, the developed questionnaire had to be translated from English (which is the language that was originally written in) to Greek, therefore, it was important to check the clarity of instructions and translated questions. The full rationale for piloting the questionnaire can be found in Appendix XV.

The pilot questionnaire was completed by 16 primary and secondary school students (eight primary and eight secondary school students) of mixed gender, science ability (as suggested by teachers) and background and therefore, their profile was as similar as to the research participants as possible. The pilot study was conducted about three months before the first administration of questionnaires (winter term 2019) to allow time for the necessary changes to the instruments. More information about the selection of students that participated in the pilot can be found in Appendix XV.

3.5.2 Findings of the questionnaire piloting

The table below shows the changes in the questionnaire following the questionnaire pilot. A more detailed description of the processes followed during piloting and how they led to the changes below can be found in Appendix XV.

Table 3.5-2 Changes in the questionnaire following the questionnaire pilot

Issue:	**Action**
Questions were spaced too close to each other, causing some participants to miss a line.	Reformatting
Boxes were placed too close together made it difficult for them to identify the one they would like to tick	Reformatting
Lack of numbering	Questions were numbered
Students were not sure about what kind of degrees their parents have	An additional choice for 'I don't know what is the highest qualification my father/mother has completed' was added
Question 6: 'I like science better than other subjects at school'	Changed to: 'Science is one of my favourite subjects'.

3.6 Development of the interview schedule for students' interviews

The group interviews covered the same topics as the questionnaires (attitudes towards school science and how they change as students move from primary to secondary school, and factors affecting this) with the year 7 and year 8 interviews altered slightly compared to the year 6 ones to include questions about the transition to secondary school, comparisons between primary and secondary school (concerning science), comparisons between attitudes towards primary and secondary science.

The interview schedule was developed by drawing on previously validated interview instruments (Gogolin and Swartz, 1992; Colette Murphy and Beggs, 2001; Raved and Ben-Zvi Assaraf, 2011; Kastrup and Mallow, 2016) and then piloted. These instruments were: 'Attitudes towards Science learning among 10th- Grade students: A qualitative look (Raved and Ben-Zvi Assaraf, 2011); A Quantitative and Qualitative Inquiry into the Attitudes toward Science of Non-science College Students (Gogolin and Swartz, 1992); 'How do students view science?'(Kastrup and Mallow, 2016); Pupils' attitudes, perceptions and understanding of primary science (Colette Murphy and Beggs, 2001).

Perspectives informing the interview schedule were also provided by literature on attitudes to science (Kind, Jones, Barmby, et al., 2007; Owen et al., 2008; Sjøberg and Schreiner, 2010; DeWitt et al., 2011). The existing instruments that had been previously tested and validated were drawn upon in creating prompts for the pilot interviews. However, some interview questions of these validated instruments were aiming to explore students' attitudes towards school *in general*; these questions were adapted to the research questions of this study which concern science. Similarly to the questionnaires, drawing on the literature and the discussions with students following the pilot group interview, for the interview questions that were to find out about the constructs and items of interest for which existing instruments were not sufficient (such as expectations of students' of secondary science and comparisons between year groups), additional items were developed.

The main known factors affecting the students' attitudes towards secondary science in the primary-secondary transition, as discussed in detail in the literature review section are: the change of school setting, approaches to teaching, practical work, career aspirations, attitudes of significant others towards science, gender and students' expectations of secondary school science. These six themes were used to inform the interview schedule which can be found in the Appendices (Appendix XII and XIII).

3.6.1 Piloting the interviews

Articles report that pilot studies are commonly associated with quantitative approach to test of a particular research instrument (e.g. a questionnaire) rather than qualitative approach (Kim, 2010; Majid et al., 2017). However, while reviewing the literature, it was noted that there was a range of literature studies retrieved, that were relevant to piloting qualitative research instruments, discussing the importance of piloting qualitative tools and the role that these play in developing the main study (Padgett, 2008; Harding, 2013; Castillo-Montoya, 2016; Dikko, 2016; Mikuska, 2017; Malmqvist et al., 2019). The full rationale for piloting the questionnaire can be found in Appendix XVI.

Six students (three boys and three girls) were involved in the pilot group interview. Two students (one boy and one girl) were (at the time of piloting) in year 6, two students (one boy and one girl) where in year 7 and two students (one boy and one girl) in year 8. The students selected were of mixed ability in science and they were all from different schools (that were not the same as the ones involved in the study). The pilot interview took place in my science classroom in the school I am currently working.

Piloting the group interviews was a very valuable experience that enabled the reflection on the interview schedule and led to the improvement and further development of the interview. Furthermore, it gave me the opportunity to practice and develop my skills as an interviewer.

3.6.2 Findings of the interview piloting

The table below shows the changes in the interview schedule following the interview pilot. A more detailed description of the processes followed during piloting and how they led to the changes below can be found in Appendix XVI.

Table 3.6-1 Changes in the interview schedule following the interview pilot

Initial Question:	**Changed to:**
What would you like to do when you leave school?	Are you planning to go to University once you leave school? What job (if you know) would you like to do?
Give an example of a science subject that you feel is important.	Removed
Some people say that only the people who want to become scientists should study science. Do you agree with this statement?	Removed
Do you expect science to be better in secondary school than primary school?	Do you expect science to be different in secondary school than primary school?
Do you like your science teacher?	Is your science teacher different to your primary school teacher? Why? How?
What do you do in your free time?	Did you attend science fairs/did you go to science museums? (How often?)' Do you watch science TV programs with your family? (How often?)'

	'Do your parents have any science books?/Do your parents watch science TV programs? (How often?)

3.7 Methods of data analysis

3.7.1 Questionnaire analysis

The analysis of the questionnaire data involved inputting and analysing a sample of 539 questionnaires (161 from primary school students and 378 from lower secondary students).

Information about the questionnaires collected from each year and each participant school can be found in table 3.4-1.

Initially, students' responses to the items in each of the components were identified by looking at each question and 'agreement level' of each student with each statement. These were coded (strongly disagree =1, disagree =2, neither agree or disagree =3, agree=4, strongly agree = 5). Most of the items on the questionnaire were positively worded so a higher score showed a higher agreement with the statement and therefore, more positive attitudes. The negatively phrased items were reverse-coded for the purpose of the analysis of the results.

The data collected from questionnaires were analysed by descriptive statistics using SPSS 27.0 (Bryman and Cramer, 2001). Descriptive statistics enabled the data to be described and summarised in a meaningful way such that patterns emerged from the data (Chapter 4). Descriptive statistics are very important as raw data is very hard to visualise and it is rather important to be able to present and interpret the data in a simple way. However, descriptive statistics do not allow for conclusions to be made beyond the data analysed or to reach conclusions regarding any hypotheses that might have been made (Holcomb, 1998). Therefore, the questionnaire data were analysed using both descriptive and inferential statistics.

Descriptive statistics were used to summarise the data gathered from students' responses to demographic questions such as age, gender and parents' education level. Frequencies were also calculated for individual questionnaire items related to students' perceptions and attitudes towards their science lessons and school science. Inferential statistics were used for hypothesis testing. Independent and paired sample T-tests were performed at the significance level of .05 to determine whether there were significant differences between the means of two given groups (e.g. between boys and girls or the difference in year 6 students' attitudes towards year 6 and year 7 school science) and the effect size (Cohen's d). Also, ANOVA tests were performed at the level of .05 to determine whether there were significant differences between the means of three or more independent groups (e.g. the effect of parents' education level on students' attitudes towards school science or the effect of the school year on students' attitudes towards school science, the differences in attitudes between the affective, cognitive and behavioural domain, the differences in attitudes towards biology, chemistry and physics) and the effect size. Finally, Spearman rank order correlation was used to identify any association and the direction of this association between two variables measured on at least an ordinal scale (e.g. to indicate whether there is an association between students' attitudes towards school science and their parents' or friends' attitudes towards science).

3.7.1.1 Creating the 'Attitudes towards school science' scale

Students' attitudes towards school science were measured using the 'Attitudes towards school science' scale. To create this scale all the questions on each year's questionnaire measuring students' attitudes towards school science in their current academic year (e.g 'I like science this year', 'I think my science lessons are interesting this year') were used to create an 'Attitude towards school science' scale for every year. Therefore, there were three developed scales (one for each year) which were: 'Attitudes of primary school students towards primary science', 'Attitudes of year 7 students towards year 7 science' and 'Attitudes of year 8 students towards year 8 science'. Please refer to figure 3.7-1 for more details about the questionnaire breakdown.

The comparative statements that required students to compare their current school science experience with previous years or their expectations from school science the following year (e.g 'I think my science lessons are more fun this year than last year', 'I think my science lessons will be more interesting next year than this year') were excluded from the scales as well as questions that were more relevant to the attitudes of the participants' significant others (such as family and friends) rather that the attitudes of the participants themselves (eg 'My parents think science is important', 'My friends like science'). These questions that were excluded from the 'Attitude to science scale' were used in the analysis for comparing the attitudes of students towards science each year and to investigate the impact of significant others on the formation of students' attitudes towards school science.

The items included in each 'Attitude to science scale' were:

- Primary school students' attitudes towards primary school science: *Questions 1-16 from the year 6 questionnaire (Appendix IX)*

- Primary school students' attitudes towards secondary school science: *Questions 21-29 from the year 6 questionnaire (Appendix IX)*
- Year 7 students' attitudes towards year 7 science: *Questions 1-16 & 21 from the year 7 questionnaire (Appendix X)*
- Year 8 students' attitudes towards year 8 science: *Questions 1-26 from the year 8 questionnaire (Appendix XI)*

The figure below gives a visual overview of how the questionnaires break down (using the year 6 questionnaire as an example. There is also a column that describes the attitudinal statement as 'affective', 'cognitive', 'behavioural'. This categorisation was done based on the literature around attitudes and their multi-dimensional nature (see section 2.1.2).

Figure 3.7-1 Visual break down of the year 6 questionnaires

Question	Type of question
1. I like Science.	Affective
2. Science lessons are fun.	Affective
3. Science lessons are interesting.	Affective
4. I look forward to my science lessons.	Affective
5. I would like to do more science at school.	Behavioural
6. Science lessons are boring.	Affective
7. Science lessons are hard.	Cognitive
8. I am good at Science.	Cognitive
9. I get good marks in Science tests.	Cognitive
10. Science is one of my best subjects.	Affective
11. Practical work in science is exciting.	Affective
12. I look forward to doing experiments in my science lessons.	Affective
13. I like watching TV programmes about Science.	Behavioural
14. I would like to study science in the University.	Behavioural
15. I think that Science is an important subject.	Cognitive
16. I would like to have a job working with science.	Behavioural
17. My parents like science.	Significant others
18. My parents think that science is important.	Significant others
19. My parents think that I should study science in the University.	Significant others
20. My friends like science.	Significant others
21. I really look forward to science in Year 7.	Comparative
22. I think science in Year 7 will be more interesting than this year.	Comparative
23. I think science in Year 7 will be more exciting than this year.	Comparative
24. I think that we will be doing more interesting experiments in year 7 than this year.	Comparative
25. I think that we will use better equipment in Year 7 than this year.	Comparative
26. I think that my Science teacher in Year 7 will have better knowledge of science than my Year 6 teacher.	Comparative
27. I think that we will be learning science in more detail in secondary school than in primary school.	Comparative
28. I think I will really like science lessons in year 7	Comparative
29. I don't think I will enjoy science lessons in year 7	Comparative

Q1-16
'Attitude to Year 6 Science' scale

Q17-20
Questions about the attitudes of the family and friends of the participants

Q21-29
Questions comparing year 6 students attitudes towards year 6 and year 7 science

3.7.1.2 Summary of the reliability analysis

Prior to creating the three new scales (measuring the attitudes of students towards school science in each year) and to calculating the means, the internal consistency of the scales was assessed performing scale reliability tests to find out how closely related the set of items (that were going to be used in each scale) were as a group (George and Mallery, 2003). All the questions that were negatively worded were reverse-coded prior to creating the new scales and before determining the Cronbach's alpha coefficients.

In addition to the three new scales, there was a number of sub-scales such as the ones created to measure the attitude of year 8 students towards individual sciences (biology, chemistry, physics) and the ones looking at individual attitude domains (affective, behavioural, cognitive). Table 3.7-1 summarises the reliability analysis for the scales and sub-scales that were created.

Table 3.7-1 Summary of Reliability Analysis

Scale	Number of scale items	Cronbach's alpha	Corrected item-total correlation range
Main Scales			
Primary school students' attitudes towards primary school science.	16	.93	.406-.830
Primary school students' attitudes towards secondary school science	9	.93	.216-.637
Year 7 students' attitudes towards year 7 science	17	.93	.401-.832
Year 8 students' attitudes towards year 8 science	26	.92	.317-.637
Sub-scales			
Year 8 students' attitudes towards Biology	6	.88	.472-.777
Year 8 students' attitudes towards Chemistry	6	.87	.614-.748
Year 8 students' attitudes towards Physics	6	.87	.612-.767
Year 6 students' affective attitudes	8	.90	.530-.849
Year 7 students' affective attitudes	8	.92	.560-.823
Year 8 students' affective attitudes	12	.89	.370-697
Year 6 students' cognitive attitudes	5	.78	.401-.679
Year 7 students' cognitive attitudes	5	.77	.468-633
Year 8 students' cognitive attitudes	10	.87	.318-772
Year 6 students' behavioural attitudes	4	.78	.350-745
Year 7 students' behavioural attitudes	4	.78	.417-718
Year 8 students' behavioural attitudes	3	.80	.407-803

As shown on table 3.7-1, for the items included in the main scales, Coefficient alpha (which can take any value between 0 and 1) was higher than .92 for all the scales. For the items included in the sub-scales, Coefficient alpha was higher than .77. These, show low measurement error and high reliability (George and Mallery, 2003; Gliem and Gliem, 2003). According to Gliem and Gliem (2003) the closer Coefficient alpha is to 1 the greater the internal consistency of the items in the scale.

Corrected item-total correlations were also calculated to find out the correlation between scores on the items and the coefficient alpha if items were removed from the scale. All of the items had a good item-total correlation value in the range of .30-.70 (with only one slipping below 0.30) which shows that the items included in the scales were correlated well with the rest of the scale (de Vaus, 2004). Therefore, none of them was removed from the new scales and sub-scales created.

In summary, the work included in this section, shows that the questionnaire scales were working well in terms of reliability.

3.7.2 Interview analysis

3.7.2.1 Using combined thematic analysis for the interview

The method of analysis chosen for the interview data was a thematic approach analysis. Thematic analysis is a method used widely in analysing interviews (Jugder, 2016) to identify, analyse and report patterns or themes within the data. Thematic approach can lead to an insightful analysis which answer the research questions and facilitate the investigation of the data from two perspectives: a data – driven perspective and a research question perspective (Braun and Clarke, 2006). The data- driven perspective refers to a perspective based on inductive coding. Inductive coding is the coding based on little or no predetermined theory, structure or framework and this leads to the development of emergent themes within the data (Williams, 2008). The research question perspective refers to checking whether the collected data are consistent with the research questions and if they provide sufficient information to answer the research questions (Jugder, 2016).

Therefore, identifying themes in the collected interview data is a key consideration. According to Braun and Clarke (2006), a theme captures the key idea about the data in relation to the research questions. It can be a patterned response or a response that has a meaning within the collected data. Stemler (2001), discusses two approaches to the thematic analysis of data: ***a priori*** coding where codes are created beforehand and applied to the text and ***emergent*** coding where codes are drawn from the text. A number of other researchers, too, explain that themes within the data can be identified in an inductive 'bottom up' way or in a theoretical, deductive 'top down' way (Boyatzis, 1998; Braun and Clarke, 2006; Jugder, 2016).

Thomas (2006), states that an inductive approach allows research findings to emerge from the frequent or dominant themes without the restraints imposed by structured methodologies. He claims that inductive approach serves three purposes: i) to condense extensive raw data into a summary format ii) to establish clear links between research objectives and findings iii) to develop a model or a theory using the evidence in the raw data.

Blair (2015), states that the a priori coding or the 'top-down' system is using concepts drawn from the key literature while the 'emergent' or 'bottom up' coding system helps reflecting on the key concepts that are found in the participant data and thus, sometimes it might worth adopting a combined approach. Jugder (2016) also acknowledges that a priori and emergent approaches are interactive in certain ways because the research keeps a specific interest in identifying themes influences by the theoretical framework. Ritchie and Spencer (1994) suggest that when analysing interview data a researcher should ideally be drawing upon a priori themes informed by the original research aims and emergent issues raised by the respondents themselves. According to Williams (2008), emergent themes are 'a basic building block of inductive approaches to qualitative social science research and are derived from the lifeworlds of research participants through the process of coding' (p. 248). Certain qualitative researchers support that emergent themes can lead to generalisable theories while others use emergent themes to provide rich and detailed insight into the interviewees' experiences and to identify a different emphasis in the data (Bazeley, 2009).

Themes emerge from the close analysis of the data source; in the present study this is the interview transcripts. Williams (2008) points out that to prepare for the development of the themes from research data or to identify any emergent themes, researchers need to start by engaging with the data through interactive reading, which facilitates the analysts' connection with the data. Ritchie and Spencer (1994) too, suggest that one of the most important stages in identifying any emergent themes is the stage of 'familiarisation' during which the researcher becomes familiar with the range and diversity of the collected data and they gain an overview of the body of the material gathered. As I have been involved in all of the data collection, I have formed an idea of the key issues and emergent themes, however, it was still very important to set this firmly in context and to gain a feel for the material as a whole. The familiarisation process 'involves immersion in the data' (Ritchie and Spencer, 1994, p. 9). According to Marshall (1999), emerging themes are developed by studying the transcripts repeatedly and considering possible meanings and how these fit with developing themes while Elliott and Gillie (1998) state that rigorous and systematic reading and coding of the transcripts allow major themes to emerge.

Therefore, it was important for me as a researcher during this familiarisation stage, to spend time listening to recordings and reading transcripts to review all the material.

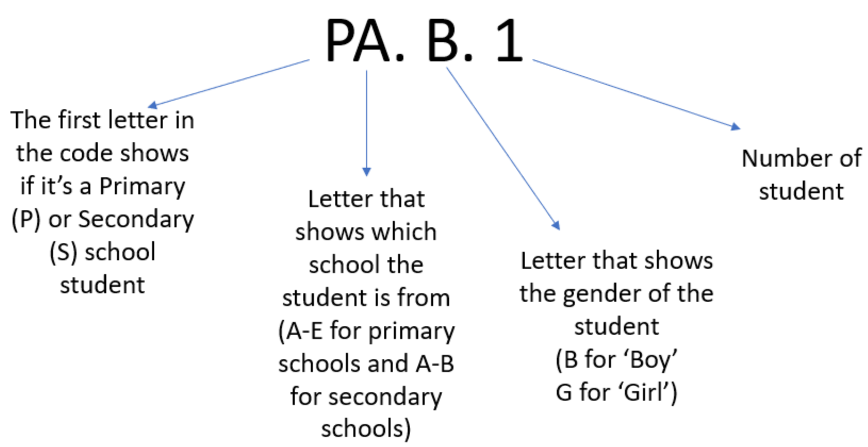
For the analysis of the interview data of the present study, a combined approach -both a priori and emergent data approaches- was used (Thomas, 2003; Braun and Clarke, 2006; Frith and Gleeson, 2011; Blair, 2015; Judger, 2016). The analysis of the interview data started with a range of a priori themes (using pre-applied codes from the literature around students' attitudes towards school science) such as 'science lessons are fun', 'science lessons are interesting', 'science lessons are important'. A number of themes emerged from the data and were also used in the qualitative analysis such as 'like to be actively involved in experiments', 'teachers are strict'. The a priori and emergent themes were then organised in sections for the presentation of the results. More information about how this was done can be found at the start of chapter 5 and in diagram 5.1-1.

The identification of both the a priori and emergent themes within the data was done manually (without the use of software). An example of how this was done can be found in Appending XIV.

3.7.2.2 The coding system for respondents

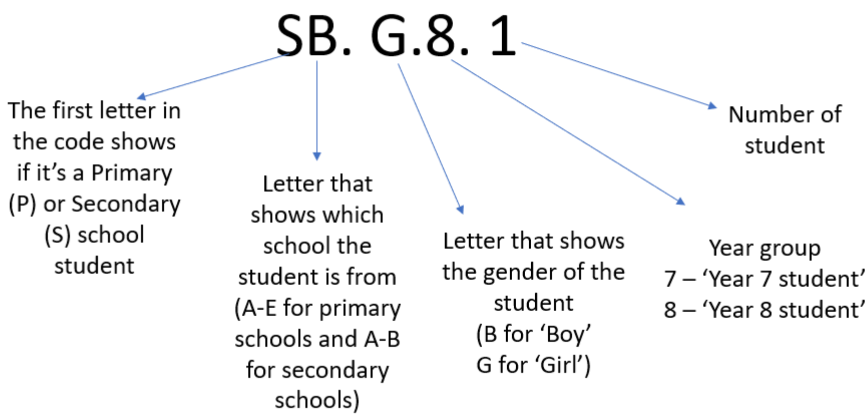
When referring to students' quotations in the analysis of the interviews, a coded name which ensured anonymity whilst also allowing connections between the schools and the year group was given to the student in question. The code begins with the code for the school, followed by the gender and a number. An example of a coded name used for a primary school student is the one below:

Figure 3.7-2 Example of the coded name used for a primary school student



When referring to secondary school students, the code is very similar with the addition of the year group (to identify year 7 and year 8 students) in the code before the number of the student in question. An example of a code used for a secondary school student is seen below.

Figure 3.7-3 Example of the coded name used for a secondary school student



The table below contains information about the codes used for each one of the primary and secondary schools that participated in the study.

Table 3.7-2 Codes used for the participant primary and secondary schools

Code	**Meaning**
PA	Primary School A
PB	Primary School B
PC	Primary School C
PD	Primary School D
PE	Primary School E
SA	Secondary School A

SB	Secondary School B
PB.B.1	***Example code for students***: Boy from Primary school B
SA.G.7.2	***Example code for students:*** Girl from year 7 in Secondary School A.

3.8 Ethical considerations

The basic ethical principle about data collection that, ′no harm should come to the respondents as a result of their participation in the research′ (Oppenheim, 1992, p.82), will be taken into consideration during the conduction of this research. Also, the belief that educational researchers should operate within an ethic respect of any persons – including themselves-involved in the study. Participants in the study should be treated fairly, sensitively and with dignity and freedom from prejudice (BERA, 2018).

According to Cohen, Manion and Morrisons (2007) the questionnaire 'is an intrusion into the life of the respondent' and therefore, data collection using questionnaires should be handled with sensitivity and responsibility. The authors (Cohen, Manion and Morrisons, 2007) also suggest that interviews 'have an ethical dimension; they concern interpersonal interaction and produce information about the human condition' (p.382).

The procedures suggested by the British Educational Research Association, BERA (2018) will be followed as guidelines in terms of the responsibilities to participants and in dealing with the ethical issues. BERA's guidelines 'are designed to support educational researchers in conducting research to the highest ethical standards in any and all contexts' (p.1).

The procedures followed are all included in Appendix XVII where they are briefly described; they were more extensively discussed in a separate document submitted to the University of

Leeds as part of the ethical approval application which has been approved (Reference: AREA 16-107). Furthermore, an ethical review which was submitted to the MoEC in Cyprus was also approved, meaning that the study was meeting the ethical and safeguarding criteria for educational research in Cyprus.

Chapter 4: Findings of Questionnaire Analysis

The aim of this study is to examine Cypriot students' attitudes towards school science. To do so, the study involved collecting and analysing data from 538 questionnaires completed by primary and secondary school students; the results are presented in this chapter. A total of 538 questionnaires were completed by students in year 6 (N=161), year 7 (N=191) and year 8 (N=186). The data obtained from the questionnaires was analysed using SPSS 27.0 (Bryman and Cramer, 2001) and the results were used alongside the data collected from group interviews with students (results presented in chapter 5) to answer the research questions.

The presentation and analysis of the questionnaire data in this section aims to answer the research questions which are discussed in detail in section 3.1.

At this point, it might be important to state that throughout this chapter, the terms students and participants are interchangeable as the collection only involved students and therefore, they were the only participants in this study.

More information about how the items for each questionnaire were created and how the questionnaire items were used to create a scale for each year – the 'Attitude towards science' scale which was used to measure how positive the attitudes of students towards science were and for comparisons across the years can be found in section 3.7.1. In the same section, can be found the process followed to create all the new scales and sub-scales used in the analysis as well as the reliability analysis for them.

This chapter starts with a summary of the participants' characteristics. The second section presents descriptive statistics related to students' perceptions and attitudes towards their science lessons and school science. To understand how attitudes change as students move from primary to secondary school and the factors that affect students' attitudes towards science, inferential statistics are used for analysis in the third section. The last section focuses on the domains of attitudes (affective, cognitive and behavioural) and the differences between them.

4.1 Analysis using descriptive statistics

4.1.1 Characteristics of the participants

The collected data included some demographic characteristics of the participants, their attitudes towards their sciences lessons, their comparisons regarding science at their current academic year with previous years (for secondary school students) and their expectations of their science lessons next year (for primary school students).

Table 4.1-1 presents data on the participants, including their academic year group.

Table 4.1-1 Descriptive Summary of Participants' Demographic data

	Boys (N=277)	Girls (N=261)	Total (N=538)
Year 6	91 (57%)	70 (43%)	161
Year 7	99 (52%)	92 (48%)	191
Year 8	87 (47%)	99 (53%)	186
Total Participants	277 (52%)	261 (48%)	538

Tables 4.1-2 and 4.1-3 show the education level of the parents of the participants. This data is used later in section 4.3.3 where one-way ANOVA testing is used to provide evidence for the impact of parents' education level on students' attitudes towards science.

Table 4.1-2 Education level of the participants' father

	Primary education	**Secondary Education**	**Undergraduate**	**Postgraduate**	**Total number**	**Don't know**
Year 6 N=161	1 (1%)	55 (43%)	57 (45%)	14 (11%)	127	34 (21%)
Year 7 N=191	2 (1%)	91 (61%)	46 (31%)	10 (7%)	149	42 (22%)
Year 8 N=186	4 (3%)	74 (54%)	38 (28%)	21 (15%)	137	49 (26%)

The collected data show that the highest education level completed by most secondary school students' fathers is secondary education. For year 6 students, most fathers have completed a university degree. It is important to note however that more than 20% of students in each year were not aware of the education level of their father so they chose the 'I don't know' option from the list.

Table 4.1-3 Education level of the participants' mother

	Primary education	**Secondary Education**	**Undergraduate**	**Postgraduate**	**Total number**	**Don't know**
Year 6 N=161	1 (1%)	46 (35%)	68 (52%)	15 (12%)	130	31 (19%)
Year 7 N=191	2 (1%)	59 (39%)	62 (40%)	31 (20%)	154	37 (19%)
Year 8 N=186	3 (2%)	58 (39%)	51 (34%)	36 (25%)	148	38 (20%)

The data on table 4.1-3 show that the highest education level completed by most students' mothers is a university degree. Similarly to father's education, about 20% of students in each year were not aware of the education level of their mother so they chose the 'I don't know' option from the list. Comparing the two tables, we can see that a higher percentage of mothers than fathers have completed a higher education level (such as undergraduate or postgraduate).

4.1.2 Year 6 students' attitudes towards science

Table 4.1-4 shows the percentage of year 6 students that agree, neither agree or disagree or disagree with questionnaire statements using a five-point scale (1=strongly disagree, 2=disagree, 3=neutral, 4=agree, 5=strongly agree). Most of the items on the questionnaire were positively worded so a higher score showed a higher agreement with the statement and therefore, more positive attitudes. Negatively phrased items were reversed coded for the purpose of the presentation of these results. For instance, for the question 'Science is boring' on the table below the original mean was 3.27; this was reverse coded to 2.73 (i.e. 6-3.27). The same process was followed for all the negatively worded items.

To make it easier for conclusions to be drawn and to identify positive and less positive attitudes towards certain aspects of students' science lessons, the percentage for the 'disagree' and 'strongly disagree' responses were combined (see 'disagree' below on table 4.1-4) as well as the 'agree' and 'strongly agree' responses (see 'agree' below on table 4.1-4).

Looking at table 4.1-4 we can see that the majority of year 6 students state that they find their science lessons interesting (77%) and important (55.9%). Most students find practical work in year 6 science lessons exciting (87%), and they are looking forward to doing experiments in their science lessons (83.3%). The results also show that most students are not planning on studying science at university (56.5%) or to work in a science-related discipline (51.6%). In fact, only 19% of year 6 students stated that they would like to study science at university and have a science-related career.

When thinking about their science lessons next year (in year 7) the vast majority of year 6 students think that they will like science in year 7 (86.9%) and that they will do more interesting experiments (83.2%) using better equipment (87.6%).

Table 4.1-4 Overview of the Y6 students' responses to the questionnaire

N=161	Disagree (%)	Neutral (%)	Agree (%)	Mean	Median	SD
1. I really enjoy science this year	18.6	38.5	42.9	3.35	3.00	1.09
2. Science lessons are fun	26.1	32.9	41	3.19	3.00	1.13
3. Science lessons are interesting	6.8	16.3	77	4.09	4.00	.99
4. I look forward to my science lessons	42.2	33.5	24.2	2.71	3.00	1.23
5. I would like to do more science at school	51.5	26.1	22.4	2.57	2.00	1.27
6. Science lessons are boring	43.5	28.6	27.9	2.73	3.00	1.32
7. Science lessons are hard	34.2	38.5	27.3	2.83	3.00	1.07
8. I am good at science	22.4	28.0	49.7	3.37	3.00	1.11
9. I get good marks in my science tests	21.1	28.6	50.3	3.45	4.00	1.17
10. Science is one of my best subjects	53.4	19.3	27.4	2.70	2.00	1.36
11. Practical work in science lessons is exciting	3.1	9.9	87	4.45	5.00	.82
12. I look forward to doing experiments in my science lessons	1.2	15.5	83.3	4.37	5.00	.79
13. I like watching TV programmes about science	32.3	26.1	41.6	3.11	3.00	1.31
14. I would like to study science at University	56.5	24.2	19.3	2.43	2.00	1.22

15. Science is an important subject	11.8	32.3	55.9	3.60	4.00	1.05
16. I would like to have a job working with science	51.6	29.2	19.3	2.53	2.00	1.19
17. My parents like science	21.7	41.0	37.3	3.24	3.00	1.09
18. My parents think science is important	14.2	33.5	52.2	3.57	4.00	1.08
19. My parents think that I should study something to do with science at University	48.4	33.5	18	2.53	3.00	1.10
20. My friends like science	48.5	29.8	21.7	2.56	3.00	1.25
21. I really look forward to science in year 7	31	24.8	44.1	3.19	3.00	1.34
22. I think that science will be more interesting in year 7 than this year	7.4	19.3	73.3	3.98	4.00	1.02
23. I think that science will be more fun in year 7 than this year	13	25.5	61.5	3.65	4.00	1.11
24. I think that we will do more interesting experiments in year 7 than this year	1.8	14.9	83.2	4.14	4.00	.78
25. I think we will use better equipment in our experiments in year 7 than this year	1.8	10.6	87.6	4.28	4.00	.75
26. I think that my year 7 science teacher will have better knowledge of science than my year 6 teacher	12.4	21.1	66.4	3.76	4.00	1.10
27. I think we will learn science in more detail in year 7 than in year 6	6.8	10.6	82.6	4.12	4.00	.98
28. I think that I will really like science in year 7	1.2	11.8	86.9	4.27	4.00	.74
29. I don't think I will enjoy science in year 7	82.6	15.5	1.9	1.86	2.00	.81

***1 = Strongly disagree, 2= Disagree, 3=Neutral, 4=Agree, 5=Strongly agree**

The mean score for individual questionnaire items (that concerned attitudes towards year 6 science) and the overall mean for the 'Primary school students' attitudes towards primary school science' scale are shown on Table 4.1-5. This table, shows in descending order, the means of only the questions that were used to create the 'Primary school students' attitudes towards primary science' from the data previously presented on table 4.1-4. It also shows each item's categorisation as affective, cognitive and behavioural (based on the multi-dimensional model of attitudes as described in section 2.1.2).

Overall, primary school students' attitudes towards primary school science were found to be positive (i.e above neutral with M=3.27, SD= .79). The mean for most of the questions was higher than '3' (between 'neutral' and 'agree'). Students gave the highest scores (and therefore have shown the most positive attitudes) in the questions about practical work and experiments in science: 'Practical work in Science is exciting' (M=4.45), 'I look forward to doing experiments in my science lessons' (M=4.37). According to the results students also agree that science lessons are interesting (M=4.09). For these three statements, students' score was higher than 4 (between 'agree' and 'strongly agree').

The examination of the corrected item-total correlations of the items of this scale showed that the lowest value was .406 (Table 4.1-5). As a result, it can be stated that the distinctiveness of each item was high and that the scale had appropriate construct validity (Field, 2005). The summary of the reliability analysis and details about Cronbach's alpha for each created scale can be found in section 3.7.1.

Table 4.1-5 Descriptive Statistics of year 6 participants' responses to questions measuring their attitudes towards primary science showing the means in descending order. (N = 161)

Item number	Domain	Questionnaire item	Mean	Median	SD	Corrected item-total correlation
11	Affective	Practical work in science is exciting	4.45	5.00	.82	.507
12	Affective	I look forward to doing experiments in my science lessons	4.37	5.00	.79	.548
3	Affective	We learn interesting things in science lessons	4.09	4.00	.99	.571
15	Cognitive	Science is an important subject	3.60	4.00	1.05	.562
9	Cognitive	I get good marks in science tests	3.45	4.00	1.17	.541
8	Cognitive	I am good at science	3.37	3.00	1.10	.704
1	Affective	I really enjoy Science this year	3.35	3.00	1.09	.830
2	Affective	Science lessons are fun	3.19	3.00	1.13	.727
13	Behavioural	I like watching TV programmes that are related to science	3.11	3.00	1.31	.406
4	Affective	I look forward to my science lessons	2.71	3.00	1.27	.795
11	Affective	Science is one of my best subjects	2.70	2.00	1.36	.810
5	Behavioural	I would like to do more science at school	2.57	2.00	1.27	.760
16	Behavioural	I would like to have a job working with science	2.53	2.00	1.19	.668
14	Behavioural	I would like to study science in University	2.43	3.00	1.22	.663
6	Affective	Science lessons are boring*	2.27	3.00	1.32	.710
7	Cognitive	Science lessons are hard*	2.17	3.00	1.07	.433
		'Overall attitudes towards Y6 Science' Mean	**3.27**		**0.79**	

Note: 1=Strongly disagree, 2=disagree, 3=Neutral, 4=Agree, 5=Strongly agree
* Negatively phrased statement so reverse coded here.

Table 4.1-6 below shows the mean scores for the year 6 questionnaire items that were used to collect data about primary school students' attitudes towards year 7 science and what they expected from their year 7 science lessons. The higher the mean, which could be a score between 1 and 5, the higher the agreement level with the statement and therefore, the more positive the attitudes of students.

Table 4.1-6 Descriptive Statistics of year 6 participants' responses to questions measuring their attitudes towards year 7 science with means in descending order. (N = 161)

Item number	Questionnaire item (N=161)	Mean	Median	SD	Corrected item-total correlation
25	I expect that we will use better equipment in our science experiments in year 7 than in year 6	4.28	4.00	0.75	.593
28	I think I will really like science in year 7	4.27	4.00	0.74	.557
24	I expect that we will do more interesting experiments in year 7 than in year 6	4.14	4.00	0.78	.693
26	I think that we will learn science in more detail in year 7 than in year 6	4.12	4.00	0.98	.501
22	I think that science will be more interesting in year 7 than in year 6	3.98	4.00	1.02	.709
26	I believe that my science teacher in year 7 will have better knowledge of science than my year 6 science teacher.	3.76	4.00	1.10	.280
22	I believe that science will be more exciting in year 7 than in year 6	3.65	4.00	1.11	.531
21	I really look forward to doing science in year 7	3.19	3.00	1.34	.531
29	I don't think I will enjoy science lessons in year 7*	1.86	2.00	0.81	.632
	'Overall attitudes towards Y7 Science' Mean	**3.95**		0.63	
	Note: 1=Strongly disagree, 2=disagree, 3=Neutral, 4=Agree, 5=Strongly agree * Negatively phrased statement – reverse coded				

These results show that year 6 students hold positive attitudes towards secondary school science as the mean for all of these items was higher than '3' with four items scoring a mean higher than '4' (which is between the 'agree' and 'strongly agree' option). Students' attitudes were positive towards all the aspects related to science experiments in year 7, e.g. 'I expect that we will be doing more interesting experiments in year 7 than in year 6 (M= 4.14), 'I expect that we will use better equipment in our science experiments in year 7 than in year 6' (M=4.27). Even though their response to 'I really look forward to doing science in year 7' scored an M=3.19 which tends to be more towards the 'neutral' option on the scale (this could be due to factors such as students feeling nervous about secondary science, their secondary science teacher etc but this is further discussed in chapter 6 – 'Discussions') they seem to mostly agree that 'Science in year 7 will be more interesting than in year 6' (M=3.98) and that they will 'Learn science in more depth and detail in year 7 than in year 6' (M=4.12). Overall, students were positive towards science in year 7 (M=3.95, SD=.63) particularly agreeing with statements such as 'I think I will really like science in year 7' (M=4.27) and disagreeing with the negative worded item 'I don't think I will enjoy science lessons in year 7' (M=1.86 before reverse-coding).

The results provide evidence that primary school students have more positive attitudes towards secondary school science (M=3.95) than they do to primary school science (M=3.27) while they are still in primary school. The paired t-test which was performed to compare the two means shows a mean difference of 13.4% on the 5-point scale (Table4.1-7); the difference was found to be statistically significant ($p<0.001$) and with a large (Cohen's d =1.1) effect size (Chen et al., 2010;Wuensch,2015).

Table 4.1-7 Comparison between primary students' attitudes towards primary and secondary school science. (N = 161)

Items compared	Mean	SD	Mean diff.	SD	Std. Error Mean	t	df	Sig.	Cohen's d
Year 6 students' attitudes towards Y6 science	3.27	.79	0.67	0.63	0.50	13.48	161	<.001	1.1
Year 6 students' attitudes towards Y7 science	3.95	.63							

4.1.3 Year 7 students' attitudes towards science

Table 4.1-8 is an overview of the data collected from the year 7 student questionnaire. The 191 year 7 students who completed the questionnaire were from two secondary schools for which the primary schools that participated in the study were feeder schools (see section 3.4.1 for more details on data collection using questionnaires).

As for year 6 data, the percentages for the disagree/strongly disagree and agree/strongly agree were combined for the purpose of conclusion drawing.

The majority of year 7 students state that they like science (56.7%), that their science lessons are interesting (81.3%), that they find practical work in their science lessons exciting (80.3%) and that they are looking forward to doing practicals in their science lessons (77.6%). Even though they seem to have positive attitude towards most aspects of their science lessons, the majority of students (similarly to year 6s) state that they do not want to follow a science related path in university (54.2%) or as their future career (53.7%).

When comparing their lessons this year (in year 7) with their lessons last year (in year 6), the majority of students find this year's lessons more interesting (68.8%) and more fun (64.1%). Most students believe that their experiments are more interesting (66.2%) and more fun (53.6%) this year than last year and that the equipment they use in experiments is better than the equipment they used to use in primary school (77.6%).

Table 4.1-8 Overview of the Y7 students' responses to the questionnaire

N=192	Disagree (%)	Neutral (%)	Agree (%)	Mean	Median	SD
1. I really enjoy science lessons this year	15.1	27.6	56.7	3.60	4.00	1.18
2. Science lessons are fun	22.9	27.1	50	3.32	3.50	1.17
3. Science lessons are interesting	5.7	13.0	81.3	4.12	4.00	.94
4. I look forward to my science lessons	28.1	38.0	33.9	3.07	3.00	1.13
5. I would like to do more science at school	45.8	25.0	29.1	2.79	3.00	1.33
6. Science lessons are boring	53.2	21.4	25.5	2.69	2.00	1.33
7. Science lessons are hard	30.3	37.0	32.8	3.04	3.00	1.09
8. I am good at science	10.4	33.3	56.3	3.62	4.00	1.05
9. I get good marks in my science tests	16.7	30.2	53.1	3.57	4.00	1.19
10. Science is one of my best subjects	38.6	27.1	34.4	2.98	3.00	1.19
11. Practical work in science lessons is exciting	5.2	14.6	80.3	4.17	4.00	.99
12. I look forward to doing experiments in my science lessons	9.4	13.0	77.6	4.10	4.00	1.14
13. I like watching TV programs about science	40.1	27.1	32.8	2.85	3.00	1.35
14. I would like to study science at University	54.2	21.9	23.9	2.51	2.00	1.39
15. Science is an important subject	10.9	17.2	71.8	3.89	4.00	1.09
16. I would like to have a job working with science	53.7	25.5	20.8	2.46	2.00	1.33
17. My parents like science	21.9	45.8	32.3	3.14	3.00	1.07
18. My parents think science is important	13.1	35.4	51.5	3.58	4.00	1.07
19. My parents think that I should study something to do with science in University	46.4	31.3	22.4	2.61	3.00	1.24
20. My friends like science	36.5	38.5	25.0	2.78	3.00	1.26
21. I like science lessons in year 7	23.9	28.1	47.9	3.35	3.00	1.32
22. I think that science lessons are more interesting in year 7 than in year 6	14	17.2	68.8	3.83	4.00	1.28
23. I think that science lessons are more fun in year 7 than in year 6	15.6	20.3	64.1	3.78	4.00	1.26
24. I think that we are doing more interesting experiments in year 7 than in year 6	16.2	17.7	66.2	3.80	4.00	1.28
25. I think that we are doing more fun experiments in year 7 than in year 6	23.9	22.4	53.6	3.49	4.00	1.28

26. I think we are using better equipment in our experiments in year 7 than in year 6	8.9	13.5	77.6	4.13	4.00	1.08
27. I think that my year 7 science teacher has better knowledge of science than my year 6 teacher	8.3	15.1	76.6	4.15	5.00	1.10
28. I think we learn science in more detail in year 7 than in year 6	5.7	17.2	77.1	4.12	4.00	1.00
29. Overall, I enjoy science lessons more in year 7 than last year	20.3	20.3	59.4	3.64	4.00	1.39

Table 4.1-9 shows the means for the items that were used to create the 'Year 7 students' attitudes towards year 7 science' scale -using only the relevant items from table 4.1-8 above- ordered from the highest to the lowest mean.

The results indicate that year 7 students have positive attitudes towards science in secondary school (year 7) as the mean for most questions was higher than '3' so the students seem to mostly agree with the statements (which were positive about science). Similarly to the Year 6 cohort, students in year 7 got the highest scores (and therefore have shown the most positive attitudes) in the questions about practical work and experiments in science agreeing that practical work in science lessons is exciting (M=4.17) and that they are looking forward to doing experiments in their science lessons (M=4.10). Students, also find their science lessons in year 7 interesting (M=4.12) and important (M=3.88).

Table 4.1-9 Descriptive Statistics of year 7 participants' responses to questions measuring their attitudes towards year 7 science showing means in descending order. (N = 191)

Item number	Domain	Questionnaire item (N=191)	Mean	Median	SD	Corrected item-total correlation
11	Affective	Practical work in science is exciting	4.17	4.00	0.99	.558
3	Affective	We learn interesting things in science lessons	4.12	4.00	0.94	.662
12	Affective	I look forward to doing experiments in my science lessons	4.10	4.00	1.14	.510
15	Cognitive	Science is an important subject	3.89	4.00	1.09	.611
8	Cognitive	I am good at science	3.62	4.00	1.04	.564
1	Affective	I really enjoy Science	3.60	4.00	1.18	.832
9	Cognitive	I get good marks in science tests	3.57	4.00	1.19	.539
21	Affective	I like my science lessons in Year 7	3.35	3.00	1.32	.815
2	Affective	Science lessons are fun	3.32	3.50	1.17	.775
4	Affective	I look forward to my science lessons	3.07	3.00	1.13	.766
7	Cognitive	Science lessons are hard*	3.04	3.00	1.10	.428
10	Affective	Science is one of my best subjects	2.98	3.00	1.41	.815
13	Behavioural	I like watching TV programmes that are related to science	2.85	3.00	1.34	.401
5	Behavioural	I would like to do more science at school	2.79	3.00	1.33	.696
6	Affective	Science lessons are boring*	2.69	2.00	1.32	.735
14	Behavioural	I would like to study science in University	2.51	2.00	1.38	.583
16	Behavioural	I would like to have a job working with science	2.46	2.00	1.33	.541
		'Overall attitudes towards Y7 Science' Mean	**3.33**		**0.82**	
	Note: 1=Strongly disagree, 2=disagree, 3=Neutral, 4=Agree, 5=Strongly agree * Negatively phrased statement so reverse coded here.					

The students mostly disagree with the attitude questions that are relevant to the behavioural component of attitudes (as defined in section 2.1.2). 'I would like to do more science at school' (M=2.79), 'I would like to study science at university' (M=2.51), 'I would like to have a job working with science' (M=2.46). These findings will be further discussed in 'Chapter 6: Discussion'. They also mostly disagree with science being boring (M=2.69). The statement about science being boring is a negatively worded phrase so it was reverse coded here as explained earlier at the start of section 4.1.

Year 7 students appear to have overall positive attitudes towards their year 7 science lessons (M=3.33, SD=.82).

The examination of the corrected item-total correlations of the items of this scale showed that the lowest value was .401 (Table 4.1-9) and therefore, the distinctiveness of each item was high and that the scale had appropriate construct validity (see more in section 3.7.1).

The comparative items in table 4.1-10 below show how year 7 students feel about different aspects of their year 7 science lessons compared to their year 6 science lessons. Year 7 students appear to have more positive attitudes towards their year 7 science lessons compared to their year 6 science as they mostly agree with all the statements below.

Table 4.1-10 Year 7 students' comparisons between year 6 and year 7 science showing means in descending order

Item number	Questionnaire item (N=191)	Mean	Median	Std. Deviation
27	My year 7 science teacher has better knowledge of science than my year 6 teacher	4.15	5.00	1.11
26	We are using better equipment in our experiments in year 7 than in year 6	4.13	4.00	1.08
28	We are learning science in more depth and detail in year 7 than in year 6	4.12	4.00	1.00
22	Science lessons are more interesting in year 7 than in year 6	3.83	4.00	1.28
23	Science lessons are more exciting in year 7 than in year 6	3.77	4.00	1.26
29	I enjoy science lessons in year 7 more than in year 6	3.63	4.00	1.39
24	We are doing more interesting experiments in year 7 than in year 6	3.60	4.00	1.28
25	We are doing more fun experiments in year 7 than in year 6	3.49	4.00	1.28

The highest scores (and therefore the most positive attitudes) were observed in the questions about the expertise of their science teacher in year 7 compared to their year 6 teacher (M=4.15), the equipment the students use in their experiments with students agreeing that they are using better equipment in their experiments in year 7 than in year 6 (M=4.13), and the detail and depth at which they are taught science this year compared to year 6 (M=4.12). Furthermore, students mostly agree that science this year is more interesting, more fun and that they enjoy it more this year than last year. Table 4.1-11 shows the means of the questions that compare year 6 students' 'expectations' of certain aspects of science lessons to the year 7 'reality'.

Table 4.1-11 Comparing year 6 students' expectations of science to year 7 students' ideas

Item	Year group	Mean	SD	Mean dif.	Std. Error dif,	t	df	Sig.	Cohen's d
Science more interesting in year 7 than in year 6	6	3.98	1.01	0.15	.12	1.61	350	.250	.12
	7	2.83	1.28						
Science more fun in year 7 than in year 6	6	3.65	1.10	.18	.13	1.48	350	.140	.16
	7	3.83	1.28						
More interesting experiments in year 7 than in year 6	6	4.14	.78	.34	.11	3.02	322	.003	.31
	7	3.80	1.28						
Using better equipment in year 7 than in year 6	6	4.28	.75	.15	.10	1.52	340	.130	.16
	7	4.13	1.08						
Year 7 science teacher has better knowledge than year 6 teacher	6	3.76	1.10	.40	.12	3.34	341	<0.01	.36
	7	4.14	1.10						
Learning science in more detail in year 7 than in year 6	6	4.12	.98	.00	.11	.01	342	.99	.00
	7	4.12	1.00						
Enjoy science more in year 7 than in year 6	6	4.27	.74	.63	.12	5.40	301	<0.01	.55
	7	3.64	1.39						

Comparing these responses to the responses that year 6 students gave in the questions asking them about their expectations from year 7 science we can see that students in year 6 expect to use better equipment in their science experiments (M=4.28) and that year 7 students state that they are indeed using better equipment this year than in year 6 (M=4.13). There was no statistically significant difference between the two means.

Generally, the expectations of year 6 students of year 7 science seem to be similar to year 7 students' experiences of year 7 science as most of the means were comparable with no statistically significant differences.

However, it is noted that other statements about practicals and experiments moved from the top of the list with higher means (students in year 6 were looking forward to it) to the bottom of the list (with lower means). For instance, year 6 students expected that they would be doing more interesting experiments in year 7 than in year 6 (M=4.14); year 7 students however, only slightly agree with 'We are doing more interesting experiments in year 7 than in year 6' (M=3.60). The difference between these two means was found to be statistically significant.

Also, when students were in year 6, they expected that they would like year 7 science more than they do in year 6 (M=4.27) but year 7 students only slightly agree (M=3.64) that they like science more in year 7 than they did in year 6. The difference between the two means was found to be statistically significant. The reasons for these differences will be discussed in Chapter 6.

4.1.4 Year 8 students' attitudes towards science

Table 4.1-12 below shows the overview of the results of the 186 year 8 questionnaires which were analysed looking into students' attitudes towards year 8 science. At this point, it is important to restate that even though this study aims to investigate the attitudes of students and how they change as they move from primary to secondary school and therefore, one would expect that data would only be collected from year 6 and year 7 students, data was also collected from year 8 students because the science transition in Cyprus is a two-phase transition. Students move from primary school (where they are taught all the three sciences as one subject ‘Science’) to year 7 (where they are only taught Biology). Therefore, it’s not until year 8 (when Chemistry and Physics are introduced) that transition from primary school science to secondary school science fully occurs (See section 1.4 for more information).

Also, it is important to note that Year 8 students in Cyprus are taught each science separately, they have different teachers for biology, chemistry and physics and they do a separate final formal exam for each subject at the end of the year. Therefore, the questionnaire items for the year 8 questionnaire, although similar to the year 6 and year 7 questionnaire items, they were sometimes broken down to ‘biology’, ‘chemistry’ and ‘physics’ as it was not always possible to treat the three subjects as one.

According to the results presented on table 4.1-12, more than half of the year 8 students state that they like chemistry (61.3%) and physics (56.5%) while less than half of the year 8 students state that they like biology (32.8%). About half of the students agree that chemistry and physics lessons are fun. The majority of students still find practical work in science exciting (70.5%) and they are looking forward to doing experiments in their science lessons (70.5%).

When comparing their science lessons in year 8 to their science lessons in year 6, most students agree that science in year 8 is more interesting (64.6%) with more interesting experiments (69.3%) than year 6 and more fun (60.7%) with more fun experiments (66.2%) than year 6. They also believe that they are learning science in more detail compared to year 6 (76.1%) and that their science teachers in year 8 have better knowledge of science compared to their year 6 teacher (74.2%).

When comparing their current science experience (year 8) with last year (year 7), only 27.9% of the year 8 students state that they preferred science in year 7 when they were only taught biology (instead of all the three sciences). The majority of students find their experiments in year 8 more interesting (63.4%) and more fun (68.3%) than in year 7 when they were only doing Biology.

Table 4.1-12 Overview of the Y8 students' responses to the questionnaire

N=186	Disagree (%)	Neutral (%)	Agree (%)	Mean	Median	SD
1. I like biology this year	31.2	36.0	32.8	3.01	3.00	1.27
2. I like chemistry this year	16.6	22.0	61.3	3.62	4.00	1.10
3. I like physics this year	21	22.6	56.5	3.47	4.00	1.25
4. Biology lessons are fun	48.9	24.2	26.9	2.67	3.00	1.28
5. Chemistry lessons are fun	24.8	22.0	53.2	3.41	4.00	1.32
6. Physics lessons are fun	31.7	21.5	46.8	3.21	3.00	1.30
7. Science lessons are interesting	13.4	23.1	63.5	3.74	4.00	1.14
8. I look forward to my biology lessons	59.2	22.6	18.3	2.37	2.00	1.28
9. I look forward to my chemistry lessons	35	38.2	26.9	2.84	3.00	1.17
10. I look forward to my physics lessons	37.1	33.9	29	2.84	3.00	1.18
11. My biology lessons are hard	30.7	30.6	38.7	3.11	3.00	1.20
12. My chemistry lessons are hard	45.7	33.3	21	2.69	3.00	1.07
13. My physics lessons are hard	28	31.7	40.3	3.18	3.00	1.15
14. I am good at biology	24.2	31.7	44.1	3.28	3.00	1.15
15. I am good at chemistry	9.7	31.7	58.6	3.66	4.00	1.01
16. I am good at physics	19.3	30.6	50	3.37	3.50	1.09
17. I get good marks in my biology tests	34.9	25.8	39.2	3.17	3.00	1.40
18. I get good marks in my chemistry tests	20.4	30.6	48.9	3.48	3.00	1.25
19. I get good marks in my physics tests	29	27.4	43.6	3.23	3.00	1.27
20. We are doing loads of experiments in sciences this year	14.5	30.6	54.9	3.50	4.00	1.09
21. Practical work in science is exciting this year	7.6	22.0	70.5	3.95	4.00	.95
22. I look forward to doing experiments in my science lessons	10.8	18.8	70.5	3.99	4.00	1.07
23. I like watching TV programmes about science	50	21.0	29	2.62	2.50	1.36
24. Science is an important subject	12.4	21.5	66.2	3.82	4.00	1.14
25. I would like to study science at University	53.2	21.5	25.3	2.52	2.00	1.43
26. I would like to have a job working with science	52.1	24.2	23.7	2.56	2.00	1.41
27. My parents like science	23.1	43.5	33.3	3.17	2.00	1.13
28. My parents think science is important	11.9	34.9	53.2	3.63	4.00	1.02
29. My parents think that I should study something to do with science at University	39.8	35.5	24.7	2.80	3.00	1.18
30. My friends like science	47.9	37.6	14.5	2.45	3.00	1.14

31. I think that science lessons are more interesting this year than in primary school	17.2	18.3	64.6	3.72	4.00	1.23
32. I think that science lessons are more fun this year than in primary school	21	18.3	60.7	3.62	4.00	1.30
33. I think that we are doing more interesting experiments this year than in primary school	14.5	16.1	69.3	3.85	4.00	1.18
34. I think that we are doing more fun experiments this year than in primary school	12.4	21.5	66.2	3.83	4.00	1.09
35. I think we are using better equipment in our experiments this year than in primary school	11.3	19.4	69.4	3.84	4.00	1.14
36. I think that my year 8 science teachers have better knowledge of science than my year 6 teacher	9.7	24.2	76.1	3.94	4.00	1.09
37. I think we learn science in more detail this year than in primary school	9.1	16.7	74.2	3.97	4.00	1.07
38. Overall, I enjoy science lessons more in year 8 than in primary school	18.3	22.6	59.2	3.60	4.00	1.25
39. I liked science more last year when we were only doing Biology in our science lessons	50	22.0	27.9	2.74	2.50	1.40
40. It's more interesting this year that we are learning all the three sciences than last year when we were only doing Biology	27.5	27.4	45.2	3.30	3.00	1.31
41. It's more fun this year that we are learning all the three sciences than last year when we were only doing Biology	27.4	24.7	47.8	3.30	3.00	1.32
42. We are doing more interesting experiments this year than last year when we were only doing Biology	15.1	21.5	63.4	3.71	4.00	1.16
43. We are doing more fun experiments this year than last year when we were only doing Biology	11.3	20.4	68.3	3.93	4.00	1.08
44. We are using better and more specialised equipment in our science experiments this year than last year when we were only doing Biology	12.4	29.6	58.1	3.66	4.00	1.09

Table 4.1-13 shows only the items that were included in the 'Year 8 students' attitudes towards Y8 science' scale with means arranged in descending order. The results presented on table 4.1-13 indicate that year 8 students maintain positive attitudes towards science in secondary school. Students in year 8 mostly agree that they like chemistry (M=3.62) and physics (M=3.47). For biology the mean was close to the 'neutral' option on the scale (M=3.01). Students find chemistry (M=3.41) and physics (M=3.21) fun as opposed to biology (M=2.67) for which their agreement level was between 'neutral' and 'disagree'. Reasons as to why students do not find biology as fun as chemistry and physics and the role of the experiments will be discussed in Chapter 6. Year 8 students still find science lessons interesting (M=3.74) and important (M=3.82) and they continue to maintain their positive attitudes towards most aspects of experiments in science; they state that they are doing a lot of experiments in science lessons this year (M=3.50), that they like doing experiments (M=3.95) and that they are looking forward to doing practical work in their science lessons (M=3.99).

The students continue to mostly disagree with the attitude questions that are relevant to the behavioural component of attitudes such as 'I like watching TV programmes that are related to science' (M=2.62), 'I would like to study science at University' (M=2.52), 'I would like to have a job working with science' (M=2.56).

Year 8 students' attitudes towards year 8 science were found to be overall positive (M=3.20, SD=.71).

Table 4.1-13 Descriptive Statistics of year 8 participants' responses to questions measuring their attitudes towards year 8 science showing the mean in descending order. (N = 186)

Item number	Domain	Questionnaire item (N=191)	Mean	Median	SD	Corrected item-total correlation
22	Affective	I always look forward to doing science experiments this year	3.99	4.00	1.07	.348
21	Affective	I really like doing experiments in science lessons this year	3.95	4.00	0.95	.396
24	Cognitive	I think that science lessons are important this year	3.82	4.00	1.14	.529
7	Affective	We learn interesting things in science lessons	3.74	4.00	1.14	.662
15	Cognitive	I am good at chemistry	3.66	4.00	1.01	.612
2	Affective	I really like chemistry this year	3.62	4.00	1.1	.551
20	Cognitive	We are doing loads of experiments in science lessons this year	3.50	4.00	1.09	.337
18	Cognitive	I get good grades in my chemistry tests	3.48	3.00	1.25	.612
3	Affective	I really like physics this year	3.47	4.00	1.25	.569
5	Affective	Chemistry lessons are fun	3.41	4.00	1.32	.545
16	Cognitive	I am good at physics	3.37	3.50	1.09	.571
14	Cognitive	I am good at biology	3.28	3.00	1.15	.579
19	Cognitive	I get good grades in my physics tests	3.23	3.00	1.27	.611
6	Affective	Physics lessons are fun	3.21	3.00	1.30	.562
13	Cognitive	I find physics lessons hard*	3.18	3.00	1.15	.411
17	Cognitive	I get good grades in my biology tests	3.17	3.00	1.40	.650
11	Cognitive	I find biology lessons hard*	3.11	3.00	1.20	.317
1	Affective	I really like biology this year	3.01	3.00	1.27	.610
9	Affective	I look forward to my chemistry lessons	2.84	3.00	1.17	.606
10	Affective	I look forward to my physics lessons	2.84	3.00	1.18	.566
12	Cognitive	I find chemistry lessons hard*	2.69	3.00	1.07	.492
4	Affective	Biology lessons are fun	2.67	3.00	1.28	.637
23	Behavioural	I like watching TV programmes that are related to science	2.62	2.50	1.36	.406
26	Behavioural	I would like to have a job working with science	2.56	2.00	1.41	.632
25	Behavioural	I would like to study science at University	2.52	2.00	1.43	.665
8	Affective	I look forward to my biology lessons	2.37	2.00	1.28	.627

	'Overall attitudes towards Y8 Science' Mean	**3.20**	**0.71**

Note: 1=Strongly disagree, 2=disagree, 3=Neutral, 4=Agree, 5=Strongly agree
* Negatively phrased statement so reverse coded here

The comparative statements for year 6 and year 8 science are shown on table 4.1-14. Year 8 students appear to have more positive attitudes towards year 8 science compared to year 6 science as none of their responses scored a mean lower than '3.60'. Students find that they are doing more (M=3.83) and more interesting experiments (M=3.85) using better equipment (M= 3.84) compared to primary school. They also state that they are learning science in more detail compared to primary school (M=3.97) and that their science teachers this year have better knowledge of science compared to their primary school teacher (M=3.94). Overall, students agree that they enjoy science more in year 8 than they did in primary school (M=3.60, SD=1.17).

As with year 6 and year 7 data, the examination of the corrected item-total correlations of the items of this scale showed that the lowest value was .317 (Table 4.1-13) and therefore, the distinctiveness of each item was high and that the scale had appropriate construct validity (see more in section 3.7.1).

Table 4.1-14 Year 8 students' comparisons between year 8 and year 6 science

Item number	Questionnaire item (N=186)	Mean		SD
37	We are learning science in more depth and detail in year 8 than in year 6	3.97	4.00	1.07
36	My year 8 science teachers have better knowledge of science than my year 6 teacher	3.94	4.00	1.10
33	We are doing more interesting experiments in year 8 than in year 6	3.85	4.00	1.18
35	We are using better equipment in our experiments in year 8 than in year 6	3.84	4.00	1.15
34	We are doing more experiments in year 8 than in year 6	3.83	4.00	1.09
31	Science lessons are more interesting in year 8 than in year 6	3.72	4.00	1.22
32	Science lessons are more exciting in year 8 than in year 6	3.62	4.00	1.30
38	I enjoy science lessons in year 8 more than in year 6	3.60	4.00	1.25
	Mean	**3.80**		**1.17**

Note: 1=Strongly disagree, 2=disagree, 3=Neutral, 4=Agree, 5=Strongly agree

Table 4.1-15 shows the means of the questions that compare year 6 students' 'expectations' of certain aspects of science lessons to the experience and ideas of year 8 students of year 8 science.

Table 4.1-15 Comparing year 6 students' expectations of science to year 8 students' ideas

Item	Year group	Mean	SD	Mean dif.	Std. Error dif,	t	df	Sig.	Cohen's d
Science more interesting in year 8 than in year 6	6	3.98	1.01	.15	.12	2.13	345	.035	.23
	8	2.72	1.23	.25					
Science more fun in year 8 than in year 6	6	3.65	1.10	.03	.13	.21	345	.831	.02
	8	3.62	1.23						
More interesting experiments in year 8 than in year 6	6	4.14	.78	.29	.11	2.71	324	.007	.28
	8	3.85	1.18						
Using better equipment in year 8 than in year 6	6	4.28	.75	.44	.11	4.30	323	<0.01	.45
	8	3.84	1.14						
Year 8 science teacher has better knowledge than year 6 teacher	6	3.76	1.10	.17	.12	1.46	338	.145	.16
	8	3.93	1.10						
Learning science in more detail in year 8 than in year 6	6	4.12	.98	.16	.11	1.42	344	.156	.15
	8	3.97	1.10						
Enjoy science more in year 8 than in year 6	6	4.27	.74	.68	.11	6.00	307	<0.01	.65
	8	3.69	1.25						

Generally, the expectations of year 6 students of secondary science seem to be similar to year 8 students' experiences of year 8 science as most of the means were comparable with no statistically significant differences except for three aspects of science lessons for which the expectations of year 6 students are different to the year 8 students' experience.

Comparing the year 8 responses to the responses that year 6 students gave in the questions asking them about their expectations from secondary school science we can see that students in year 6 agree that science in secondary school will be more interesting that science in primary school (M=3.98). However, year 8 students disagree that science in year 8 is more interesting than primary school science (M=2.72). The difference between the two means was found to be statistically significant.

Students in year 6 expect that they will use better equipment in their secondary science experiments (M=4.28). Although 8 students slightly agree that they are using better equipment compared to year 6 science the mean was found to be significantly lower (M=3.84).

Finally, year 6 students expect that they would like science in secondary school more than they do in year 6 (M=4.27) but year 8 students only slightly agree (M=3.69) that they like science more in year 8 than they did in year 6. The difference between the two means was found to be statistically significant.

The results also show (Table 4.1-16) that students in year 8 agree that they like Science more this year that they are taught all the three sciences compared to year 7 when they only did Biology, finding especially experiments more interesting (M=3.93) and more fun (M=3.71) this year compared to year 7.

Table 4.1-16 Year 8 students' comparisons between year 8 and year 7 science

Item number	Questionnaire item (N=186)	Mean	Median	SD
43	We are doing more fun experiments in year 8 compared to last year when we only did Biology	3.93	4.00	1.08
42	We are doing more interesting experiments in year 8 compared to last year when we only did Biology	3.71	4.00	1.16
44	We are using better equipment in our experiments in year 8 compared to last year when we only did Biology	3.66	4.00	1.10
40	It's more interesting we are learning all the three sciences this year compared to last year when we only did Biology	3.30	3.00	1.32
41	It's more fun we are learning all the three sciences this year compared to last year when we only did Biology	3.30	3.00	1.32
39	I liked more last year when we only did Biology*	2.74	3.00	1.15
	Mean	**3.52**		**1.19**

Note: 1=Strongly disagree, 2=disagree, 3=Neutral, 4=Agree, 5=Strongly agree
*** Negatively phrased statement so reverse coded here**

As mentioned earlier, students in year 8 are taught biology, chemistry and physics as three separate subjects. The three subjects are distinctively separated as students have three different teachers (one for each science), they are separated on the students' timetables and termly reports and the students need to take a separate end-of-year exam for each of the three science subjects. This is quite important as it allows one to confidently assume that students are aware of which science is which and that they could respond to the questions about separate sciences in the questionnaire with confidence and as accurately as possible. The items on the year 8 questionnaire that were used to measure the attitudes of students towards biology, chemistry and physics were used to create three new sub-scales and the means were compared to find out if there were any differences in the attitudes of students towards the three sciences they were taught in year 8. Coefficient alpha for the three sub-scales (biology, chemistry and physics) was higher than .87 showing high reliability (George and Mallery, 2003; Gliem and Gliem, 2003) and the corrected item-total correlations for all the items was higher than .472 which shows that the items correlated well with the rest of the scale (de Vaus, 2004) so none of the items was excluded from the new variables (for more information on this, please refer to the reliability analysis section 3.7.1).

Year 8 students appear to have more positive attitudes towards chemistry, followed by physics. They have the least favourable attitudes towards biology. Repeated measure ANOVA tests have shown that the difference between the attitudes towards biology and the two other subjects were statistically significant while there was no significant difference between attitudes towards physics and chemistry which were overall positive (Table 4.1-17).

Table 4.1-17 Differences between the attitudes of year 8 students towards Biology, Chemistry and Physics

	Descriptives		**Multiple comparisons**				**Overall ANOVA**			
	Mean (N=186)	**SD**	**Comparisons with**	**Mean diff.**	**Std. Error**	**Sig.**	**df**	**F**	**Sig**	**Eta-squared**
Biology	2.89	.73	Chemistry	.44	.098	<.001	557	10.2	<.001	.035
			Physics	.26	.098	0.21				
Chemistry	3.33	.87	Biology	.44	.098	.000				
			Physics	.18	.098	.169				
Physics	3.16	.94	Biology	.26	.098	0.21				
			Chemistry	.18	.098	0.169				
*. The mean difference is significant at the 0.05 level.										

4.2 Difference in the attitudes as students move from primary to secondary school: Do students' attitudes change as they move from primary to secondary school science?

One -way ANOVA was used to investigate the effect of the school year on students' attitudes towards science. According to the results, school year had no significant effect and small effect size (P=.28>.05, η^2=.005) on students' attitudes towards science which shows that students' attitudes as they move from year 6 to year 8 (transition between primary and secondary school science) do not change significantly. Looking at the means for the 'Attitudes towards school science' scale for each year which are: Year 6 (M=3.27), Year 7 (M=3.33) and Year 8 (M=3.20) we can conclude that not only overall attitudes towards science do not change very much but that students maintain generally positive attitudes towards science as they move from primary to secondary school. 4.2-1 shows the results of the ANOVA tests in detail.

Table 4.2-1 Differences between the attitudes of year 6, 7 and 8 students towards school science

	Descriptive		**Multiple comparisons**				**Overall ANOVA**			
Year	**Mean**	**SD**	**Comparisons with**	**Mean diff.**	**Std. Error**	**Sig.**	**df**	**F**	**Sig**	**Eta-squared**
6 (N=161)	3.27	.62	7	.057	.083	.770	535	1.26	.284	.005
			8	.070	.084	.684				
7(N=191)	3.33	.60	6	.057	.083	.770				
			8	.127	.080	.252				
8 (N=186)	3.20	.52	6	.070	.084	.684				
			7	.012	.080	.252				
*. The mean difference is significant at the 0.05 level.										

4.3 Factors that affect students' attitudes towards science

4.3.1 The relationship between students' gender and their attitudes towards science as they move from primary to secondary school

Independent sample t-tests were used to investigate the effect of the gender on students' attitudes towards school science. According to the results, gender had no significant effect in any of the years ($p > .05$ for all the years) and had a small effect size ($d < 0.2$ for all the years). Looking at the means (Table 4.3-1) we can see that both boys and girls in year 6 have favourable attitudes towards science (with boys having slightly more favourable attitudes but with no statistical significance). In year 7, students continue to have positive attitudes towards science and although boys have slightly higher mean, the difference is not statistically significant. Both boys and girls maintain overall positive attitudes towards science in year 8. Girls in year 8 have a higher mean score than boys but still this difference is not statistically significant. Therefore, we can conclude that students maintain their positive attitudes as they move from primary to secondary science and that there are no significant differences between the attitudes of boys and girls towards school science.

Table 4.3-1 Attitudes towards school science and the effect of gender

Year Group	Gender	N	Mean	SD	df	F	Sig (2-tailed)	Cohen's d
Year 6								
	Boys	91	3.30	.82	154	.131	.668	.068
	Girls	70	3.25	.75				
Year 7								
	Boys	99	3.37	.87	189	.670	.442	.111
	Girls	92	3.28	.77				
Year 8								
	Boys	87	3.16	.58	178	11.5	.381	.126
	Girls	99	3.24	.81				

4.3.2 Is there an association between the attitudes of significant others towards science and students' attitudes towards school science?

A Spearman rank order correlation was run to determine the relationship between the attitudes of the participants' significant others such as parents and friends (according to the participants) and the participants' attitudes towards school science. The results (Table 4.3-2) indicate that there are weak/moderate positive relationships between significant others' attitudes towards science and students' attitudes towards school science. Students' attitudes towards science seem to be more associated to their parents' attitudes towards science (r>.40, p<.001 for most of the questions that concerned parents' attitudes towards science) as the data show a strong positive correlation between them and less to their friends' attitudes towards science with the data indicating a weak correlation between them (Cohen, 1988).

Table 4.3-2 Attitudes towards school science and the effect of significant others

Statement	Year	Mean for the statement	Mean for attitudes towards science	Spearman's rho	Sig (2 tailed)
My parents like science	6	3.24	3.27	.402	<.001
	7	3.14	3.33	.475	<.001
	8	3.20	3.20	.380	<.001
My parents think I should study a science related degree in University	6	2.53	3.27	.427	<.001
	7	2.61	3.33	.425	<.001
	8	2.80	3.20	.375	<.001
My parents think that Science is important	6	3.57	3.27	.372	<.001
	7	3.58	3.33	.459	<.001
	8	3.63	3.20	.338	<.001
My friends like Science	6	2.56	3.27	.261	<.001
	7	2.78	3.33	.436	<.001
	8	2.45	3.20	.353	<.001

4.4.3 Is there a correlation between the parental education and students' attitudes towards science as they move from primary to secondary school?

One -way ANOVA was used to investigate the effect of parental education on students' attitudes towards science. According to the results, presented on table 4.3-3 and figures 4.3-1 to 4.3-3, father's education had a significant effect (for all years $p<.005$) and medium (year 7 and 8 with η^2= or >.06) or large size effect (year 6 with η^2=.14) on students' attitudes towards science. In general, it is observed that the higher the education level of the father (according to the students' response to the questionnaire), the higher the mean score for students' attitudes towards science and therefore, the more positive their attitudes towards school science.

Table 4.3-3 Father's education and the impact on students' attitudes towards science

Descriptives					**Overall ANOVA**			
Year Group	**Education**	**N**	**Mean**	**SD**	**Df**	**F**	**Sig**	**Eta-squared**
Year 6	Primary	1	3.12	-	121	3.92	**.002**	**.14**
	Lower Secondary	14	3.18	.96				
	Upper secondary	41	3.00	.65				
	Undergraduate	57	3.48	.75				
	Postgraduate	12	3.73	.81				
	Doctorate	2	4.56	.79				
Year 7	Primary	2	2.88	.75	144	2.11	**.08**	**.06**
	Lower Secondary	20	2.90	.83				
	Upper secondary	71	3.40	.82				
	Undergraduate	46	3.49	.83				
	Postgraduate	10	3.52	.84				
Year 8	Primary	4	2.81	.96	132	2.88	**0.025**	**.08**
	Lower Secondary	17	3.08	.79				
	Upper secondary	57	3.15	.60				
	Undergraduate	38	3.40	.82				
	Postgraduate	21	3.63	.82				

Figure 4.3-1 Father's education and the impact on Year 6 students' attitudes towards science

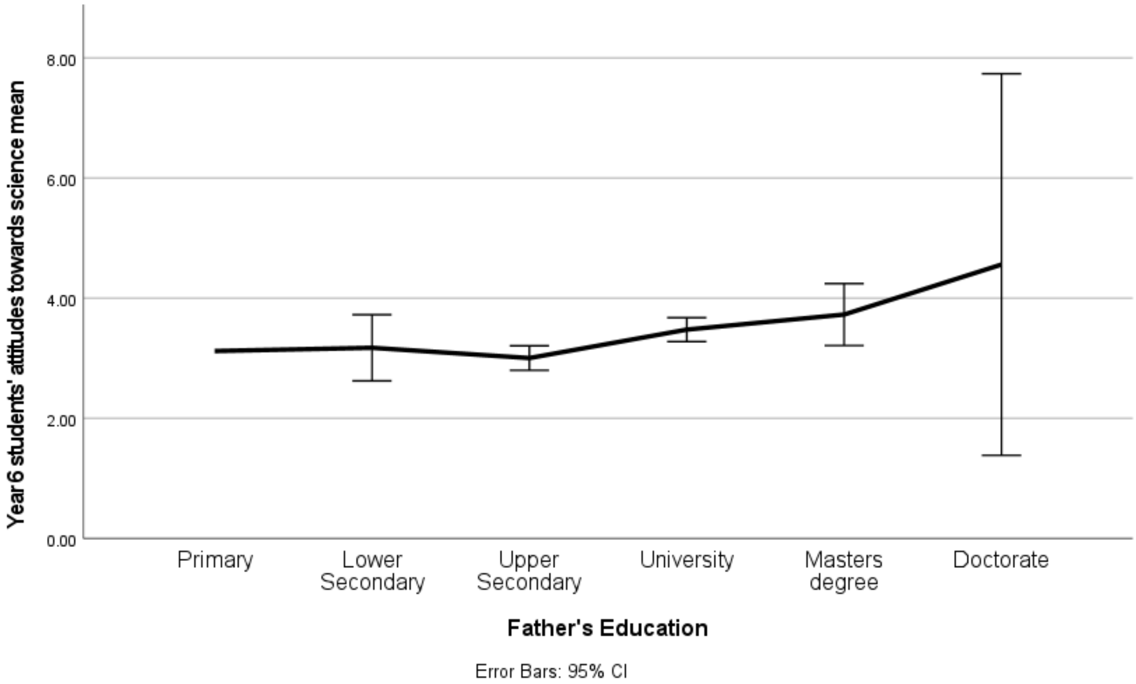


Figure 4.3-2 Father's education and the impact on Year 7 students' attitudes towards science

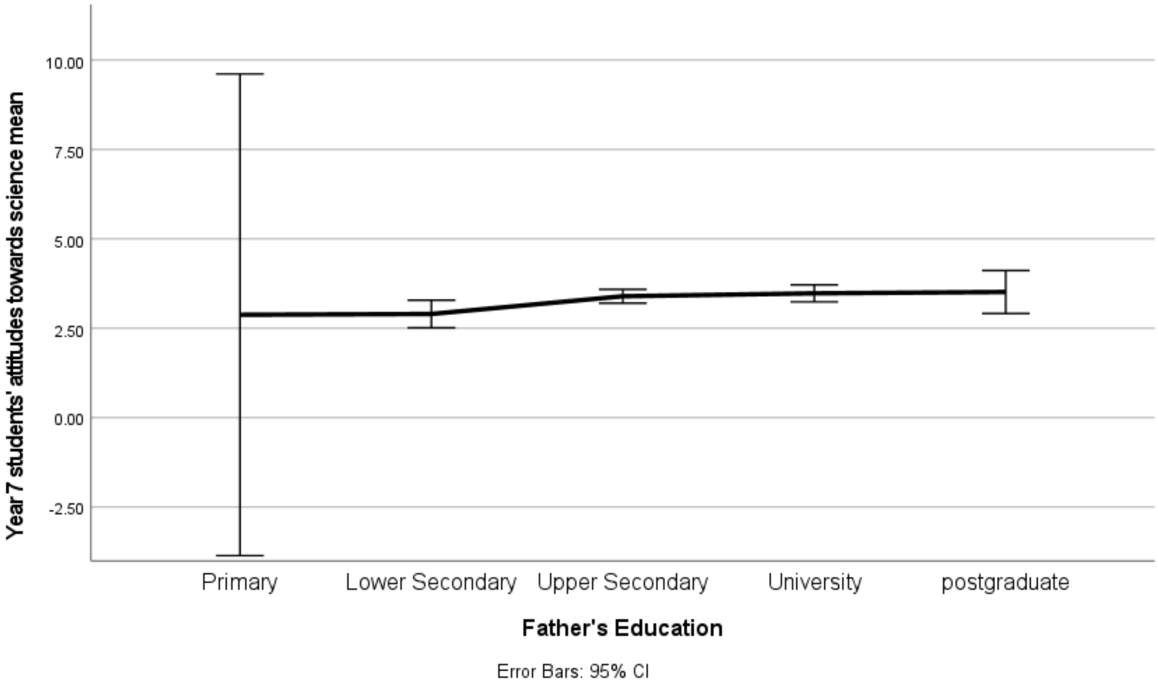


Figure 4.3-3 Father's education and the impact on Year 8 students' attitudes towards science

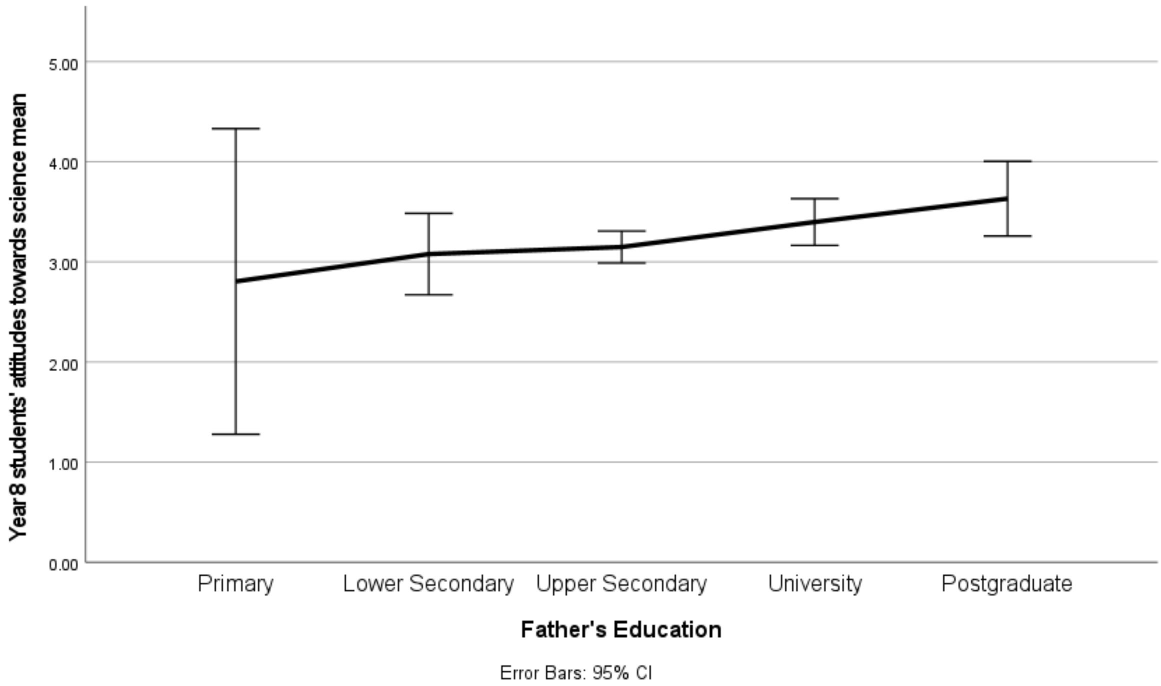


Table 4.3-4 and figures 4.3-4 to 4.3-6 show how students' attitudes towards school science change with their mothers' education level. For year 6 and year 8 students, it is observed that the higher the education level of the mother, the more positive the attitudes of students towards school science. For year 8, the results showed significant variations ($p= .005$) and medium size effect ($\eta^2= .10$). For year 6, there was some variation in the results, showing that as mothers' education level gets higher, students' attitudes towards school science becomes more positive, however, this variation was not found to be statistically significant ($p=.006$, $\eta^2=.12$). Finally, for year 7 there were no significant variations between the means of students whose mothers have completed a lower education level and the students whose mothers have completed a higher education level ($p=.109$, $\eta^2=.05$).

Table 4.3-4 Mother's education and the impact on students' attitudes towards science

Descriptives					**Overall ANOVA**			
Year Group	**Education**	**N**	**Mean**	**SD**	**df**	**F**	**Sig**	**Eta-squared**
Year 6	Primary	1	2.38	-	124	3.49	**.006**	**.12**
	Lower Secondary	6	2.80	.56				
	Upper secondary	40	3.05	.61				
	Undergraduate	68	3.59	.85				
	Postgraduate	14	3.39	.96				
	PhD	1	3.06	-				
Year 7	Primary	2	2.50	.04	149	1.92	**.109**	**.05**
	Lower Secondary	7	3.04	.65				
	Upper secondary	52	3.33	.75				
	Undergraduate	62	3.56	.83				
	Postgraduate	31	3.26	.81				
Year 8	Primary	3	2.54	.60	143	3.48	**.005**	**.10**
	Lower Secondary	9	2.97	.71				
	Upper secondary	49	3.20	.73				
	Undergraduate	51	3.24	.63				
	Postgraduate	36	3.63	.71				

Figure 4.3-4 Mother's education and the impact on Year 6 students' attitudes towards science

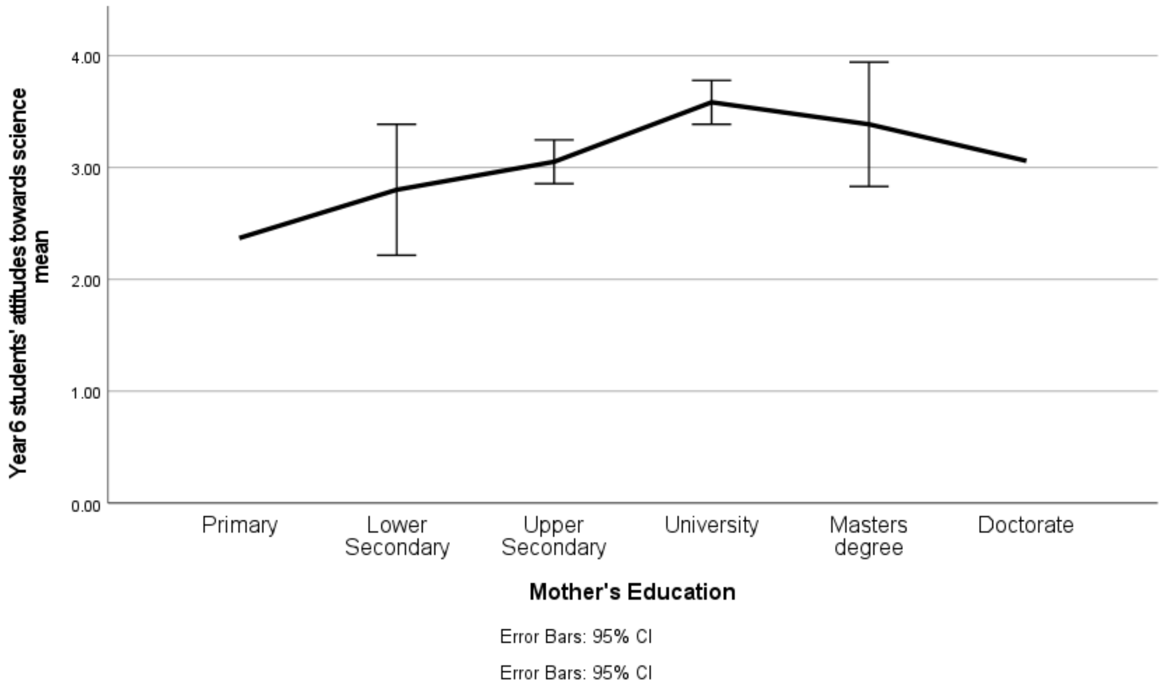


Figure 4.3-5 Mother's education and the impact on Year 7 students' attitudes towards science

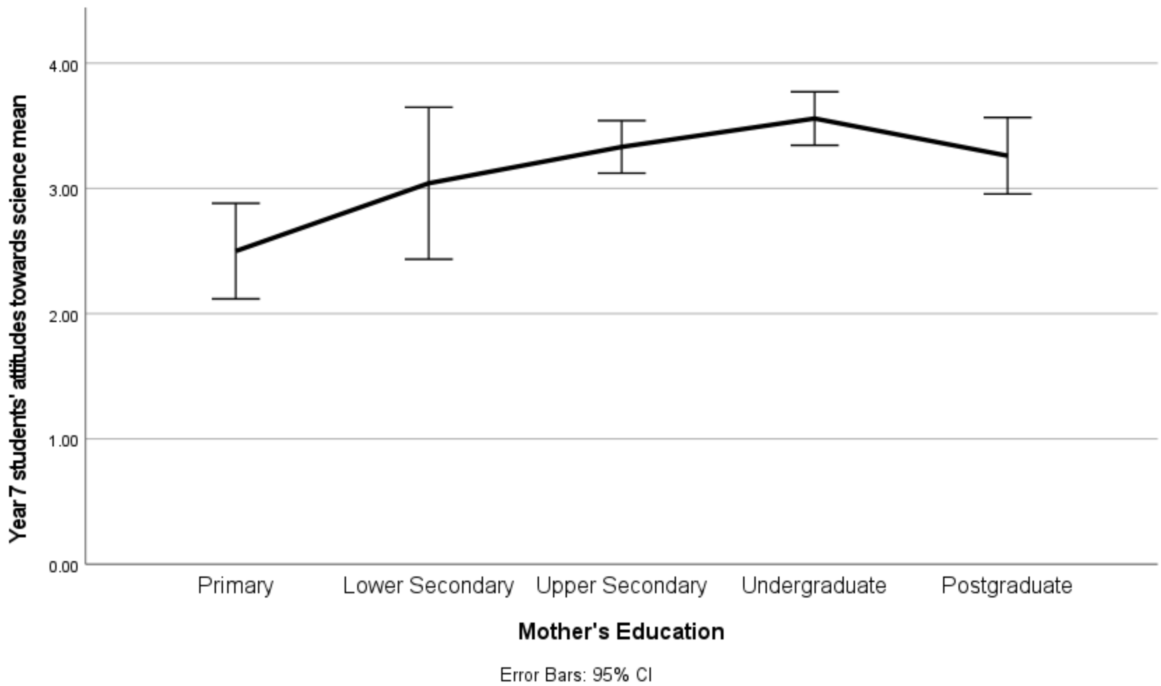
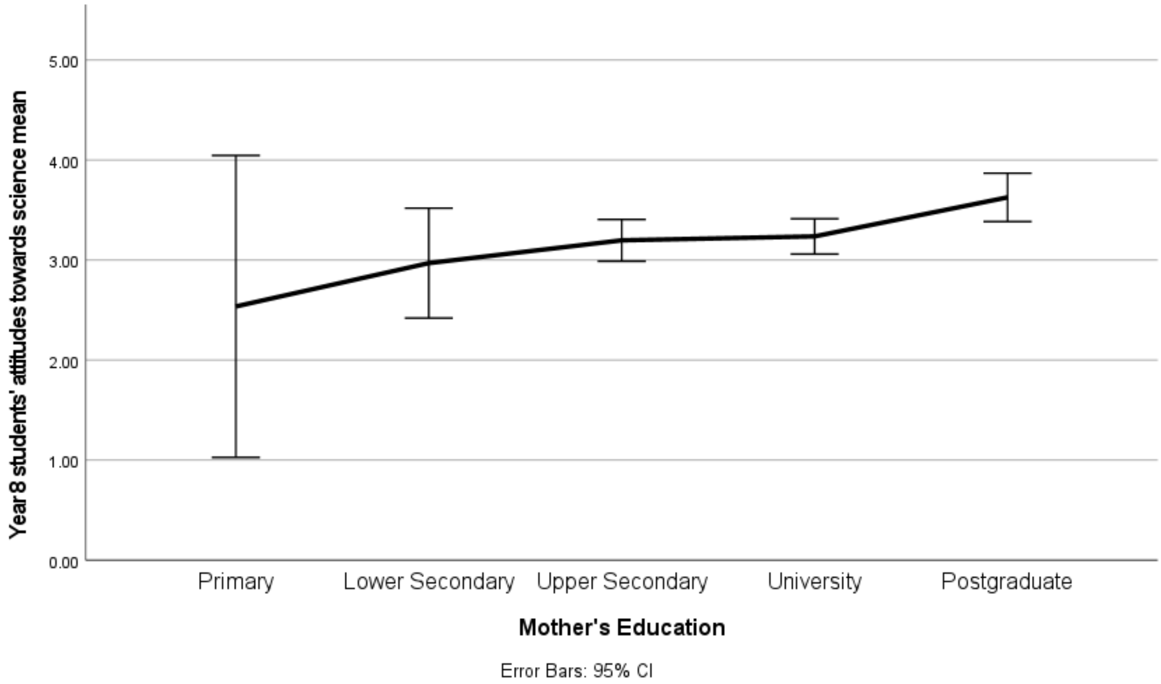


Figure 4.3-6 Mother's education and the impact on Year 8 students' attitudes towards science



4.4 The difference between the affective, cognitive and behavioural attitudes of students

The analysis of the results of the present study indicate that students have overall positive attitudes towards school science and that they maintain those positive attitudes as they move from primary to secondary school. However, as already discussed in literature review (section 2.1.2), attitudes can be considered as a multidimensional model consisting of the affective, cognitive and behavioural domain. Therefore, the items in each questionnaire that were used to measure the affective, cognitive and behavioural component of the attitudes of students were used to create three new sub-scales and the means were compared to find out if there were any differences between them. Coefficient alpha for the three sub-scales (affective, cognitive and behavioural) was higher than .77 showing high reliability (George and Mallery, 2003; Gliem and Gliem, 2003) and the corrected item-total correlations for all the items was higher than .318 which shows that the items correlated well with the rest of the scale (de Vaus, 2004) so none of the items was excluded from the new variables (for more information on this, please refer to the reliability analysis section 3.7.1).

This section focuses on looking at any differences between the domains in each year as well as how the attitude domains change (if they do so), as students move from primary to secondary school (Table 4.4-1). The results show that students hold, overall positive affective attitudes towards school science (with means higher than '3.00' – between the 'neutral' and 'agree' options) and that their positive affective attitudes are maintained as they move from primary to secondary school. Cognitive attitudes were also positive with means higher than '3.00' for all the years. The behavioural component was the one with the lowest mean across the years which indicates that although students have positive feelings and perceptions towards school science, they do not always have the intention to change the way they act or behave based on this. These findings are further discussed in Chapter 6.

Figure 4.4-1 Differences of attitude domains across the years

Descriptives					**Overall ANOVA**			
Domain	**Y**	**N of items**	**Mean**	**SD**	**df**	**F**	**Sig**	**Eta-squared**
Affective	6	8	3.52	.86	538	7.37	**<.001**	**.027**
	7	8	3.58	.93				
	8	12	3.26	.80				
	6	5	3.37	.83	538	2.13	**.120**	**.008**
Cognitive	7	5	3.47	.83				
	8	10	3.30	.79				
Behaviour	6	4	2.66	.96	538	.47	**.626**	**.002**
	7	4	2.65	1.04				
	8	3	2.56	1.19				

Post hoc pairwise comparison showed that the only significant difference between the means of students' responses related to affective, cognitive and behavioural attitudes was found between the affective attitudes of year 7 and year 8 students ($p < .001$, with small effect size $\eta^2 = .027$).

Figure 4.4-2 Differences between the affective, cognitive and behavioural attitudes of year 6, 7 and 8 students towards school Science

		Affective domain			**Cognitive domain**			**Behavioural domain**		
		Mean diff	**Std. Error**	**Sig.**	**Mean diff**	**Std. Error**	**Sig.**	**Mean diff**	**Std. Error**	**Sig.**
6	7	.068	.082	.740	.102	.087	.476	.009	.115	.996
	8	.257	.093	.016	.071	.088	.698	.099	.116	.669
7	6	.068	.082	.740	.102	.087	.476	.009	.115	.996
	8	.326	.089	<.001	.173	.084	.101	.896	.110	.696
8	6	.257	.093	.016	.071	.088	.698	.099	.116	.669
	7	.326	.089	<.001	.173	.084	.101	.896	.110	.696

* The mean difference is significant at the 0.05 level.

4.5 Summary

To investigate students' attitudes towards school science, a sample that consisted of 538 questionnaires (277 boys and 261 girls) was collected from primary (N=161) and secondary school students (N=191 from year 7 and N=186 from year 8). The results were analysed using descriptive and inferential statistics on SPSS 27.0.

Year 6 students were found to hold favourable attitudes towards primary school science (M=3.27, SD=.79). They were also found to have positive attitudes towards secondary school science while they are still in primary school (M=3.95, SD= .63). Students in year 6 appeared to have the most favourable attitudes towards all the aspects of science related to practical work and experiments.

Year 7 students' attitudes towards school science continued be positive (M=3.33, SD=.82), showing, -similarly to year 6, - the most positive attitudes towards experiments in science, as well as the fact that their science lessons were interesting and important.

Year 8 students also appeared to have overall positive attitudes towards school science (M=3.20, SD=.71). They were also found to have statistically more favourable attitudes towards their physics and chemistry lessons compared to their biology lessons.

Although there was a variation in the 'Attitudes towards Science' mean in the three years, the difference was not found to be statistically significant, so it can be concluded that students' attitudes towards science do not change very much as students move from primary to secondary school and that they are maintained overall positive.

There were no significant differences between the attitudes of boys and girls towards school science in any of the three years.

Some of the factors that found to be associated to students' attitudes towards school science were their parents' attitudes towards science and their father's education level (mother's education level was not found to significantly affect students' attitudes towards science).

In terms of the three attitude domains (affective, cognitive and behavioural), students were found to hold overall positive affective and cognitive attitudes towards school science which were maintained as students move from primary to secondary school. The behavioural component had the lowest mean compared to the other two domains.

We discuss these findings, and their relationship with the existing literature, further in Chapter 6.

Chapter 5: Findings of Interview analysis

The aim of this chapter is to present the findings from the group interviews with students in years 6, 7 and 8.

The data for this section was collected using semi-structured, group interviews with 34 students (18 year 6 students from five different primary schools, eight year 7 students and eight year 8 students from two different secondary schools). The results presented in this chapter were used alongside questionnaire data (Chapter 4) to answer the research questions. More details about the data collection processes followed can be found in section 3.4.

At this point, it might be useful to restate that when referring to students' quotations for the purpose of the presentation of the group interview results, a coded name which ensures anonymity whilst also allowing connections between the schools and the year group was given to the student in question. For more information about how the coded name used for students was developed please refer to section 3.7.2.

As mentioned in section 3.7.1, the method of analysis chosen for the interview data is a combined thematic approach analysis -both a priori and emergent approaches were used. Therefore, a range of emergent themes were drawn (or emerged) from the interview data (Blair, 2015; Frith and Gleeson, 2011; Thomas, 2003) and a range of a priori themes were drawn from the literature around attitudes towards school science (see literature review, sections 2.2 and 2.3). The findings presented in this chapter seek to provide insight and understanding in relation to the attitudes of students towards school science, what impacts their formation, how they change and the factors that might influence the change in attitudes towards school science as students move from primary to secondary school (see research questions, section 3.1). The themes that were identified in the qualitative data (a priori and emerging) were grouped under the following four sections, to help me tell the story of this data (Braun and Clarke, 2006) and to answer the research questions:

- ***Students' attitudes towards science as a school subject***
- ***Students' attitudes towards science experiments***
- ***Students' attitudes towards their science teachers and***
- ***The impact of family and friends on students' attitudes towards school science***

Therefore, this chapter is split into three main sections: 5.1 Findings of year 6 group interview analysis, 5.2 Findings of year 7 group interview analysis and 5.3 Findings of year 8 group interview analysis. Then, each of these main sections is further split into the four sub-sections which were developed using the a priori and emergent themes and which are stated above.

Figure 5.1-1 uses the year 7 qualitative data to exemplify how the identified a priori and emergent themes were used to organise the four sections listed above.

Figure 5.1-1 Using combined thematic analysis in analysing the year 7 group interviews

Theme		**Section developed**
Liking science lessons	A priori	***Students' attitudes towards science as a school subject***
Science lessons are interesting	A priori	
Science lessons are relevant to our everyday life	Emergent	
Science lessons are important for our everyday life	Emergent	
Science lessons are fun	A priori	
Science lessons are important for our future studies and careers	A priori	
Year 7 science is more interesting than year 6 science	Emergent	
Year 7 science is more important than year 6 science	Emergent	
Science lessons are challenging	A priori	
Frequency of experiments	A priori	***Students' attitudes towards science experiments***
Using better equipment/ more advanced equipment	A priori	
Experiments are more interesting	A priori	
Experiments as demonstrations	Emergent	
Students actively involved in experiments	Emergent	
More challenging experiments	Emergent	
Using a laboratory	A priori	
Liking the science teacher	A priori	***Students' attitudes towards their science teachers***
Science teachers' attitude towards teaching	A priori	
Science teachers stricter in secondary school	Emergent	
Science teachers having higher expectations of students	Emergent	
Science teachers having better knowledge of science in secondary school	A priori	
Have heard about secondary science from friends	Emergent	***The impact of family and friends on students' attitudes towards school science***
Have heard about secondary science from family	Emergent	
The influence of extracurricular activities with family	A priori	
Parents helping with homework	Emergent	
Parents influence career aspirations	A priori	
The influence of parents' occupation	A priori	

5.1 Year 6 group interview analysis

5.1.1 Year 6 students' attitudes towards primary science as a school subject

Most year 6 students (13 out of 18 students) stated that they liked science. When they were asked whether the liked science, they used words such as 'fun', 'nice' 'different' to describe it. Also, a number of students talked about how exciting the experiments they did in science were (this is further discussed in section 5.1.2 below).

> PD.B.2: I like science in primary school. I think science is nice and fun! For me, the best part is when we are doing experiments or watching documentaries.

> PA.B.1: I like our science lessons! They are fun and different.

The interview data show that over half of the students who were interviewed found science or certain topics and aspects of science in primary school interesting, most of them since they link to everyday life and how it works. This idea was expressed by both boys and girls in year 6.

> PB.B.2: I like science because it's interesting. We learn about everyday life, things like plants and animals and the body and we learn how it works.

> PB.G.4: I like science especially when we learn about interesting topics like Light or Sound.

> PA.G.2: I really like science. We know a lot of things about our life but in science we understand more about it. With science we answer a lot of questions we might have about different things […] I think the words that would describe our science lessons best are interesting, different and unpredictable.

Only three of the students (two boys and a girl) expressed the idea that science is not interesting in primary school and that sometimes they get bored in the lessons.

> PA.B.3: Most of the times science lessons are boring because we learn the same things every time.

> PD.B.2: I like science but sometimes it's really easy, so it gets a bit boring.

> PD.G.1: I like it most of the times but sometimes it can be a bit boring.

The interview data also suggest that the vast majority (16 out of 18) of year 6 students believed that their science lessons in primary school were important for their everyday life as well as their future career or studies. Students showed overall, positive attitudes towards the utility of science. Utility of science as explained in the literature review is the usefulness of science in everyday life and for future careers (George, 2006). Both boys and girls mentioned the importance of science lessons.

> PA.G.4: Definitely science is important because you will for sure have to use science in your life so our science lessons are like … 'fuel' for the future.

PB.B.1: I would say science is important because it is related to so many aspects of our life.

PA.B.1: I think it is really important to learn science in school because you learn about useful things you will definitely use in your life. Also, it gives you more choices for your studies…It gives you access to more jobs.

PB.G.3: Science is very important because we will do science in secondary school and we will need it in the future, especially if we want to study something … 'scientific'.

Even the students who stated that they did not like science, they found the subject boring or not as interesting, agreed that science is important, especially for their future career aspirations.

PD.B.2: I think science is very important because we might need it in the future for our studies.

PA.B.3: I don't like science…But, I think it is very important and will be useful for our lives. Like.... I want to become a doctor so I need to study science in secondary school.

PC.G.1: I don't like science as a subject in school...But I think it is the most important subject. I think it is as important as maths and Greek – it's not like PE. Everything around us, even food…how we cook it and how we grow it is science. I think it's important because if you know science you get a good job when you are older.

5.1.2 Year 6 students' attitudes towards science experiments in year 6

The interview data shows that one of the reasons that students have positive attitudes towards primary school science is science experiments. Over half of the students mentioned that they enjoyed science in primary school because they liked doing experiments or they stated that science in primary school was fun when they were doing experiments. When asked, most of them stated that they really enjoyed or were looking forward to practical activities and experiments in their science lessons. The majority of students (15 out of 18) that were interviewed explained that their favourite and most exciting part of their science lesson was when they had the opportunity to do experiments.

> PD.G.1: Science can be a bit boring, when we are writing for a long time, but when we do experiments is really fun.
>
> PC.B.6: Science is nice when we are doing experiments but not so nice when we need to write a lot of stuff.
>
> PB.G.3: I like science because we do experiments.

In a particular school, all the year 6 students that were interviewed, stated that they used to love science in year 5 because they were doing a lot of experiments but in year 6 they did not really like it because they were not doing a lot of experiments. They stated that they were doing a lot of writing instead. This again, suggests that there is a link between students' positive attitudes towards school science and the extent to which science experiments are incorporated in science lessons. A year 6 girl commented on this:

> PC.G.2: I don't like science this year. It was so so fun last year. Last year it was different because our teacher did loads of experiments with us. This year we don't do any experiments. It's been so many months since the start of the year and we've only done one experiment. Well... It wasn't even an experiment. It was just copying the experiment diagram from the book.

Three students expressed a neutral opinion about primary school science, but even they made it clear that they really liked experiments. An example is the year 6 boy below who said:

> PC.B.3: I will start with the answer I gave to the questionnaire, Miss… For the question about if we like science in primary school, I chose the 'Neutral' option, Miss. Because sometimes it is boring, Miss when we are doing only theory and tests are hard, but when we are doing experiments and we discover new things it is so fun.

We can see that some of the students emphasised on the difference between looking at the experiments as demonstrations and doing the experiments themselves. The girl below made a comment which shows that students feel that it is important for them to participate in the experiment process actively.

> PA.G.6: I like experiments in science. It is my favourite part of the science lesson, especially when ***WE*** [student's emphasis] do the experiments and not just watch them.

As discussed earlier, when students were asked what their favourite part of their science lesson was, the majority of them stated that experiments were their favourite part; some of them because experiments were 'fun' and some of them, like the year 6 boy below, because they felt that experiments helped them to understand a scientific concept better.

> PA.B.5: I love experiments in science and I learn a lot from them. Like that time when I had no idea what friction was and then we did that experiment where we had to use different materials to see with which one it would be hard for the car to move.

5.1.3 Year 6 students' attitudes towards the primary science teacher

The interview data show that teachers play an important role in students' attitudes towards school science. Discussion with participant students revealed that the relationship between the students and the teacher, as well as the teaching style, are amongst factors determining students' attitudes towards science in primary school with more than half of the participant students mentioning their teacher when talking about whether they liked science or not.

> PC.G.2: Last year [in year 5], the teacher really tried to make it [science] really interesting and she was trying to make us love science.

> PE.G.1: I think it really depends on the teacher. Our teacher uses difficult language that we don't understand and when we ask a question she will shout and say: 'Have you really not understood this? It's the easiest thing in the world.'

> PA.G.2: I really like our teacher. She knows us all really well and we have a good relationship.

5.1.4 Year 6 students' attitudes towards secondary school science as a school subject

Over half of the year 6 students (12 out of 18) stated that they were looking forward to doing science in year 7. A number of these students (10 out of 12), stated that the reason for this was that they expected science to be more interesting in secondary school than in year 6.

> PA.G.4: I really look forward to science in year 7. I think I will find it very interesting.

> PB.B.1: I think that we will look at new stuff, more interesting in science next year [in year 7].

> PA.B.5: I think that next year [in year 7] we will learn more and more interesting things in science.

The students stated that they expected to find it more interesting because they would learn science in more detail. They expected to learn more difficult things than in primary school science and this, according to the students, would make their science lessons more interesting.

> PA.B.1: I think it will be similar to the science in primary school but better because for the science lessons next year, I think they will give us more details for every topic.

> PA.G.2: Yes, science [in year 7] might be a little bit different from this year; we will learn more information about science. I think it will be better.

> PB.G.3: I am really looking forward to science lessons next year. We will learn different things, it will be more difficult and we will learn more….more stuff about each topic.

Some of the students stated that the idea of science being more challenging in year 7 compared to year 6 made them feel a bit anxious but for others this was something that got them excited as they saw this as an opportunity to learn new things.

> PC.G.2: I am looking forward to it [secondary school science] because teachers are older so they must know more. But I know there will be more theory and more tests and these are the things I am not looking forward to.

> PD.G.1: I think that science next year will be more difficult….will have more chapters than this year. We will learn more than this year.

> PB.B.2: Science next year will be more interesting because it will be more difficult.

A number of year 6 students mentioned that they expected science to be fun in secondary school. This was the case even when students expected that they would possibly have to study harder for it.

PA.G.2: I think science next year will be fun, but it is already fun this year.

PB.B.1: Next year, science will be more fun and exciting for sure! We will look at new stuff.

PB.B.2: We will have to study harder, but it will be more fun, I think.

A few students pointed out that they were looking forward to science in secondary school because it would be taught as three different subjects by three different teachers; they perceived this as an opportunity for them to learn more about each science.

PA.B.5: I think science in secondary school will be… more interesting next year because we will do loads of chemistry and biology and physics…[pauses] separately… so we will learn more about it. It will be more interesting and fun.

PC.B.3: Science next year will be more interesting. Especially because it will be more than one subjects, not just one. We will learn everything more…[paused]. I mean we will get more information about each one.

PA.G.4: I really look forward to science in year 7. I think I will find it very interesting. I think because it will be three different subjects and each one will be different, I will find it very interesting.

Another theme that emerged while looking at the group interview transcripts was the perceived 'seriousness' of secondary school science. Students felt that they needed to take secondary school science more seriously than primary school science. Students expressed the idea that they would need to work harder in their science lessons in secondary school compared to primary school. According to the participants, one of the reasons was that they would be assessed every term and they would get grades which would be sent home (this is considered as a ‘formal’ secondary school result and it counts towards their end-of-year grade). They also discussed about the formal exam at the end of the year and how they would get formally assessed based on their result.

> PA.G.4: I think science will not be as fun in secondary school because we will have an exam so at some point we will have to revise for the exams and this won’t be as fun.

> PB.G.3: Next year [in secondary school] we will have to work harder in science because we will be given grades every term. They will expect more from us.

> PC.B.6: Grades of our science tests really count in secondary school, it’s not like here, in primary school were grades mean nothing.

Certain students expressed the idea that even students who did not like science in secondary school they would have to try hard because of the science exam at the end of the year. The year 6 girl below states:

> PA.G.6: Science is an examined subject in secondary school so we really need to take it more seriously. Some students might not be so interested- same as in primary school - but they will try harder in secondary school because they will have to take an exam.

5.1.5 Year 6 students' attitudes towards secondary science experiments

Half of the interviewed students seemed to look forward to secondary school science as they appeared to expect that they would do more and more interesting experiments compared to primary school. Some of the interview responses highlight this.

> PA.G.6: I can't wait because I think our teacher will do fewer experiments and we will do more. They can teach us for example, how to use a microscope.

> PC.G.2: There will be more experiments in secondary school so I am excited about it.

> PB.G.4: I look a little bit forward to year 7 science because we will do more experiments than this year.

A year 6 girl (below), expressed the idea that in year 7, they expected to do more challenging experiments and this would expand their science knowledge.

> PB.G.3: I think that we will do more complicated experiments and we will learn new things we haven't learned yet.

The comment of student PB.G.3 above as well as the comment of the student PA.B.5 below suggest that students expected to be more actively involved in the experimental process in year 7 science and spend less time watching teachers doing experiments; and this was something they were looking forward to in secondary school.

PA.B.5: I believe that we will do more experiments – most of them we will do them by ourselves and not by teacher demonstration.

For some of the students, experiments were the only reason that made them to look forward to secondary school science.

PC.G.2: I am only excited for the experiments if I am honest with you, Miss.

The analysis of the interview data shows that using better equipment in their science experiments compared to year 6 science was one of the reasons why students were looking forward to year 7 science.

PD.G.1: Next year [in year 7] we will have a lab with loads of different equipment. It will be interesting because it will have more and better equipment. It will be similar equipment to primary school but it will be bigger and better than now.

PB.G.3: Next year, we will have to use more tools and equipment and we will have to be more careful when handling them because they will be more fragile.

The students seemed to relate the advanced equipment to a more interesting science lesson:

PA.G.6: In secondary school, we will have more tools, dangerous tools and microscopes [….] It will have a torso [the science lab] and the students will listen carefully because they will find it interesting.

PA.B.1: For the science lessons in year 7, I think we will use better equipment in our experiments so it will be even more interesting than in primary school. I think there will be a science room similar to our primary school one but we will have a bigger storage room with loads of equipment in –more equipment than in primary school. I think they will have interesting things for us to see, like a skeleton.

Students that had less positive attitudes towards primary school science also stated that they looked forward to be using more specialised equipment in secondary school, for instance the year 6 boys, below.

PA.B.3: Next year, it will have loads of tools that we will not know because they will be more scientific. The equipment will be better, much better, new tools and we will wear special protective clothes and goggles.

PD.B.2: We don't have a lab in primary school. We just have the normal classroom and we just bring the equipment here if we want to do an experiment. The lab will be very nice in secondary school with different equipment like microscopes. We will have more equipment….for everyone….and it will be better than primary school.

Finally, students appeared excited to be using a laboratory in secondary school as many of them stated that they had no laboratory in primary school. A number of students claimed that the laboratory would be bigger or better equipped in secondary school and therefore, they were looking forward to it. Some students seemed to relate the presence of a laboratory in secondary school to a better learning science experience.

> PC.G.2: The lab will be way better and nicer in secondary school with more stuff and it will be more fun.
>
> PA.G.2: Yes, they will have a special room [in secondary school]. It will be like a classroom but it will also have a special space for us to do all our experiments. Here in primary school, we only have a normal classroom and a storage room where we keep all the equipment and other things for each topic. We use them when we do experiments but a lot of things break.
>
> PA.G.4: It [Science lab in the secondary school] will have all the equipment for all the experiments that we need to do not just a few of them like here in primary school.

5.1.6 Year 6 students' attitudes towards the secondary science teacher

Primary school students expressed the idea that whether they would like or not secondary science next year would depend on their secondary school teacher. Some of the students identified this as the main single factor affecting how they would feel about secondary school science.

PD.B.2: I think science will be more fun in secondary school than in primary school, **IF** [emphasises on 'if'] my teacher is good.

PC.G.1: To be honest, Miss, next year [in secondary school], if science will be more fun or not than primary school it really depends on the teacher. If the teacher loves science, they will make it really fun.

PC.G.2: I think science next year will be really fun... But this also depends on the teacher. If they are really bored then it will be really boring for us too and I think we will not learn anything if they are bored.

Some of the students interviewed mentioned that they expected their secondary school science teacher to be stricter than their primary school teacher. Some of them just stated this without expressing a positive or negative opinion about it but certain students stated that the strictness of the science teacher would consequently mean that the science lessons in secondary school would be less fun.

PA.G.6: I don't think it [science in year 7] will be very fun. The teachers will be strict and we won't be able to joke in the class or spend time looking and exploring the experiment equipment.

PA.B.1: I believe science lessons are more fun now [in primary school] because we can be a little bit naughty and more relaxed. But we won't be able to do this in secondary school – the science teacher will be really strict.

Another idea that emerged while examining the transcripts was the idea that science teachers in secondary school would spend less time explaining things to them. They also stated that secondary science teachers would expect more from the students in secondary school. Some of the students appeared a bit worried about this.

> PA.G.2: I am a bit worried about my science teacher [in year 7] because I think they will not pay attention to each individual student. I mean...They will care for us but as a class, as a group…Maybe not so much for each one separately.

> PD.G.1: My secondary school teacher will be stricter and expect more from us. They will spend less time explaining things to us. I am a bit scared about this…

Another factor that seemed to impact students' attitudes towards secondary science was the belief that their secondary school teacher would have better knowledge of science compared to their primary school teacher.

> PA.B.5: I can't predict if my secondary school science teacher will be different [from my primary school teacher] because each teacher has different style. But I think that in secondary school, because each teacher teaches their own subject they will know more about it and they will teach it better. In primary school they teach everything in a simpler way.

> PB.G.4: I don't think that our teacher next year [in year 7] will have a lot of differences to our teacher this year but I think they will know more things about science and so they will be able to analyse things more and give us more information.

> PE.B.3: I think my secondary school teacher will explain science better so we can do well. They will know more things [than the primary school teacher] because they have studied science at the university.

5.1.7 Year 6 students' attitudes towards secondary science and the impact of family and friends

The results of the interview analysis show that in addition to teacher influence, peer and family influence is also important in forming students' attitudes towards school science. Comments made from the participants indicate that attitudes held by peers or other family members toward secondary school science were influential. Some of the primary school students reported that they expected to like science in secondary school because of what they had heard from their family members or their friends who had already joined secondary school.

> PA.G.2: Yes, I really want to see what it will be like. I heard from my friends that it will be better than primary school. My brother also loves science. He wants to become a science researcher. And I think that because I already like it I will love it in secondary school.

> PD.B.2: Yes, I am [looking forward to secondary school science]. My brother is older and he always says that they learn interesting things in secondary school and that he really likes science in secondary school. My brother loves science and I believe I will love it too next year.

> PA.G.6: My sister really loves biology in secondary school. She said it's interesting. And I have a cousin as well and she really likes science too.

As opposed to students above who have formed positive attitudes towards secondary school science due to the positive attitudes of their family and friends, students below have formed less positive attitudes due to what they have heard in their discussions with family and friends about secondary school science.

> PD.G.1: No, I am not really looking forward. My brother who is already in secondary school says it's not nice. He does not like science.

> PB.G.3: My brother had his summer science exam yesterday. He says that it's really hard and he needs to study a lot.

Finally, students have mentioned the extracurricular activities they had the opportunity to do with their parents and/or their family, such as visiting museums and science related events. A year 6 girl stated that this experience had an impact on her decision to follow a career related to medicine.

> PA.G.2: Me too. I went to the Science Museum and the Natural History museum in London with my parents and in similar museums in other countries. My mum also took us to another science event where you could take bloods from a doll. I really enjoyed it and that's why I decided to study something to do with medicine in the future. Also, both of us [her and the boy sitting next to her] took part in the National Science Olympiad.

5.1.8 Summary of the findings from the year 6 group interviews

- Overall, year 6 students have favourable attitudes towards primary school science while they are still in primary school.
- Most year 6 students reported that science in primary school is interesting, important for their life and their future career aspirations. They also reported that they enjoy science experiments in primary school.
- Most year 6 respondents expected science in year 7 to be more interesting than primary school science and more difficult than year 6. They also expected to learn science in more detail and that science in year 7 would be more fun and exciting compared to primary school.
- Most year 6 students expected that they would do more experiments in year 7 using better equipment in their science experiments than year 6. They also expected that when moving to year 7 they would be more involved in practical activities than in year 6.
- Some of the factors that were identified to affect students' attitudes towards science (in general) and during the transition from primary to secondary school were the teacher, the teaching style and the relationship between the student and the teacher. Additionally, the expectations that students had of secondary science to be more interesting, more fun and include more experiments performed with better equipment and in which students expected that would be more actively involved. Finally, the attitudes of family and friends towards

school science appeared to have impacted the formation of students' attitudes towards secondary school science.

5.2 Year 7 group interview analysis

This section looks into the findings from the analysis of the group interviews with year 7 students. At this point, it is worth reminding the reader that due to the 'two-phase' science transition, students are only taught biology in year 7 (see section 1.4 for further information). Therefore, just for the year 7 interview results which are presented in this section the terms 'science' and 'biology' are interchangeable as biology was the only science that students were taught in year 7.

5.2.1 Year 7 students' attitudes towards secondary science as a school subject

Similarly to year 6, some year 7 students stated that year 7 science was interesting when they were asked to describe their science lessons; half of the year 7 interview participants used the word 'interesting' to describe their science lessons or aspects of their science lessons.

> SB.G.7.2: I like that we learn interesting things, for example about cancer and how we can protect ourselves.

SA.B.7.4: It's interesting because we learn about interesting things like when we did a chapter about animals and I found this interesting.

A number of students explained that they liked science in year 7 because they found it to be relevant to everyday life (also in line with what year 6 students had said).

SA.G.7.1: Science lessons are relevant to our everyday life so if anything happens, we will know how to deal with it. We learn about things like diseases and how we can keep healthy.

SA.B.7.3: Science is important because we learn about our body and about animals for example, and we learn a lot of information that is necessary to know in our life.

SB.G.7.1: I like that we learn about things in our body that I didn't know they were there. We learn about these things in detail and I like this.

Only one year 7 student expressed the idea that science in year 7 was not interesting when they were asked to explain why they did not like science.

SB.G.7.2: I personally don't like science. I don't find it interesting – I don't like it and I don't see the point of it.

Students have generally expressed the idea that science lessons in year 7 were more interesting compared to year 6.

SB.G.7.1: I remember I was really bored in primary school – I didn't find it interesting. This year, things are more interesting and this makes me want to learn more about our body and nature.

Some students stated that despite the fact that science lessons were harder in year 7 and that they were doing fewer experiments than in year 6, they still found science more interesting than year 6.

SA.G.7.1: Science this year is different. It's more difficult this year. But I remember we were doing more experiments in primary school than this year. I like it more than primary school though because we learn more interesting things.

Over half of the interviewed students that had positive attitudes towards year 7 science explained that it was because science is important. Students mentioned both, the importance of science in their every day life and for future career purposes.

SA.B.7.3: I like that you learn important information about our everyday life!

SA.G.7.2: Science is very important! All we are doing has to do with our life.

SB.B.7.4: Science lessons are very important. We will always need this knowledge about science we are learning now. We can learn how to protect ourselves – it's useful in life and for our future jobs.

Even students that had overall neutral attitudes towards year 7 science, recognised the importance of science lessons in year 7.

> SA.G.7.2: Sometimes I like science and sometimes I don't. There are some lessons I like and some I don't. Generally, it's fine [...]. Science is very important. That's why it's a core subject and we have an exam on it at the end of the year. We learn about our body and our self and how diseases can affect us.

Students also suggested that secondary school science was more important than primary school science.

> SA.B.7.3: I think that science lessons are more important in secondary school. In primary school we were only learning about plants. Now, in year 7 we are learning about more important things. But in year 6, lessons were more fun because we did more experiments and we visited science places in school trips.

The statement of the student above shows that although they found science more important in year 7, they enjoyed science more in year 6 because of the activities they were doing in their science lessons. Most interviewed students expressed similar ideas – this is explored further in Discussion (Chapter 6).

Some students referred to the perceived difficulty of science when explaining if they liked science in year 7. A number of students expressed the idea that they liked science because it was easy while some others stated that they did not like it because they found it hard.

> SA.B.7.4: I like it because I think it's easy!

SB.B.7.3: I like it, it has a lot of theory and I find it easy.

SB.B.7.4: I don't really like it. I find it harder than last year (in year 6).

SB.G.7.2: I think my science lessons are complicated.

SB.G.7.1: My science lessons are difficult but interesting.

The last statement from the year 7 girl shows that although some students find science lessons hard, they have positive attitudes towards their science lessons.

5.2.2 Year 7 students' attitudes towards secondary science experiments

Most of the interviewed students (5 out of 8) agreed that they found year 6 science more fun than year 7, mainly due to the fact that they did more experiments or activities. When year 6 students were interviewed, most of them stated that they expected to do more experiments using better equipment in year 7. However, in the year 7 interviews, when students were asked to compare year 6 and year 7 science, students appeared to be disappointed by the frequency of experiments in year 7.

SB.G.7.2: I think science was more fun in primary school because we did more experiments. This year, we are only working from our book unless sometimes we need to use a magnifying glass or something. But rarely to be honest… so I think it's more interesting this year because we learn more interesting things but it was more fun in primary school.

> SA.B.7.4: I liked science more last year because we did more activities in class and we made stuff like models for example. This year it's all work, work…

> SA.B.7.3: We did more experiments in primary school. I liked my teacher more [in year 6] because we did more activities and more experiments so the lesson was more fun.

> SA.B.7.3: When we have science, we move to a science lab but we don't do experiments there. We rarely do experiments There is special equipment there but only the teacher uses it.

Even students who believed that science was generally, boring in year 6, still enjoyed it when they were doing experiments or activities:

> SA.G.7.2: I found science in primary school boring but when we did experiments, I found it really fun. So, I think the stuff we learn this year is more interesting and more important but last year it was more fun because we did a lot of activities and experiments.

5.2.3 Year 7 students' attitudes towards their secondary science teacher

Looking at the interview transcripts it is clear that one of the important factors that impact students' attitudes towards year 7 science (similarly to year 6 science) is their science teacher. A number of year 7 students stated that science is their favourite subject because of their teacher.

SA.G.7.1: My favourite subject this year is science because I have an amazing science teacher and the lessons are really interesting because of her.

SB.G.7.2: I like science because I personally love my science teacher.

The statement from the year 7 boy above shows that the 'fun' element of the lesson is often linked to how students feel about their teachers. Other students expressed similar ideas as well.

SB.G.7.1: This year [year 7], we are more scared of our teacher because they are stricter. In primary school it was more relaxed so I think it's not as fun this year.

SA.B.7.4: I liked the primary school teacher. She was fun. But… my year 7 teacher is fun too. She always tells us jokes and we have time to relax in class!

Statements from year 7 students also show that students valued the specialism of their science teacher.

SB.B.7.4: I don't think science this year is fun, but I remember in primary school it was the same, only theory! No experiments at all. The science teacher [in year 6] was the same teacher teaching us PE and technology so sometimes he was teaching us PE or technology when we had science!

5.2.4 Summary of the findings from the year 7 interviews

- Students in year 7 appeared to have generally, positive attitudes towards year 7 science. They stated that they found science in year 7 interesting and important for their every day life and their future careers.
- Most year 7 students stated that science in year 7 was more interesting than year 6 which was in line with the responses from year 6 students who stated that they expected science in year 7 to be more interesting in year 6.
- When interviewed, year 7 students stated that they found secondary school science to be more difficult than year 6 and that they learned science in more detail than in year 6. This was also in line with year 6 students' expectations.
- Most year 7 interviewees, stated that science was more fun and exciting in year 6 than in year 7, perhaps because they did more activities and experiments in lessons. This was in contrast to the year 6 students' expectations who stated that they expected science to be more fun and exciting in year 7.
- Most year 7 students stated that they did not do as many experiments as they expected in year 7 and that they were doing more experiments when they were in year 6. They also mentioned that although they had laboratories with special equipment in secondary school, they rarely used it. They stated that they were also disappointed because even

when there was an experiment involved in the lesson, it was usually performed by the teacher and they only got to watch.

- A number of year 7 students mentioned their science teacher as one of the factors affecting whether they liked science lessons in year 7.

5.3 Year 8 group interview analysis

This section looks into the findings from the analysis of the group interviews with year 8 students. At this point, it is worth reminding the reader that chemistry and physics are introduced in year 8 and therefore, students in year 8 are taught all the three sciences. As explained in section 1.4 students in year 8 are taught the three subjects separately, they have separate timetabled sessions for each science and a different science teacher who specialises in each science. They also have different assessments for each science and a separate end-of-year exam. Therefore, we can assume that when students are referring to separate sciences (biology, chemistry and physics) they are confident about which science is which.

5.3.1 Year 8 students' attitudes towards secondary science as a school subject

Similarly to year 7, year 8 students discussed about the importance of their science lessons. Students stated that they liked sciences because they were important for their life and their future.

> SB.B.8.1: I like all the three sciences. I think sciences are important because they offer you general knowledge. You need to know about

them, even if it's not… a perfect match to what I want to study, I might still need it because if for example, I am developing a game that is about doctors, I need to know the science behind it. [This student said he wanted to work in the game and software development sector.]

SB.B.8.2: I think they are all important because you learn a lot about everyday life, I might not need it in my future studies but I still need to know about them.

Some students, even though they were asked about how they find their science lessons in general, they identified the science they found the most important for them.

SA.B.8.2: I personally like chemistry. I think it's very important and relevant to what I want to do in the future.

SA.B.8.2: My favourite subject is biology because it has to do with human body and diseases so it's really relevant to the job I want to do. It will help me with my future job.

SA.G.8.1: I like biology because it's a subject that it can open loads of 'doors' let's say in your future.

SA.G.8.3: I always loved biology because it is information about our body, and the different systems in our body and I think it's important things and we all need to know about how our body works.

Even students who did not particularly liked certain sciences and they stated they did not like all or some of them, discussed about their importance. An example is the statement from a year 8 girl, below.

> SB.G.8.4: Physics is boring and hard to understand but all the units are important. I think chemistry is interesting but not as important as other sciences. Biology is useful and interesting, however, some units in biology, like leaves and chlorophyll are not important at all.

Most (5 out of 8) of the year 8 students that participated in the interviews found sciences interesting.

> SA.G.8.3: Sciences are interesting. We learn a lot of things. We study them in depth and we learn information about different things around us.

> SA.G.8.1: I personally like them [sciences] a lot. We learn a lot of things through them. They are very interesting and I think they will always be part of our lives and we will definitely need them in the future.

> SB.G.8.3: I like chemistry, it's better and more interesting because we do more experiments.

A number of year 8 students explained that the main reason they liked or disliked sciences (or individual sciences) was how easy or how difficult they thought it was.

SA.B.8.4: I love biology because I find it easy – it has a lot of theory and I am good at learning theory. Chemistry is one of the lessons that I don't really like because I find it hard. And same with physics- I don't like it, I find it hard.

SB.G.8.4 Physics is my worst subject this year. I find it hard and boring. It's the subject that I get the lowest grades. Even though for every other subject I get 20, for physics, I get 18. Chemistry is better than physics, if you know the formulas, you find it easy. [Note: 20 is the highest grade in the '1 to 20' system.]

SA.B.8.2 I think sciences are a little bit hard. The easiest for me is biology. The hardest is chemistry because you need to memorise the formulas.

Some students, however, appeared to have positive attitudes towards science in year 8 although they found it hard while some students mentioned that although they did not necessarily find them hard, they needed to study quite hard for them.

SB.B.8.2: I love biology but it's hard. I think it's important because we learn about our body.

SA.G.8.1: You need to study for them [for sciences]. I don't think they are hard but you need to study a lot for them but they are very interesting.

The majority of year 8 students (6 out of 8) stated that they preferred science in year 8 compared to primary school because they found it more interesting. Some students thought that the reason it was more interesting was because they learned everything in more detail.

> SA.G.8.1: I prefer science this year. We learn more things and it's more interesting.
>
> SB.B.8.1: I think science in primary school was easier but this year is more interesting. In primary school we were learning on the 'surface' but teachers in secondary school give you more details so I like it more.
>
> SA.B.8.2: I prefer it this year than in year 6. When I was in primary school, I was looking forward to doing science in secondary school because I expected that we would learn more about each subject, in more… depth.
>
> SB.G.8.3: I prefer science this year because it's more interesting, more scientific…as in…gives us more information…It's more linked to everyday life and it makes more sense.

Some comments from year 8 students show that they expected science to be harder in secondary school compared to primary school. For some of them sciences proved to be easier than they expected and for some of them harder.

> SA.G.8.1: I personally thought that it would be more difficult than it is. Especially biology… I thought I would find this subject very hard. But once I got to know it, it became one of my favourite subjects.

SA.B.8.2: I expected that physics would be hard because we would have to learn equations and how to use them but I really liked it once we started doing it.

SB.B.8.1: All the three sciences are easier than I expected! Especially for physics, I expected it to be hard but it's not! I am good at it [happy voice]!

SB.B.8.2: Physics is a bit worse than I expected it – I didn't expect it to be as hard.

SB.G.8.3: I expected science to be different than primary school and I was right. It's easier than I expected…biology and chemistry….but physics is harder than I expected.

Finally, some of the comments from students in the previous sections show that students found science in secondary school more 'fun' than primary school especially due to experiments or not as 'fun' as primary school because of the increased amount of assessments compared to primary school.

SA.G.8.1: This year, sciences are way more fun as we do more experiments and so we learn more things.

SB.G.8.4: Primary science was more fun…We have to learn more theory in secondary school and we do a lot of tests and exams in secondary school.

5.3.2 Year 8 students' attitudes towards secondary science experiments

Most year 8 students explained that they liked sciences or at least one of them due to the fact that they were doing experiments. They used words such as 'fun' and 'interesting' to describe experiments in their science lessons.

> SB.B.8.2: In chemistry, I like the experiments because they are fun.

> SB.G.8.3: I like chemistry because experiments are fun and …action. Physics is quite hard, we do some experiments but they are not as exciting as in chemistry and in physics we do more theory than experiments.

> SA.B.8.2: My favourite part in physics lessons is the experiments because I think we learn more when we are doing experiments.

> SA.G.8.1: I like the experiments because there are some exciting reactions [in Chemistry]. The two elements combine to create something new. When we are doing experiments, our lesson is more …practical and we can understand chemistry better.

Comparing science in year 8 to primary school, a number of year 8 students stated that they preferred year 8 science because they were doing more experiments than in year 6.

> SA.G.8.3: In year 6, we didn't do any experiments. I think it was boring in year 6 because we did a few or no experiments at all. I prefer sciences as we do it in year 8. We do more experiments.

SA.G.8.1: We learn more things and it's more interesting [in year 8]. When I was in primary school, I expected that we would do more experiments when we went to secondary school and I was right.

SB.B.8.2: In primary school, we were only doing a few experiments so we were really excited when our teacher told us we were doing an experiment and this is because we were not doing a lot. This year, we are doing more experiments than in primary school. The experiments we do this year are more interesting… they are more 'scientific'. In primary school, we were learning about washing our hands or how to not waste water but this year, we are doing more experiments and especially in chemistry, they are more important.

The students who felt that they were not doing enough experiments appeared disappointed as they felt that they would learn more by doing experiments.

SB.G.8.4: We only did two experiments in physics; in biology we didn't do any. I think that in all the sciences we should do more experiments but especially in physics. I don't understand why my teacher thinks that experiments are not needed. However, when we do experiments is better this year than primary school because we use better equipment and have a science lab and I like this.

Some students mentioned the importance of performing the experiments themselves.

SB.B.8.1: In secondary school, we are using more specialised equipment. In primary school we didn't do as many experiments

> and if we did, we used simple equipment. Sometimes, the experiments are done by our teacher but in chemistry I really like it because we get to do the experiments ourselves.
>
> SA.G.8.3: In biology, we only did a few experiments. We mostly watch the experiments [disappointed voice]; we don't do as many experiments ourselves because we don't have time as my teacher says.

Finally, the idea that they had different expectations from secondary school experiments was expressed.

> SB.B.8.1: I remember when I was in primary school, I expected that in science in secondary school we would wear white lab coats and use fire and chemicals all the time to create explosions. So, it wasn't exactly as I expected it but I wasn't disappointed because I still like chemistry.

5.3.3 Year 8 students' attitudes towards secondary science teacher

Some year 8 students thought that their science teacher was one of the important factors that determined whether they like their science lessons in year 8 or not.

> SB.G.8.4: For physics, I don't like my teacher. She makes you feel really bored, she could make the lesson more interesting if we did more experiments or activities. Chemistry is not as great as a subject but I really love my chemistry teacher so this makes me love the lessons even though I think chemistry is not as important as other sciences. In

physics, it’s the opposite because physics is more important but my teacher is so boring that she kills it.

SB.G.8.3: My science teachers sometimes make the lesson boring but my chemistry teacher is more relaxed and we get to joke with her. She gives funny examples in class to help us understand the lesson.

SA.B.8.2: I don’t think my family affected how I feel about sciences… but how good my teachers are, did.

While discussing about the differences between year 6 and year 8 science, a number of year 8 students discussed about the importance of their science teachers.

SA.B.8.2: I remember, I didn’t like science in primary school. We didn’t have a teacher for science in primary school. Every lesson we had a different teacher so we didn’t have just one teacher. Everything was a bit all over the place […] My secondary school [science] teachers have more knowledge than my primary school teacher, they studied these subjects so they are really ..ermmm…knowledgeable and they know a lot so they can give us more information.

SA.G.8.3: I expected the teachers to be very strict and more serious than my primary school [science] teacher but I think in the end, the secondary school teachers made me love the three subjects. I love my teachers […] This year, our lessons are better than in year 6 and I think it’s because I have better teachers that make the lessons fun and exciting.

SA.B.8.4: It's more fun this year than primary school but I think, this is because of my teachers. I think if teachers are good, they can make science lessons really fun.

SA.G.8.1: I believe that my [science] teachers this year are great as well as my year 6 teacher. I think I was lucky to have such good teachers in primary and secondary school so far because they all made me love their subjects.

5.3.4 Year 8 students' attitudes towards secondary science and the impact of family and friends

A number of year 8s mentioned their family or friends when discussing the factors that might have affected whether they liked science in year 8 or not. Most of them stated that nothing impacted how they felt such as the comments below.

SB.B.8.1: No, nothing and no one really affected how I feel. I decided if I liked it or not [science] based on what I felt about the subjects myself.

SB.B.8.2: My friends have nothing to do with whether I like science or not. Some of them like it and some of them don't but I always have my own opinion about subjects and my friends can't change it.

SA.G.8.1: My friends did not affect me. I have a lot of friends that are weaker students so they are saying that they don't like sciences…But I am not the kind of person that will be affected by what other people say so I did not let this change how I feel about science.

However, a number of students, although they stated that nothing had an impact on how they felt about year 8 science, mentioned their family members in their responses.

> SA.G.8.3: My dad likes chemistry and I think that hasn't really changed how I feel about chemistry but I like how he can help me with my homework.

> SA.G.8.1: Personally….My mum is a Greek language teacher so this made me want to follow sciences so I could get to know these sciences too, not just languages.

Some students explained that their family or friends have not had an impact on how they feel about science but other things they did outside of school, did.

> SB.B.8.2: No one has affected how I feel about science. I play some games that are…scientific… about sciences e.g a game I was playing was about how you can escape from a planet and this made me learn more about sciences and I got to like them more.

> SB.G.8.4: In my dad's school, I started doing afternoon online lessons before I started year 8 and in biology and chemistry they learn about exciting things like DNA etc and this made me to get excited about sciences. [Her dad is a headteacher in a private school.]

5.3.5 Summary of the findings from the year 8 interviews

- Year 8 students stated that they found science in year 8 interesting and important.
- Students said that they liked sciences in year 8 because they were relevant to everyday life and the world around them.
- Year 8 students expressed the idea that science in year 8 was fun, exciting or interesting because of experiments.
- A number of year 8 students stated that if they liked science or not depended on their science teachers.
- Year 8 students stated that science in year 8 was more interesting and more important than in primary school.
- A number of students expressed the idea that sciences in year 8 were harder or required more studying than in primary school and year 7.
- A number of students stated that if they liked science or not depended on how easy or hard, they found it.
- Most year 8 students preferred that they were taught all the three sciences separately compared to year 6 and 7 when they did it as a single science because they felt they were doing everything in more detail and they were learning more.
- Year 8 students stated that they preferred year 8 science to year 6 and 7 science because they were doing more experiments.
- Some of the factors identified to have an impact on students' attitudes (in general) and during transition were: science teacher, students' expectations of secondary science, science experiments, students' family and extra-curricular activities that were related to science.

Chapter 6: Discussion

In previous chapters in this thesis, the results regarding students' attitudes towards school science were examined through participants' responses to questionnaires (Chapter 4) and interviews (Chapter 5). This chapter discusses the findings of the study, starting with the findings relevant to the affective, cognitive and behavioural attitudes as this is one of the ways in which this thesis contributes to knowledge (see section 7.2). Then, the discussion focuses on addressing the research questions in turn, using the data collected and previously presented in Chapters 4 and 5 and by relating the findings to the literature. The discussion about the implications of the findings of this study, the limitations of the project and the suggestions for future research are included in the final chapter (Chapter 7 – Conclusions).

6.1 Students' affective, cognitive and behavioural attitudes towards school science

This discussion section focuses on students' attitudes towards school science in terms of the three attitude domains: the affective, cognitive and behavioural domain. As already stated in the literature review (2.1.2), in summary, the affective domain refers to the person's feelings and emotions about an attitude object, the cognitive domain refers to people's beliefs about an attitude object, and the behavioural component refers to the way that the attitude we have influences how we act or behave (Reid, 2006).

The questionnaire analysis showed that students hold, overall positive affective and cognitive attitudes towards school science and that these attitudes are maintained as they move from primary to secondary school. Interview analysis also led to similar findings. With regards to the affective domain, most students, in each of the years, talked about science being interesting or fun (especially the practical aspect of it) and exciting. Only a small number of students expressed the idea that science in primary or secondary school is boring. Also, the majority of students describe science as important for their everyday life or future (cognitive domain).

The behavioural component had the lowest means across the years indicating that although students hold positive affective and cognitive attitudes towards school science this does not always lead to an action such as the intention to study science at University or work in a science related job. According to Tavsancil (2010), this could be because every attitude does not need to have a behavioural element. As Triandis (1964) explained, a person can think that painting is something to enjoy, but this doesn't always mean that the person will feel the need to visit art exhibitions or to read books about painting. Therefore, students can have positive cognitive attitudes (e.g., having the perception that science is important, useful for their future, easy) and affective attitudes (e.g., finding science fun, exciting, interesting) but they will not necessarily change their actions based on these positive attitudes. For instance, as this study shows, even if students find science fun and interesting, it does not mean that they will necessarily want to watch more documentaries about science, read more books about science or study science at university. This contradicts the findings of the study by Hanley et al. (2020) in the U.K who found out that students who had positive attitudes towards science, also had positive behavioural attitudes with 94% of students reporting that they accessed science content such as reading online, watching science related programmes on TV or reading about science on magazines, books and newspapers. When it came to science related studies and careers though, Hamlyn et al. (2020) also reported that the positive attitudes towards science did not necessarily led students to develop an interest in science related careers. In fact, Xu and Lewis (2011), have suggested that when measuring attitudes for research purposes, removing the behavioural dimension from the attitudes scales serves better to most researchers' purpose. This, according to Sen et al. (2016) could be because it is more difficult for participants to give realistic answers to items related to behaviours than to give answers to items related to feelings and beliefs.

Francis and Greer (1999) also found that students have positive affective attitudes towards science with boys having more positive affective attitudes than girls. However, contrary to the present study, Francis and Greer (1999) provided evidence that affective attitudes become less positive as students move to older school years. Cannon and Simpson (1985), Yager and Yager (1985) and George (2006) also provide evidence of a general deterioration in affective attitudes towards science with age. On the other hand, Sharpe (2015) suggests that although overall attitudes towards science experiments remain positive as students progress through their secondary school, the relative importance of cognitive, affective and behavioural domains changes; they move away from the focus of the affective domain such as enjoyment, and/or excitement to cognitive aspects such as importance and/or preparation for exams. This was also observed during interviews in the present study. While year 6 students focused more on the affective domain stating that they liked science because it was fun, interesting and exciting, when they were thinking about year 7 science they started thinking more about science's importance as an examined subject, for their future studies and careers. The questionnaire data enhances this view as the affective attitudes significantly in year 8 but with the overall attitudes remaining positive, this suggests that potentially the cognitive attitude becomes more positive as students move to older years.

Through interview responses it was noted that when explaining the reasons why they liked science, students used more than one domain. For example, students might have said that they liked science (affective domain) because it was easy (cognitive domain) or they might have stated that they did not like science (affective domain) but that they needed to study it in secondary school (behavioural) because it was important for their future (cognitive). However, looking at the literature, the behavioural component is defined by certain authors as the way the attitudes we have influence how we act or behave (Reiss, 2004; Mcleod, 2018). Therefore, one would expect that students would decide to study science because they like science; because of their positive affective and cognitive attitudes they would choose to behave in a certain way. Nevertheless, when talking to the students who participated in the interviews, a number of students expressed the idea that they wanted to study science and therefore, they had positive attitudes towards science because they considered it important for their future studies and not the other way around.

6.2 Addressing the research questions

6.2.1 Research question 1: What are Cypriot students' attitudes towards primary school science when they are in their final year of primary school (year 6)?

The findings of this study show that primary school students have overall positive (only slightly positive) attitudes towards primary school science when they are in their final year of primary school. The mean for the 'Attitude of year 6 students towards year 6 science' scale was 3.27 (SD=.79) which is positive on the 1-5 scale where 3 is neutral (neither agree or disagree). The study found no significant difference between the attitudes of year 6 boys and girls towards year 6 science (more about gender differences and attitudes towards school science can be found later in this chapter, in section 6.1.4.1). The questionnaire data was consistent with the interview data – the analysis of the year 6 interviews showed that most of the year 6 students that were interviewed had positive attitudes towards school science in year 6. The findings of this study are broadly in line with previous research studies in the field around the world. Hadden and Johnstone (1982) conducting semi-structured interviews and questionnaires, and Galton using classroom observations (2002) also found that year 6 students in the UK reported high enjoyment of school science during their last primary school year. Similar conclusions were drawn in research studies in Australia (Speering and Rennie, 1996; Logan and Skamp, 2008), Spain (Cézar and Pinto, 2017), Turkey (Cermik, 2020), Hungary (Chrappán and Bencze, 2017) and the U.S (Yager and Penick, 1986); these studies also reported that primary school students have positive attitudes towards their primary school science. Some of these research studies are quite old; this shows that 40 years on, primary school students still hold positive attitudes towards primary school science. However, a number of studies conducted in England, Northern Ireland and Oman reveal that although they stay generally positive, primary students' attitudes towards school science decline with age (Galton et al., 2000; Colette Murphy and Beggs, 2001; Murphy and Beggs, 2003).

6.2.1.1 Interest in science lessons

The year 6 questionnaire data also show that the majority of the students (77%) find their year 6 science lessons interesting (as they either strongly agreed or agreed with the statement 'science lessons are interesting'), again in line with the interview responses which showed that over half of the year 6 students that were interviewed stated that they found primary science (or certain aspects/topics of it) interesting (the theme 'interesting' was coded for – please see Chapter 5). The results of this study confirm earlier findings by Hadden and

Johnstone (1982) in the UK as well as findings by Yager and Penick (1986), in the U.S which show that students in primary school had high levels of interest towards their science lessons. In the research by Yager and Penick (1986), two thirds of the primary school students that participated stated that they found their primary school lessons interesting. The studies mentioned above, despite being quite old, are still relevant as a number of more recent studies in the UK (Osborne et al., 2003) and around the world (Dawson, 2000; Anderhag et al., 2016) have also shown that children leave primary school with high interest in science. Anderhag et al., (2016) analysed audio and video recordings showing that primary school students in Sweden find primary science interesting; similar conclusions were drawn by Dawson (2010) who collected data using questionnaires showing that Australian upper primary school students consider primary science interesting.

6.2.1.2 Importance of science lessons

Results from both questionnaire and interview analysis (the theme 'importance' was coded in interview analysis, please see Chapter 5) show that most students find their science lessons important (56% of questionnaire respondents stated that they strongly agree or agree that science lessons are important and 80% of interview respondents stated that science lessons are important for their life and future career). This indicates that students hold, overall positive attitudes towards the utility of science, which is according to George (2006), the perception of the usefulness of science in everyday life and for future career purposes. The findings are consistent with findings of older (as old as forty years) and more recent studies in the field. Hadden and Johnstone (1982), analysing the questionnaire results, have shown that the majority (75%) of the participant primary school students consider their science lessons in primary school important while Yager and Penick (1986) analysing assessment forms completed by the primary school participants have shown that primary school students consider their science lessons important for their daily living (72%), for their further studies (83%) and their future in general (90%). A relationship between positive students' attitudes and the importance or usefulness of science was also reported in the UK by Hodson and Freeman (1983), Mujtaba et al., (2018), and Smail, (1993). Bennett et al., (2013), worked on a review of the UK literature regarding students attitudes, engagement and participation in STEM subjects, which revealed that science is seen by the majority of students as an important subject in the school curriculum and that regardless of students' views about their school science experiences students believe that the importance of science is 'strategic' (p.26) in following desirable careers. Dewitt et al. (2014), Osborne and Collins (2010) as well as Jenkins and Nelson (2005) also emphasise on the fact that the perception of science lessons as important appear to derive from the possibility of future career benefits rather than their engaging and interesting nature.

Also, Braund and Driver (2002), using questionnaire with closed and open-ended questions have provided evidence that year 6 students in the UK consider their science lessons (or certain aspects of it such as practical work) as important in improving their career prospects while an overview of large – scale assessments like the 'Programme for International Student Assessment (PISA)' by Krapp and Prenzel (2011), revealed that over two-thirds of the participant students (looking at all countries together), stated that they consider science lessons to be important and useful.

6.2.1.3 Enjoyment for practical work

Although certain science educators have questioned the purpose of practical work in school science (Wellington, 1998), the vast majority of the year 6 students (87%) that participated in the present study, stated that they like practical work in their science lessons with 75% of the interviewed students stating that experiments are their favourite part of the lesson. Similarly, the data collected using Likert-type questionnaires for a research in Israel by Agranovich and Ben-Zvi Assaraf (2013), provides evidence for primary students' enthusiasm for experiments. The results are also in line with a qualitative, longitudinal study conducted in Australia (Logan and Skamp, 2008) which showed that primary school students are enthusiastic and interested in practical science, especially enjoying to plan and carry out science experiments in school or at home while Braund and Driver (2005), using questionnaires with open-ended questions, found that primary school students in the UK find practical work in science lessons to be enjoyable and useful for learning in school or as part of a job. Also, Eren et al., (2015), have shown that Turkish primary students have favourable attitudes towards science experiments. The results of their study, however, suggest that private school students have more favourable attitudes towards science experiments compared to state school students and this poses a question about how, how often and with what resources the science experiments are taught in state schools. This finding could be particularly relevant to science teaching and learning in Cypriot state schools, especially for biology for which students (who participated in the present study) stated that they have limited opportunities to use the equipment and resources to perform experiments; this is discussed in more detail in section 6.1.3. In line with the findings from the interview analysis of the present study, Campbell (2002) and Ponchaud (2001), have also reported students' positive attitudes towards science experiments, underlining that when primary school students were asked what they liked best in their science lessons, they often stated ‘doing experiments’.

6.2.1.4 Importance of the teacher

In-depth discussion with the students that participated in group interviews revealed that students had positive attitudes towards their school science if they liked their teacher, or the teachers’ teaching style (see section 5.1.3). These findings are supported by literature which has a range of examples of studies that show the relationship between teacher and/or teaching style and student attitudes towards their subject – not just science. For instance, several studies have documented how enthusiastic teachers can increase students’ engagement, motivation and enjoyment for their subject (Keller et al., 2016; Moè, 2016; Lazarides et al., 2019). This view is not only supported by students but from teachers themselves; qualitative interviews with teachers as part of a longitudinal study (Frenzel et al., 2009), revealed that teachers recognise that their enjoyment for their subject has a positive effect on students’ enjoyment for the subject and that the attitudes of students towards the subject depends on the enthusiasm they (teachers) bring to teaching.

The results of the present study are also supported by research around the impact of the teacher on students’ attitudes towards science, which is not new – in fact a range of studies conducted since the 1980s have provided evidence of the importance of the science teacher in shaping students’ positive attitudes towards school science. Studies conducted in the U.S as old as 1982, (Haladyna et al., 1982), indicate that there is a very high correlation between quality of teaching and students' attitudes towards science. Keeves (1992), in their cross-national studies of science achievement with participant students from 23 countries, reported the impact of teachers on students' attitudes stating that teachers are in a position to affect the attitudes of students in their classroom by developing students' interest in science. Therefore, teacher's impact on students' attitudes towards science is widely recognised with Martin (1996), adding that it is the teachers that have the most experience, scientific knowledge, interest and training in science that have the greatest positive effect on students' science attitudes and achievement.

More recent studies, such as Denessen et al. (2015), who used questionnaires to collect data from Dutch primary school students also show that the development of positive attitudes towards primary science is linked to teachers' enjoyment in teaching about science. It was also shown that there was a decline of students' positive attitudes towards primary science when teachers were less enthusiastic about teaching science. Darby (2005), has focused on the role of the relationship between the science teacher and the students in developing positive attitudes towards school science in Australia. Employing participant observation and interviews with focus groups of students and their teacher, she concluded that the relationships formed between the teacher and the students is a critical factor in engaging students with science learning. Research in Sweden (Lindahl, 2012), has also provided evidence of the important role of the science teacher in shaping students' positive attitudes towards science. Students that participated in the interviews of Lindahl's (2012) study stated that science was their favourite subject because they had 'brilliant' teachers while others stated that they did not really like science as science teachers were 'very serious'. Indeed, a range of research studies, conducted worldwide, have also shown a correlation between teacher conduct, class atmosphere, teacher style and students' attitudes towards science. In

Australia, Fraser (1994), highlights that exemplary science teaching involves 'pleasant interaction with students', 'using subtle humour with students' and 'a respect for students' ideas' (Fraser, 1994, p. 518) while Ferguson and Fraser (1998) emphasise on the importance of the teacher-students relationship for the positive attitudes towards science to be formed and maintained. They also highlight the importance of including learning environment dimensions (such as teaching style, teachers' attitude) when researching students' attitudes to science and how they change in the primary-secondary transition. The students that participated in the group interviews of the present study used similar terminology (as the ones used in the studies mentioned above) when explaining why they liked their science lessons with some of them stating that they liked their science lessons because their science teachers were 'amazing' and 'fun' and that they enjoyed their science lessons because their teachers were 'relaxed' and they could 'joke with them' (see sections 5.1.3, 5.2.3 and 5.3.3). They also mentioned that they were worried about secondary science (when they were still in primary school) because they expected their science teachers to be 'more serious' than their primary teacher (see section 5.1.6).

In the present study, the interviewed year 6 students underlined the science teacher as an important factor determining whether they would like science in secondary school or not; in line with the findings of the present study, Speering and Rennie (1996), too, find that the teacher-student relationship is a critical factor when it comes to students' attitudes and how they change as students move from primary to secondary school. The authors, using their results, explain that the students they followed from year 6 to year 7 in their longitudinal study were disappointed with the teaching strategies used in secondary science and they preferred the close teacher-student relationship they had while they were still in primary school. Similar problems were identified in Canada and the U.S by Ebenezer (1993), Eccles et al., (1993) and Hargreaves and Earl (1994) with Eccles (1989), in an older study, stressing out that the change in the teacher-students relationship after the transition to secondary school has a detrimental effect on students' motivation and attitudes towards science. In Brunei, Brok et al., (2005), used quantitative data collection methods to provide evidence for the strong, positive relationship between students' perceptions of their science teacher's interpersonal behaviour and their attitudes towards primary science. In England, Osborne and Collins (2010), state that one of the most important themes that emerged from their focus-group discussions with students was the importance of the role played by teachers in stimulating and maintaining students' interest in science which was raised unprompted by pupils in every group. Research in Cyprus has also shown that teacher is among the most important factors affecting students' attitudes towards science (Papanastasiou, 2002). Their study involved analysing the data collected from the student questionnaires for TIMMS 1995; the model developed showed that the strongest direct influence on students' attitudes towards science is teaching. The author explains that attitudes can be learned and taught and therefore, positive attitudes should be important educational objectives.

Only one study in the reviewed literature supports that teacher, teacher's attitudes and teaching methods are found to have no significant impact on students' attitudes (Chrappán and Bencze, 2017). The authors, who based their conclusions on data they collected from Hungarian schools using questionnaires, argue that it is the curriculum and subject content we need to focus on when looking into students' attitudes towards school science. The findings in the current study contradict this earlier work.

6.2.2 <u>Research question 2</u>: What are Cypriot students' attitudes towards secondary school science when they are in their final year of primary school (year 6)?

The findings of this study show that primary school students have overall positive attitudes towards secondary school science when they are in their final year of primary school. The mean for the 'Attitude of year 6 students towards year 7 science' was 3.95 (SD=.63) which is positive on the 1-5 scale and more positive than year 6 students' attitudes towards primary school science (which was 3.27). The questionnaire results which indicated that most year 6 students were looking forward to year 7 science (please see section 4.1.2 for more details) were found to be in line with the group interviews (please see section 5.1.4 for more details).

6.2.2.1 Excitement of secondary science

Participant students in year 6 appeared to have high expectations of year 7 science – this was indicated both by questionnaire and interview results. Both questionnaire and interview data revealed that year 6 students expected that they would do more interesting experiments in year 7, that they would use better equipment in their experiments, that science would be more interesting in year 7 than in year 6 and that they would learn science in more detail than in year 6. Studies that were conducted previously had similar findings; Griffiths and Jones (1994), found out that primary school students had positive attitudes towards secondary science as they were looking forward to the excitement and danger that secondary school practical work would offer. This was evident in students' interview responses, with one characteristically saying with excitement: 'And you have to dissect frogs' (p.83). Speering and Rennie (1996) , Campbell (2002) and Braund and Driver (2005) also found out that primary school students were looking forward to secondary science as they would be doing 'lots of experiments' and 'better equipment would be used'. Furthermore, students in Galton et al. (2000), stated that the subject they were mostly looking forward to when they joined secondary school was science, explaining that they would be doing experiments 'making bangs and smells' (p. 348).

Primary students in Cyprus (like in the UK) usually have a secondary school induction day during the summer term, just before they move to secondary school. The induction day includes 'typical lessons' for a variety of subjects. Therefore, students' high expectations of secondary science could be a result of the first encounter with the secondary laboratory and experiments on their induction day. However, as Galton (2002), explains these 'typical' science induction days which are full of experiments 'accompanied by dramatic colour changes, dense smoke, loud noises and peculiar smells' (p.256) can create expectations for the first science lessons in the autumn term after transfer which could be unreasonably high. This is also the case in other countries, such as Sweden (Lindahl, 2012), where primary school students have high expectations of secondary science because they get to experience a 'day with experiments' (p.9) towards the end of their final primary year and therefore they expect that secondary science will be just like that.

6.2.2.2 Challenge in secondary science

During group interviews, a number of students shared the idea that they were looking forward to secondary science because it would be more difficult compared to primary school science or because they would be learning challenging things and they appeared to value this as an opportunity to challenge themselves and learn new things. A number of studies have similar findings (Baird et al., 1990; Speering and Rennie, 1996; Galton et al., 2000). Speering and Rennie (1996), concluded that most of the students that participated in their study, expected to enjoy science at secondary school. When asked why they thought so, some students explained that they would enjoy secondary science because it would be harder and more challenging than primary school. Baird et al. (1990), reached the conclusion that when students feel challenged by a science task, they are more engaged in the task. The authors using the answers of students in their written responses and during interviews, explain that lack of challenge can lead to a decline in students' interest and enjoyment of science with students describing work that lacks challenge as boring. Other studies (Logan and Skamp, 2008; Lindahl, 2012), nevertheless, suggest that challenge in science can sometimes lead students to think that they have low ability in science, which in return might lower their positive attitudes towards science. Logan and Skamp (2008), in particular, find a negative correlation between 'difficulty' and 'science interest' and they explain that when students find science difficult, they tend to perceive that they have low ability in science and this can impact their science achievement, attitude and behaviour. Using the results of their research which involved student interviews, Osborne and Collins (2000), draw the conclusion that most of the students welcome challenge in science lessons as a means of pushing themselves to develop their learning and understanding, stating however that some students find it demoralising, boring and 'uninteresting' (p. 22) when the difficulty in science lessons is sustained and unfamiliar words are used. Jarman (1990), also suggests that although science lessons which 'lack demand' (p.22) can be perceived by students as boring and not engaging, a balance needs to be found between low and high challenge in order to achieve an engaging science learning environment.

6.2.2.3 Importance of year 7 science teacher

Finally, in line with a number of studies which were conducted around the world and are already mentioned in section 6.1.2 (Keeves, 1992; Martin, 1996; Papanastasiou, 2002; Brok et al., 2005; Lindahl, 2012; Denessen et al., 2015), students have highlighted the importance of their secondary school science teacher, frequently stating that they believed they would like secondary science if they liked their science teacher. Therefore, it is noticed that the teacher is one of the major factors in the current study that impact students' attitudes towards school science, both when they are in year 6 and they are thinking about the reasons that they like science and when they are thinking about their expectations of year 7 science.

6.2.3 Research question 3: How do Cypriot students' attitudes towards secondary school science change as they move from primary to secondary school.

Analysis of the questionnaire data indicate that students' overall attitudes towards school science as they move from year 6 to year 8 (two-phased transition for science) do not change significantly. Contrary to a wide range of studies across the world that show a decline in students' positive attitudes as they move from primary to secondary school (Breakwell and Beardsell, 1992; Galton and Hargreaves, 2002; Braund and Driver, 2005; Logan and Skamp, 2008; Tytler et al., 2008; Fredricks et al., 2011), this study indicates that overall attitudes towards school science do not change and that they are maintained as positive as students move from primary to secondary school. The reasons that Cypriot students' attitudes are maintained positive are further discussed in more detail below and include factors such as: secondary school science being interesting, secondary science teacher, more experiments especially when chemistry and physics are introduced in year 8. The results of the present study are in line with a study conducted in England by Dewitt et al. (2014), which showed that the majority of students continue to have positive attitudes towards school science between 10-14 years of age. Also, Hamlyn et al. (2020), in a large scale study which was conducted by Wellcome Trust and the Department for Education (UK), indicate that not only students' attitudes during transition do not change but most students (especially the ones who have recently completed year 7) appear to enjoy secondary science more than primary science.

6.2.3.1 Relevance of science to students' everyday life

Some students explained their positive feelings about secondary science in their group interviews using ideas such as: 'learning interesting things', 'learning about our body', 'learning about health' (note: as discussed in section 1.4 due to the two-phase science transition, students in year 7 science are only taught biology). A number of students expressed the idea that what they were learning in year 7 science was relevant to their everyday life, the human body, world diseases and ways to keep healthy. Hamlyn et al. (2020), on the other hand, found that only 27% of secondary school students consider relevance to everyday life a motivating factor to learn science. Previous research studies, however, in line with the present study, have also shown that students have positive attitudes towards secondary biology because they find its relevance to them and their body interesting (Baram-tsabari et al., 2010; Uitto, 2016). Studies have also shown that as students move to older school years, they are more interested in studying human biology, human health, cell biology and gene technology but less living organisms or environmentally-related issues (Tamir and Gardner, 1989; Osborne and Collins, 2000; Baram-tsabari et al., 2010). This could potentially be due to the fact that as students grow older and they are approaching puberty, they are more aware and increasingly more interested in human body and human health (Osborne and Collins, 2000; Baram-tsabari et al., 2010). Thus, although students who participated in the present study, were not performing as many experiments as they expected, which is what they were really looking forward to doing in year 7 (this is further discussed later), they still held positive attitudes towards year 7 science. A possible reason for this might be the interesting and relevant to them topics they were taught in year 7 science such as the reproductive system, puberty and adolescence, hygiene in puberty, menstrual cycle and reproduction, IVF, pregnancy and giving birth, cells, variation, inheritance, biotechnology (MoEC, 2019b). Unfortunately, there were no specific data collected on this as part of the current study.

6.2.3.2 Differences in attitudes between biology, chemistry and physics

However, in year 8, when the other two sciences are introduced (physics and chemistry), we can see that students have more positive attitudes towards them compared to biology (see section 4.1.4). Looking at the questionnaire data, while more than half of the students in year 8 stated that they liked chemistry and physics, only 33% stated that they liked biology. This is in contrast with the study by Hamlyn et al. (2020) which shows that out of the three sciences, secondary school students typically like biology the most and physics the least. The majority of students that participated in the present study, stated that experiments they did in year 8 were more interesting and more fun than in year 7 when they were only doing biology and that they preferred their science experience in year 8 when they were taught all the three sciences compared to year 7 when they only did biology. Students that participated in interviews, when explaining why they liked science in year 8, mentioned experiments in chemistry and physics with some students mentioning that in year 8 biology they did not do any experiments or that they watched experiments instead of doing them themselves. These results are in line with a study conducted amongst Portuguese secondary schools students by Vilia and Candeias (2020); the study concluded that one of the main reasons that students like chemistry and physics is laboratory and practical work or inquiry based tasks. Hamlyn et al. (2020) stated that experience of practical work is key to motivating students in science with more than half of the students in their study listing practical work as the most important motivation to learn science; Dewitt et al. (2014), draw the conclusion that some students preferred secondary school science compared to primary science because of the science experiments they were performing. A number of students in their research explained that practical work in secondary school is exciting because it is more 'dangerous' as they use chemicals and create explosions; although the research by Dewitt et al. (2014) does not differentiate between the three sciences, the reference to chemicals and explosions indicates that it is most likely chemistry experiments that the students find exciting in secondary school. This is in agreement with the discussions and responses of the students that participated in the group interviews of the present study.

Krapp (2002), on the other hand, identifies a significant decline in students' attitudes towards physics and chemistry as students progress through secondary school, possibly due to the increasing difficulty of the two subjects (Gedrovics et al., 2010). Krapp's findings are not in line with the present study's results, however, we need to keep in mind that the data (related to physics and chemistry) for the present study were collected only from year 8, which was students' first encounter with these subjects and therefore, decline of their positive attitudes towards these two subjects might come later as students progress through secondary school. Other studies too, state that although secondary school students have overall positive

attitudes towards secondary science, they find chemistry and physics challenging and many of the topics covered in these two subjects are quite abstract and not experienced in daily life (Ogunkola and Samuel, 2011).
For biology, year 8s -similarly to year 7s-, mentioned how interesting biology was as they were learning about things that were relevant to their body and everyday life. Therefore, year 8s appeared to have positive attitudes towards separate sciences for different reasons; for chemistry and physics because they were more practical and hands-on and for biology because it was relevant to them. Ogunkola and Samuel (2011), analysing data from students' group interviews, have also reached the conclusion that students find biology less difficult than physics and chemistry and more interesting and easier to study because it involves studying the human body and other topics which are relevant to everyday life.

The findings of the present study are in contrast with previous research in secondary schools in Cyprus by Papanastasiou and Zembylas (2004). The researchers found out that attitudes to chemistry and physics were negatively correlated, indicating that the students might tend to have strong preferences towards only one of the two subjects. On the other hand, there was a significant positive relationship between attitudes towards biology and chemistry showing that students who liked chemistry usually also liked biology. This could be because biology and chemistry are both needed for certain studies and careers; in Cyprus, students that want to follow a medical or paramedical career need to study biology and chemistry as compulsory subjects in secondary school. Eurostat data (EUROSTAT, 2020) show that Cyprus is 10th amongst European countries for healthcare professionals per 100 000 inhabitants with a 36% increase in healthcare professional graduates between 2008 and 2018. Therefore, if a number of Cypriot students have aspirations to follow studies or a career in healthcare sector, a positive correlation between attitudes towards biology and chemistry is somewhat expected as research has shown that students have positive attitudes towards sciences when they consider them useful or important for their future studies and careers (Smail, 1993; George, 2006; Bennett, Lubben, et al., 2013; Dewitt et al., 2014; Mujtaba et al., 2018). Similar findings were reported by Elias et al. (2006), who looked into ethnic minority groups' participation in STEM in U.S and found that secondary school students had more positive attitudes towards chemistry than physics; their results were interpreted on the basis that chemistry was a pre-requisite for medicine, a career favoured by non-white U.S students, particularly Asian students.

6.2.3.3 Importance of year 8 science teacher

As with year 6 interviewees, in-depth discussions with year 8s during group interviews, indicated that year 8 students maintained or formed positive attitudes towards science if they liked their science teacher. Some students mentioned that their secondary science teachers made them love sciences and that because of them, science lessons were fun and exciting. Other students stated that what they liked about their secondary teachers compared to their primary ones is that they have studied sciences and therefore, this made students feel that in secondary school their teachers were more enthusiastic, they knew more things about science and they could share this knowledge with them. Therefore, it is noticed that a number of students assumed that because their secondary teachers studied science at university, they are more enthusiastic about science. When students that participated in the present study, felt that their teachers were knowledgeable and enthusiastic about science subjects, making their lessons fun and exciting, they showed more positive attitudes towards science which was also discussed in other studies. Lindahl (2012), Lyons (2006), Osborne and Collins (2001) have argued that one of the challenges in engaging students with science as they move from primary to secondary school is the teaching and learning practices used in secondary school science, especially where the pedagogy is transmissive and the content is decontextualised. Denessen (2015), showed that if science teachers are positive and enthusiastic about their subject, their students appear to have positive attitudes towards the subject too. Also, a long-scale survey that involved 6400 secondary school students (ages 11-18) in the UK (Hamlyn et al., 2020), showed that the teacher is amongst the most important factors impacting students' positive attitudes towards school science. More than half of the surveyed students explicitly stated that they value the science teacher's ability to explain things well and more than a third stated that having a teacher that makes learning fun, that is enthusiastic or passionate and supportive, motivates them to learn science. Finally, in line with students responses in the group interviews which show that students value their teacher knowledge and training, Bennett et al. (2013), underline the importance of enthusiastic teaching from specialist teachers for higher post-compulsory participation with the results of their study showing that low post-compulsory uptake of sciences is associated with non-specialist teaching.

6.2.3.4 Secondary expectations vs reality

Looking at year 6 questionnaire and interview responses, we can see that year 6 students have very positive attitudes towards year 7. Not only are the majority of year 6 students looking forward to doing science in year 7, but they also expect that science will be more fun, more interesting and that they will be doing more interesting and fun experiments in year 7 than in year 6. However, the results show that attitudes of students towards school science remain the same and do not become more positive when students move from primary to secondary school. Therefore, we can draw the conclusion that although students' positive attitudes towards school science are maintained, students are possibly not enjoying science in year 7 as much as they expected. Galton (2002), also found that students come to secondary school with high expectations of science, with many students listing science as one of the subjects they are most looking forward to. However, their enjoyment for school science (which is measured pre- and post-transfer) significantly declines at the end of year 7 compared to year 6. Also, Galton et al. (2000), state that while students had high expectations of science prior to their transfer to secondary school, after transfer the proportion of the students fully engaged with science lessons fell by nearly half. Speering and Rennie (1996) also report that primary school students expected that year 7 science would be exciting, fun, hands – on and challenging with many of the students who enjoyed science in primary school stating that they expected to continue doing so in secondary school. Instead, most year 7 students stated that they were generally bored and their enthusiasm for science lessons was dampened.

Discussions with students in group interviews suggest that this could be because students were disappointed by the frequency of experiments in year 7 stating that they were not doing experiments as often as they expected or that they were watching the experiments instead of doing them themselves. Students in the study conducted by Lindahl (2012), also expected that their secondary science lessons would be filled with activities and science experiments but they stated that they felt disappointed in their first year in secondary school when they were 'supposed to sit still and listen and copy the board' (p.9). Logan and Skamp (2008) have also discussed about students' attitudes declining once they joined secondary school because much of the practical work in secondary school was more teacher directed than students expected. Hamlyn et al. (2020) too, found that students were disappointed in secondary school by the frequency of the practical experiments with 65% stating that they wanted to do more practical work than they were doing. On the other hand, Dewitt et al. (2014), who found that students' attitudes towards school science maintained positive, also highlighted the importance of secondary science experiments expectations to be fulfilled for the students to maintain their positive attitudes. In an earlier study, Speering and Rennie (1996) have also highlighted the difference between students' expectations of secondary science compared to the secondary science reality and the impact this had on students attitudes which declined during the transition between primary and secondary school. The expectations of the year 7 school science were that it would be exciting, fun and hands – on; instead, as shown in responses to the questionnaire, most students were generally bored in their sciences lessons because they felt they involved excessive note-taking and working from a text.

The students that participated in this study stated that although they expected year 7 science to be more fun and exciting than year 6, once they joined year 7 they actually realised that they had been doing more activities and experiments when they were in year 6 and therefore, their year 6 lessons were 'more fun' than their year 7 lessons. Finally, the interviewed year 7 students stated that when they were in year 6, they expected to use better equipment in their science lessons but in year 7 they realised that although they had laboratories equipped with specialised equipment, they rarely had the opportunity to use it. Campbell (2002), also stated that while students are in primary school, they have the expectation of learning science at secondary school with better facilities, specialist equipment and more experiments and hands-on activities. The study draws the conclusion that although the expectations for better facilities and specialist equipment in secondary school are fulfilled, the perception of learning science by doing more experiments with new and exciting equipment was not entirely realistic with more than half of the students stating an unfulfilled expectation in this area.

Another important factor we need to keep in mind when discussing students' disappointment over experiments in year 7, is that, because of the two-phased science transition, students are only taught biology in their year 7 science lessons. Secondary school biology in Cyprus, is at the moment, heavily theoretical with almost no practical lessons or experiments (Agapiou, 2021). Biology teachers in Cyprus have recently protested and taken strike action, demanding the introduction of practical lessons and experiments in the currently theoretical biology courses taught at public secondary schools. Teachers' representatives explained that despite the schools are equipped with all the necessary equipment and resources, they are rarely used by students, with the Ministry of Education suggesting that students only watch visual experiments instead of performing them themselves. The Ministry of Education does not really explain the rationale behind this or if there are certain reasons (such as time pressure, lack of teacher training, health and safety reasons) why the students are not yet to use the equipment to perform the experiments (Agapiou, 2021). This confirms the ideas that students shared in their interviews; that they do have laboratories and equipment in secondary school, but they almost never use it themselves and it is in line with previous studies in the field (Campbell, 2002). The representative of biology teachers has explained that although the Ministry of Education has repeatedly expressed the need to introduce experiments in the biology course since 2015, 'it has not taken the slightest action in this direction' with students still being passive recipients of teacher demonstrations (Cyprus Mail, 2021).

6.2.4 Research question 4: What are the factors influencing Cypriot students' attitudes towards school science?

Some of the factors influencing Cypriot students' attitudes towards school science such as interest, importance, experiments, teachers, high expectations are already discussed in previous sections as they were relevant to research questions 1-3 which are addressed in sections 6.1.1-6.1.3. The factors that are not already discussed such as gender, impact of significant others and parental education level are discussed in turn in this section.

6.2.4.1 Differences by gender

This study shows that both boys and girls have positive attitudes towards science in years 6-8. Analysis of the questionnaire data, showed that gender had no significant impact on the attitudes towards science in any of the years. Other studies have shown that there are no significant differences between the attitudes of girls and boys towards science (Galton, 2002; Sofiani et al., 2017; Hamlyn et al., 2020). A review from Krapp and Prenzel (2011) has suggested that at least in earlier years and lower secondary school, boys and girls do not differ much in their attitudes towards science and in their expectations of having a science related career in the future.

Galton's study (2002) also indicated that both boys and girls had positive attitudes towards year 6 and year 7 science (while they were still in primary school); however, contrary to the present study which shows that the positive attitudes of both boys and girls are maintained, Galton's work (2002) provides evidence that attitudes towards science of both boys and girls decline as students move to secondary school. In line with the findings of the present study, Hanson et al. (2020) have also found no significant differences in attitudes of boys and girls towards school science. Nevertheless, as opposed to the findings of the present study, a number of studies have found significant differences between the attitudes of boys and girls towards science. In certain studies, boys were found to have more positive attitudes towards science than girls (Weinburgh, 1995; Francis and Greer, 1999; DfE, 2019), while other studies showed that boys' attitudes declined faster when students joined secondary school (Simpson and Oliver, 1985; George, 2006; Barmby, Kind, et al., 2008) or girls' attitudes declined faster when students joined secondary school (Hadden and Johnstone, 1982; Doherty and Dawe, 1985).

Although there were no significant differences identified in the attitudes of boys and girls towards science, when looking at the year 8 interview data (when students were able to talk about individual sciences) we can see that in certain cases boys and girls expressed about separate sciences in a different way from each other. A number of girls expressed the idea that they 'like biology' or 'love biology' that 'biology is useful' or 'interesting'. For physics a number of girls stated that is 'boring' and 'hard to understand' or even their 'worst subject this year'. Girls also mentioned that physics in secondary school is harder than they expected. Boys on the other hand seemed to use positive words for all the three sciences. For instance, they used words such as 'important' and 'relevant' to describe chemistry, 'favourite subject', 'easy', 'relevant', 'good at it' for biology and 'really like it', 'easier than I expected', 'good at it' for physics. This shows the importance of using a combination of methods (group interviews along with questionnaires) in data collection if we are to gain a better understanding of a matter as it seems that questionnaires sometimes fail to get to the 'heart' of the matter.

Therefore, the interview data shows that girls show more positive attitudes towards biology and less favourable attitudes towards chemistry and especially physics. The findings related to girls are supported by previous studies as old as 1984 which consider gender to be an important personal factor influencing lower secondary students' attitudes towards sciences. Measor and Woods (1984), found gender differences in students' attitudes to different science subjects with boys tending to dislike strongly biology and the girls tending to dislike strongly physical sciences. More recent studies have also reached similar conclusions, showing that girls are favouring biology (Bourdieu, 1986; Osborne et al., 2003; Prokop, Prokop, et al., 2007; Gedrovics et al., 2010; Kang et al., 2019). However, contrary to these studies which suggest that boys favour 'harder sciences' such as physics, in the present study boys appear to have positive attitudes towards all the three sciences and they are not just favouring physics.

6.2.4.2 The impact of parents and siblings

The analysis of the questionnaire data shows that there is a strong correlation (see results in section 4.3.2) between parents' and students' attitudes towards science in all the years. This does not come as a surprise as other research studies such as Hamlyn et al. (2020) and Osborne et al. (1998), have shown that home background, including ethnicity, can influence students' attitudes towards science. Reports have shown that Cypriot parents have an important influence on their children's course and career choices (Karagiorges, 1986; Papanastasiou, 2002; Papanastasiou and Zembylas, 2002; Papanastasiou and Papanastasiou, 2004). Papanastasiou and Zembylas (2002) explain that because the sense of family is very strong in Cyprus, it is not surprising that there is a high degree of agreement between students and their parents' perceptions of science.

However, when talking to students in group interviews about whether they thought the way their parents felt about science has impacted on the way they feel about science most of them said that this was not the case. Nevertheless, some students mentioned that because their parents liked science, they were able to help them with their homework and students liked this or they mentioned that different science-related activities they did with their parents encouraged them to be interested in science. Therefore, even without the students realising (as people are not necessarily aware of the impact that other people have on them), it appears that the positive perceptions and values of their parents towards science is usually linked to students' positive attitudes towards science. According to Halim et al. (2018), this could be because when parents have positive attitudes towards science it leads them to cultivate their children's interest in science and science -related careers through actions such as sending children to science tuition classes and extra-curricular activities. As Bourdieu (Bourdieu, 1986) explains, within social groups, children tend to develop certain academic motivations and preferences based on the experiences provided by their parents. Thus, when parental involvement exists, students are likely to show more positive attitudes towards science (George and Kaplan, 1998; George, 2000).

The fact that positive attitudes of parents towards science can influence their children's attitudes was also acknowledged by a number of studies conducted worldwide (Simpson and Oliver, 1985; Tenebaum and Leaper, 2003; Archer et al., 2012) with Rainey et al (2018) highlighting that a student's sense of belonging in the science field is related to interpersonal relationships including family. Archer et al. (2010) have explained the effect of parents on students' attitudes towards science using the term 'science capital' and we return to this in more detail in the next section where the effect of parental education and income is discussed.

Another finding of interview analysis is that a number of students, especially the ones in year 6, appeared to shape their attitudes towards science based on the science experience of their siblings or other family members from secondary school science. More specifically, some year 6 students stated that they were looking forward to year 7 science because their siblings or cousins (who are already in year 7) told them that science would be better in secondary school than in primary school. These students said that their siblings or other family members liked science in secondary school so they expected they would like it too. A few students stated that they are not looking forward to secondary science as their siblings told them that they do not like science in secondary school or because they have heard from their siblings that science is hard in secondary school and they need to study a lot. Other studies in the literature have also underlined the impact of family on students' attitudes towards science (Papanastasiou, 2002; Nugent et al., 2015; Rainey et al., 2018).

6.2.4.3 The impact of parental education

Using One -way ANOVA, father's education was found to be significantly related to students' attitudes towards science in all years (see section 4.4.3). In general, it was observed that the higher the education level of the father (according to the students' response to the questionnaire), the higher the mean score for students' attitudes towards science and therefore, the more positive their attitudes towards school science. For year 8 students, it was observed that the education level of the mother was significantly related to students' attitudes towards science. For the year 8 group, the higher the education level of the mother (as reported by the students), the more positive the attitudes of students towards school science. For year 6 and 7, there was some variation in the results, showing that as mothers' education level got higher, students' attitudes towards school science became more positive, however, this variation was not found to be statistically significant. Therefore, the results of this study indicate that parents' education impact students' attitudes towards science, especially father's education in line with Hu et al. (2018) who concluded that students with higher level of paternal education had more positive attitudes towards science. Previous research in Cyprus has also shown that the educational background of the family affect student attitudes towards science (Papanastasiou, 2002). Other studies too (Germann, 1994; Telli et al., 2010) have shown that the higher the academic education parents have, the more positive attitudes students have towards science. Some of these studies mention that parents' education indirectly influences the possibility of students pursuing science by positively influencing their attitudes towards science (Simpkins et al., 2006). The literature suggests that this could be because parents with higher academic level would potentially have a higher income and therefore, they would be able to support their children financially in extra-curricular activities, support them with their homework and in general provide them with support (Fan and Chen, 2001; Byrnes and Miller, 2007; Rice et al., 2013). However, Perera (2014) argues that there is mixed evidence on whether parental involvement differs based on family's socioeconomic status. Studies have also shown that students with parents with higher income, had more positive attitudes towards science (Cibir and Ozden, 2017). As discussed in literature review in more detail (section 2.3.6) Archer et al. (2010) also found that students with 'higher science capital' appear to have more positive attitudes, career aspirations towards and attainment in STEM subjects.

Nevertheless, contrary to the present study and the studies mentioned above, a number of studies in U.S (George, 2000; Dabney et al., 2013) show that students' attitudes towards science do not change statistically based on the parents' education level.

6.2.4.4 The impact of friends and peers

The analysis of the questionnaire data showed only a weak positive correlation between peers’ and individual students’ attitudes towards school science (see section 4.3.2). Most interviewed students stated that their friends’ opinions about school science have not affected theirs and that they always decide whether they like a subject or not based on their own opinion and experience. However, a year 6 student mentioned that they heard from their friends (that were already in year 7) that science was better in secondary school, so they were looking forward to it.

Atwater et al. (1995) analysing data collected from U.S middle school students as well as Schibeci (1984) using quantitative data collected from Australian high school students also found that there was no impact of the peer group on the attitudes towards science of individuals. More specifically, Atwater et al. (1995) found that the attitudes towards science of the students that participated in the study were significantly more positive than the attitudes of their friends. However, most of the previous studies have found positive correlations between peer and individual attitudes towards school science (Talton and Simpson, 1985; Simpson and Oliver, 1985; George, 2000; George, 2006). This could be because peer attitudes can have a strong impact on adolescents’ motivation for learning, course and career choices (Ryan, 2001; Mcinerney, 2008; Olitsky et al., 2010) especially in secondary school, a time when students develop their identity and sense of self and therefore, peer influence can be even stronger (Vedder-Weiss and Fortus, 2012). Papanastasiou and Zembylas (2004) discuss peer pressure in their findings, suggesting that due to peer pressure, students in secondary schools in Cyprus pretend that science is not important to them although personally they might consider it important.

However, there was only one question on the questionnaire of the present study regarding peer attitudes ('My friends like science'). This is further discussed in limitations.

6.3 Summary

This discussion chapter addresses the research questions in turn, relating the findings to the literature.

The first research question looks at what the attitudes of Cypriot students towards primary school science are when they are still in primary school. The data collected from both, questionnaires and interviews show that students have overall positive attitudes towards primary school science when they are still in primary school and this is in line with a range of studies that were performed around the world in the last forty years (Hadden and Johnstone, 1982; Yager and Penick, 1986; Speering and Rennie, 1996; Galton, 2002; Logan and Skamp, 2008; Cézar and Pinto, 2017; Chrappán and Bencze, 2017; Cermik, 2020). Students' responses to both questionnaire and interview questions indicate that they find year 6 science interesting and important- both for their everyday life and their future which is also in line with a number of studies in the field (Hadden and Johnstone, 1982; Hodson and Freeman, 1983; Yager and Penick, 1986; Dawson, 2000; Osborne et al., 2003; George, 2006; Bennett, Braund, et al., 2013; Anderhag et al., 2016; Mujtaba et al., 2018). Also, the majority of year 6 students that participated in the study stated that they enjoy practical work in their science lessons in line with the findings of previous studies (Ponchaud, 2001; Campbell, 2002; Agranovich and Ben-Zvi Assaraf, 2013; Eren et al., 2015). A significant number of studies, conducted around the world since 1980s, show that there is a relationship between teachers' attitudes towards science, teachers' teaching style, the learning environment and the teacher-student relationship and students' attitudes towards school science. The findings of the present study are in agreement with previous studies in the field as the interviews with year 6 students highlighted the importance of the science teacher in shaping students' positive attitudes towards school science (Haladyna et al., 1982; Keeves, 1992; Fraser, 1994; Martin, 1996; Papanastasiou, 2002; Lindahl, 2012; Denessen et al., 2015).

The second research question looks at what the attitudes of Cypriot students towards secondary school science are when they are still in primary school. In line with literature (Baird et al., 1990; Griffiths and Jones, 1994; Speering and Rennie, 1996; Galton et al., 2000; Campbell, 2002; Braund and Driver, 2005; Lindahl, 2012), the data collected from both, questionnaires and interviews show that students have overall positive attitudes towards secondary school science when they are still in primary school. Students' responses to both questionnaire and interview questions reveal that while students are still in primary school, they have high expectations of secondary science. They expect that their science lessons in year 7 will be more challenging, more interesting and that they will perform more experiments with better equipment compared to year 7. Research studies that were conducted in the UK and around the word reached similar conclusions with some of them stating, however, that challenge can have either a positive or a negative impact on students' attitudes towards school science (Jarman, 1990; Osborne et al., 2003; Logan and Skamp, 2008; Lindahl, 2012).

The third research question focuses on how the attitudes of Cypriot students towards school science change as they move from primary to secondary school. Contrary to the vast majority of studies reviewed in the literature and which show that students' positive attitudes towards school science decline as students move from primary to secondary school (Breakwell and Beardsell, 1992; Galton and Hargreaves, 2002; Braund and Driver, 2005; Logan and Skamp, 2008; Tytler et al., 2008; Fredricks et al., 2011), the current study using the collected data shows that students maintain positive attitudes as they move from primary to secondary school in line with studies such as Hamlyn et al. (2020) and Dewitt et al. (2014). Data collected from questionnaires and interviews show that students' positive attitudes are maintained because students find secondary science interesting, important, because of their science teacher and due to the fact that they are doing more experiments, especially in year 8 when chemistry and physics are introduced. Students' attitudes towards year 7 science (when students are only taught biology) appeared to be positive as students find learning about the body and health interesting while in year 8, students appear to have positive attitudes towards science as they get excited about practical work in physics and chemistry. These findings are in line with findings of other research studies (Tamir and Gardner, 1989; Baram-tsabari et al., 2010; Uitto, 2016). Year 8 students appear to have more positive attitudes towards chemistry and physics compared to biology; this finding, however, is in contrast to other research that was conducted in Cyprus and which shows that students' attitudes towards physics and chemistry were negatively correlated (Papanastasiou and Zembylas, 2004). Although year 7 students' attitudes towards science appear to be maintained positive, discussions with students during group interviews reveal that they did not enjoy science in year 7 as much as they expected; they felt that their expectations of secondary science were not met, mainly because they were disappointed by the frequency of the experiments that they were performing in year 7. This confirms the findings of other studies in the field (Speering and Rennie, 1996; Galton et al., 2000; Galton and Hargreaves, 2002; Lindahl, 2012; Hamlyn et al., 2020).

The last research question's focus is the factors influencing Cypriot students' attitudes towards school science in general and during the transition. This chapter includes a discussion about a range of factors that potentially impact the formation or change of students' attitudes towards school science in general and during the transition such as: interest, importance, experiments, science teacher, high expectations of secondary science, gender, attitudes of friends, parents and siblings and parental education. The analysis of the results showed that both boys and girls maintained positive attitudes towards school science and that there were no significant differences in the attitudes of boys and girls towards school science and this result confirms the findings of studies that were reviewed as part of the literature review (Galton and Hargreaves, 2002; Krapp and Prenzel, 2011; Sofiani et al., 2017; Hamlyn et al., 2020; Hanson et al., 2020), although there is an extended part of literature which suggests that there are significant differences between the attitudes of boys and girls towards school science (George, 2006; Barmby, Per M Kind, et al., 2008; DfE, 2019). A strong correlation was found between parents' and students' attitudes towards school science, in line with previous research that was conducted in Cyprus and worldwide (Karagiorges, 1986; Papanastasiou, 2002; Halim et al., 2018). Also, father's education was found to be significantly related to students' attitudes towards science, confirming the results of earlier studies in the field of science education in Cyprus and internationally (Germann, 1994; Papanastasiou, 2002; Simpkins et al., 2006; Telli et al., 2010; Cibir and Ozden, 2017; Hu et al., 2018). Contrary to most of the studies that were reviewed and which show that students' attitudes towards school science are affected by their peers/friends attitudes towards school science (Simpson and Oliver, 1985; Talton and Simpson, 1985; George, 2000; Papanastasiou and Zembylas, 2004; George, 2006; Vedder-Weiss and Fortus, 2012), the present study shows only a weak correlation between peers' and individual students' attitudes towards school science in line with a number of studies in the literature (Schibeci, 1984; Atwater et al., 1995).

Finally, when looking at the three attitude domains, the students appear to have overall positive affective and cognitive attitudes towards school science which are maintained as students move from primary to secondary school as opposed to the results of a number of studies which show a general decline in the positive affective attitudes as they move to older school years (Yager and Yager, 1985; Francis and Greer, 1999; George, 2006; Sharpe, 2015). On the contrary, students appear to have less positive behavioural attitudes towards school science; as Tavsancil (2010) and Triandis (1964) state, this could be because every attitude does not necessarily have a behavioural element.

Chapter 7: Conclusions

By employing mixed methods, this study was set out to investigate Cypriot students' attitudes towards school science, if and how they change as students move from primary to secondary school and the factors that impact the formation of students' attitudes towards school science. The findings indicate that Cypriot students' attitudes towards school science are overall positive, that they do not change significantly as students move from primary to secondary school and that there are no significant differences identified between the attitudes of girls and boys towards school science. A range of factors were found to have an effect on the formation of students' attitudes towards school science in general and during the transition with the most important ones being the science teacher and the enjoyment of experiments/practical work. Other factors that were identified to affect students' attitudes were the importance of science, students' interest in science, students' expectations of secondary science, parents' attitudes towards science, science-related career aspirations and fathers' education level. Students in secondary school were found to have significantly more positive attitudes towards physics and chemistry than biology. Looking at the three attitude domains, students were found to have more positive affective and cognitive attitudes and less positive behavioural attitudes towards school science.

This final chapter, looks at the implications of the study for policy makers and practice (7.1), the contributions of the findings to knowledge, theory and understanding (7.2), the limitations of the study (7.3) and suggestions for further research (7.4). The chapter (and this thesis) closes with some personal reflections (7.5).

7.1 Implications for policy makers and practice

The study findings suggest that policies and curriculum development in Cyprus need to further consider the relevance of science to students as this is something that came up as impacting students' positive attitudes towards science. Students indicated that they like science lessons when they feel they are relevant to their everyday life, their health, their body and their future (see sections 5.1-5.3). Students in year 8 (when they are taught the three sciences separately) have mentioned that they experienced this relevance to their everyday life in their biology lessons (see section 5.3.1). Therefore, policy makers could look into how the physics and chemistry curriculum could be developed further so as to be at least in part more relevant to the students.

Students are only taught biology in year 7 while chemistry and physics are introduced in year 8. Students in year 8 appeared to have more positive attitudes towards chemistry and physics than biology. If policy makers were to consider developing a science curriculum that would engage students in the primary – secondary transition perhaps it would be worth considering introducing all the three science subjects in year 7.

Also, as this study shows that science teacher plays a vital role in students' attitudes towards science (see sections 6.1.1 and 6.1.2), policy makers should consider integrating more compulsory and optional teacher training and personal development opportunities for science teachers into each school's improvement and development plan. This will help to ensure that teachers are kept up to date with any recent advancements in the teaching field, their subject knowledge and contemporary teaching strategies. Furthermore, as discussed in section 1.4, current policy is that, the recruitment of teachers is based on seniority (although this is changing by 2027); teachers are currently on a waiting list, and they are recruited by the Ministry of Education when they reach the top of the list. Students have commented (section 6.1.3) on the importance of their science teacher knowledge and expertise. Therefore, this poses the question whether it would be worth, as well as changing the recruitment processes for teachers, reviewing the promotion policy. For instance, promoting and regularly assessing teachers could be based on other qualities such as their expertise, teaching and qualifications (assessment and promotion of teachers is also currently based on seniority).

All the students who participated in this study showed very positive attitudes towards science experiments. Year 7 and 8 students have commented on the very few opportunities they had to work on practical activities in their biology lessons (see section 6.1.3). Therefore, another important aspect that policy makers need to consider is the wider incorporation of experimental work in science lessons, especially in subjects like biology that have, currently, limited practical opportunities for students. This was both stated by the students that participated in the study and supported by the Cypriot news with biology teachers going on a strike over the limited practical opportunities in secondary biology (Agapiou, 2021). As experimental work seems to have a positive impact on students' attitudes towards science, policy makers need to consider it when devising a curriculum and assessment policies that educate but also keep students engaged and motivated at the same time.

The results show that students' attitudes are positively affected by parental involvement, it would possibly be beneficial if policy makers considered training sessions, workshops and seminar for parents where they would have the opportunity to work with specialists and develop their interest for science, work on strategies that will enable them to support their child’s science learning at home, encourage them and support them to take part in extra-curricular activities that are related to science. Although this may not sound realistic, it is relevant to the Cypriot context; most parents are keen to get involved in their children’s education and schools are often organising seminars for parents on a range of topics which are always well attended by the parents. Currently, only students have the opportunity to attend ‘transition’ days (when they are moving from primary to secondary school) and they have the opportunity to experience a day in secondary school while they are still in primary school. It could therefore, be beneficial for parents and students, if there were open days which parents could attend; these open days could involve talks from different departments (e.g science) about the transition and advice to parents about how to best support their children during transition.

This study also has implications for teaching practice. The main implications of the findings for teachers from this study, are that teachers need to be aware of what students’ attitudes towards science are and what impacts these attitudes, especially the important role they, as teachers, have in the formation of students’ positive attitudes towards science (see section 6.1.1). The findings suggest that science teachers should bring enthusiasm in their teaching, good subject knowledge, planning and incorporating of hands-on activities and experiments in science lessons (see section 6.1.1 and 6.1.2). These findings are also supported by a range of studies that were reviewed in the literature (see section 2.3.2).

One area that has extensively been studied in the literature is the relationship between students’ attitudes towards science and the uptake of science in the post compulsory stage (see section 1.1) -which is typically at age 14 in Cyprus. Literature suggests that if students’ attitudes are maintained positive towards science, they will be keener to take science post-compulsory (see section 1.1). Schools, curricula and assessment should be facilitating teacher lesson planning that considers the factors affecting students' attitudes towards science (including the relevance of science to students' everyday life, the importance of science for their future career and studies, students' excitement about practical work, the appropriate level of challenge in the science lessons). For example, as primary school and early secondary school students have been found to be enthusiastic about practical work in science, it might be advisable to have more practical work in primary school and lower secondary school and then adjust the number and frequency of experiments in upper secondary school appropriately so students can cover the theoretical content in preparation for their exams.

7.2 Contributions of the findings to theory, knowledge and understanding

This thesis has contributed to the theory and knowledge about the three attitude domains: the affective, cognitive and behavioural, regarding students attitudes towards science. Although a number of studies have explored students attitudes towards school science in the past (see section 2.2), in the reviewed literature there was only a small number of studies making the distinction between the affective, cognitive and behavioural domains of the attitudes. A limited number of studies, for instance, have looked at some of the attitude dimensions in relation to science but these were either looking at only one of the science subjects or it was more related to other stages of education. For instance, the study by Sen et al., (2016) looked at the affective and cognitive attitudes of prospective chemistry teachers towards chemistry. Kind et al. (2007) have developed the 'attitudes towards science measures'. While the authors define the affective, cognitive and behavioural domain in their study and they include items related to all the three domains in their questionnaire, there is no distinction or comparison between the attitude components in the analysis or discussions.

Therefore, the present study is, to my knowledge, the first attempt to fully investigate students attitudes towards school science, differentiating between the three attitude domains, to compare students affective, cognitive and behavioural domain and explore how the attitudes towards each domain change as students move from primary to secondary school. The results show that students have positive affective and cognitive attitudes towards school science which are maintained as students move from primary to secondary school and less positive behavioural attitudes. This shows that although students have positive feelings and perceptions about school science, they are not necessarily acting in a certain way based on this (e.g., by choosing science post-compulsory or as their future studies and careers path). The results also show that affective attitudes significantly drop by year 8, and based on the fact that the overall attitudes of students towards school science are maintained positive, it might be an indication that there is a shift in the attitudinal component that students are more positive towards as they move from primary to secondary school (e.g., the affective domain becomes less positive and the cognitive component more positive).

This study has also contributed to knowledge about Cypriot students' attitudes towards science in several ways. It has resulted in a validated instrument that can be used to collect data regarding students' attitudes towards school science in Cyprus and other countries. The items that were used in the questionnaire were taken and adapted from previously validated instruments (see section 3.4). However, the current study marks the first instance of using this kind of attitude measuring items within Cyprus. Also, despite previous studies conducted in Cyprus, showing a relationship between students' positive attitudes and students' achievement in science (see section 1.1), this is the first time that an attempt is made to measure these attitudes, investigate the factors that impact the formation of these attitudes and examine whether they change as students move from primary to secondary school.

Previous studies have highlighted the importance of students forming and maintaining positive attitudes towards science as this can positively impact on their attainment, course selection and career choices (see section 1.1).

The use of the instrument has shown that students in year 8 have significantly more positive attitudes towards chemistry and physics compared to biology. This study gives a new insight into why the attitudes of Cypriot students are significantly more positive towards chemistry and physics. It is shown that attitudes are significantly different between the three subjects due to the difference in nature of the three subjects and how they are taught in Cypriot secondary schools – biology being heavily theoretical, while physics and chemistry curriculum provides opportunities for more hands-on experiences for students.

Another contribution of the present study is that it provides the means for understanding more about the factors that impact Cypriot students' attitudes towards science such as the role of interest, importance, science experiments, expectations, the role of the teacher, family and peers in general and during the transition more particularly. While previous studies have explored some of the factors that impact the formation of Cypriot students' attitudes towards school science (Papanastasiou, 2002; Papanastasiou and Zembylas, 2004; Mettas, 2006) such as the role of the teacher and family, this marks the first research study in Cyprus that attempts to investigate a comprehensive range of factors that affect students' attitudes both in general and during the transition from primary to secondary school.

7.3 Study limitations

As with all research (Price and Murnan, 2004) this study has limitations.

7.3.1 Data collection limitations

One of the key challenges was access to schools at times when students were preparing for their end-of-year formal exams. As mentioned in earlier section, in Cypriot secondary schools, there are formal exams at the end of the year (see section 1.4). Especially in secondary schools, teachers start revision as early as March, with the exam period taking place in the first and second week of May. Students finish school when exam period starts and they do not return until September for the new academic year. Therefore, schools -particularly secondary schools- were undeniably under pressure both due to trying to cover the content and to prepare students for the exam period when the researcher went in to collect data towards the end of the academic year. This means that schools were keen to ensure that students' learning was not disrupted so some of them kindly requested that the researcher only visited the school once. Initially, it was planned that the researcher would visit schools twice- the first time to collect data using questionnaires and the second time to collect data using interviews (after an initial analysis of the questionnaire data that would be used to choose the interview participants). However, because the researcher decided to go to schools only once, the data for the questionnaires and interviews were collected on the same day with teachers choosing the students that would participate in the interviews. Despite the teachers being given directions from the researcher regarding participant selection (for example students of all abilities, equal number of boys and girls, students that like or do not like science), we cannot disregard the fact that there could be bias from teachers when selecting the participant students (with teachers, choosing for example the students that would be more comfortable talking during interviews).

7.3.2 Terminology - ‘science’

Another limitation concerns the use of ‘science’ as an umbrella term to encompass biology, chemistry and physics (Ramsden, 1998). Although in year 8 there was a focus on the separate subjects within science, it was not always possible due to the length of the questionnaire. Therefore, for some items, there were separate questions about each science (e.g ‘I like biology’, ‘I like chemistry’, ‘I like physics’), but for some questions there was no distinction between sciences (e.g ‘I think science lessons are important’, ‘I think science lessons are interesting). This could be problematic as different students could have different attitudes towards different science subjects. For example, as discussed in section 6.1.4.1 , girls and boys could have different attitudes towards different science subjects and therefore, answering accurately questions such as ‘I think science lessons are important’ could be challenging for them because they might, for instance, felt that biology was important to them or their future career but physics and chemistry was not. It would be important in future research to focus more on the attitudes towards the separate disciplines within science.

7.3.3 Validity limitations

The internal validity of this study would be enhanced if there were more items included for the behavioural domain. There were only three items about behavioural domain in the questionnaires that students had to complete. More behavioural domain questions would have further strengthened the validity of the instruments but in this instance, we did not wish to overload students with lengthy questionnaires.

7.3.4 Views on other subjects

This study investigated students' attitudes and how they change as students move from primary to secondary school. However, there were no comparisons with other subjects and there was no measurement of how they felt about the school change (from primary to secondary school). It would be important to investigate students' attitudes and attitude change for other subjects and the school setting – this would provide a reference for comparisons, e.g if students' attitudes about school became less positive as students moved to older years but their attitudes towards science were maintained positive, this would be perceived as a positive outcome etc.

7.3.5 Research design limitations

As one of the aspects that this study focuses on is the change of attitudes in the transition from primary to secondary school, the design could be longitudinal (as described in section 3.3.1) instead of cross-sectional. A longitudinal design would study change in attitudes over time, following the same participants from primary to secondary school. However, this was not possible in the present study, for feasibility reasons; with the two-phase transition for science, it would take at least three years to collect the data.

7.3.6 Other limitations

This study looked into possible factors impacting students' attitudes towards school science- one of them being the impact of peers. However, there was only one question on the questionnaire of the present study regarding peer attitudes ('My friends like science'). Perhaps it would be more appropriate to include a range of questions related to peer attitudes such as importance, interest, career aspirations; this is something that can be looked at in future research. Furthermore, a number of studies state that girls have less peer support for their science interests than boys (Stake & Nickens, 2005) and that the influence of peer groups is a reason that dissuade females from considering science because students tend to engage in activities of their peer groups (Reinkin and Martin, 2017). The present study did not study the effect of peer group on boys and girls separately. This could, again be looked at in future research.

7.4 Suggestions for further research

The current study reports no difference to the attitudes of Cypriot students as they move from primary to secondary school. However, a number of studies in the literature suggest that the change in attitudes comes later, as students progress through their secondary school years. It would be useful to carry out further, longitudinal research in Cyprus, investigating how students' attitudes change as students move through the whole secondary education phase and how these attitudes affect their subject choices post-compulsory and career choices.

Although this study involved a relatively large sample of participants (538 questionnaires and 9 group interviews with 34 participant students), the secondary school data collection was limited to two secondary state schools in Cyprus for which the primary schools were feeder schools. It would be useful to conduct further mixed-methods research across more secondary schools in Cyprus as well as different settings such as private primary and secondary schools, schools that follow a different curriculum and UK schools in Cyprus in order to explore students attitudes further and if there are any differences on students' attitudes based on the type of school (as the science curriculum followed in this schools is different to the one followed in Cypriot state schools). Also, this kind of studies would benefit from considering factors such as the socio-economic backgrounds, parental education and income in a systematic way.

As with other literature (section 2.3.2), the findings of this study confirm that teacher is one of the most important factors that impact students' attitudes towards science. Therefore, further research could be conducted that would involve collecting data, for instance, looking at teachers' attitudes towards science teaching and whether there is a link between teacher attitudes and students' attitudes towards school science.

The current study has shown that in year 8, students have different attitudes towards separate sciences (biology, chemistry and physics), but it has not looked at students attitudes towards separate sciences in primary school and how they change as students move to secondary school as science was treated as one subject in the year 6 and 7 questionnaires. Further research could look more into separate sciences and investigate how attitudes towards individual science subjects change as students move from primary to secondary school. This would also give the opportunity for more comparisons between genders; to investigate boys’ and girls’ attitudes towards certain sciences and whether they change as students move from primary to secondary school. Finally, for comparative purposes it would be useful if further research investigated students’ attitudes towards science in comparison to other subjects or in comparison to their attitudes towards the primary-secondary transition.

7.5 Final remarks and personal reflections

Undoubtedly, attitudes towards school science are an important predictor of students’ attainment, engagement and participation in science and this study has shown that Cypriot students hold positive attitudes towards school science which are maintained as students move from primary to secondary school. This study has also identified the main factors affecting students attitudes in general and during the transition. Therefore, this research journey was given a conclusion, but many of its stories are yet to be told. The experience left by this research study exceeds the findings and conclusions reported in the limits of this PhD thesis. My research journey was surely, a learning curve, that taught me a lot. For instance, perseverance, during challenging times such as through the COVID-19 pandemic and the lockdown period or when dealing with my son’s health challenges. It has also taught me inquisitiveness and enabled me to develop a range of skills that I would have never imagined I could acquire at the start of this journey such as using statistical analysis software, presenting in (online) conferences, reading and writing at academic level.

I enjoyed every stage in the completion of this project, no matter how challenging it was: reviewing the literature, collecting and analysing the data, bringing the results together for the discussion and conclusions. However, what I particularly enjoyed was all the long discussions about science education that I had with the Headteachers and fellow teachers in the different schools I visited, who have genuinely shown interest in my research. Also, I really enjoyed working with students, listening to their views, ideas and opinions about school science and I was particularly impressed with their respectful attitude towards myself and the data collection activities they were involved in. Finally, one of the primary and one of the secondary schools that participated in my data collection were once my schools; it was a really emotional time for me returning to my old schools, where I made some of the best memories in my life, 20 years later, as a researcher and these moments might not be printed in this thesis but they will be for sure printed in my heart forever.

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Appendices

Appendix I: Ethical Approval

The Secretariat
University of Leeds
Leeds, LS2 9JT
Tel: 0113 343 4873
Email: ResearchEthics@leeds.ac.uk

UNIVERSITY OF LEEDS

Agathi Prodromou

School of Education

University of Leeds

Leeds, LS2 9JT

ESSL, Environment and LUBS (AREA) Faculty Research Ethics Committee

University of Leeds

5th January 2018

Dear Agathi

Title of study: **Cypriot Students' Attitudes towards school science: What are they, what impacts them and how do they change as students move from primary to secondary school?**

Ethics reference: **AREA 16-107**

I am pleased to inform you that the above research application has been reviewed by the ESSL, Environment and LUBS (AREA) Faculty Research Ethics Committee and following receipt of your response to the Committee's comments, I can confirm a favourable ethical opinion as of the date of this letter. The following documentation was considered:

Document	Version	Date
AREA 16-107 Ethical_Review_Form_V3_NEW2.doc	2	24/09/17
AREA 16-107 Participant Information Sheet.docx	1	19/02/17
AREA 16-107 Questionnaire -24-9-2017 - Summer Term Year 6.docx	1	24/09/17
AREA 16-107 Questionnaire -24-9-2017 - Summer Term year 7.docx	1	24/09/17
AREA 16-107 Questionnaire -24-9-2017 – Summer term year 8.docx	1	24/09/17

AREA 16-107 Committee Provisional 2 with action taken.docx	1	20/10/17
AREA 16-107 Participant Information Sheet - students2.docx	2	20/10/17
AREA 16-107 Participant Information Sheet -parents2.docx	2	20/10/17
AREA 16-107 Consent form -new2.docx	3	20/10/17

Please notify the committee if you intend to make any amendments to the information in your ethics application as submitted at date of this approval as all changes must receive ethical approval prior to implementation. The amendment form is available at http://ris.leeds.ac.uk/EthicsAmendment.

Please note: You are expected to keep a record of all your approved documentation and other documents relating to the study, including any risk assessments. This should be kept in your study file, which should be readily available for audit purposes. You will be given a two week notice period if your project is to be audited. There is a checklist listing examples of documents to be kept which is available at http://ris.leeds.ac.uk/EthicsAudits.

We welcome feedback on your experience of the ethical review process and suggestions for improvement. Please email any comments to ResearchEthics@leeds.ac.uk.

Yours sincerely

Jennifer Blaikie

Senior Research Ethics Administrator, the Secretariat

On behalf of Dr Kahryn Hughes, Chair, AREA Faculty Research Ethics Committee

CC: Student's supervisor(s)

Appendix II: Ethical approval from the Ministry of Education and Culture, Cyprus for collecting data from schools in Cyprus.

ΚΥΠΡΙΑΚΗ ΔΗΜΟΚΡΑΤΙΑ

ΥΠΟΥΡΓΕΙΟ ΠΑΙΔΕΙΑΣ ΚΑΙ ΠΟΛΙΤΙΣΜΟΥ

ΔΙΕΥΘΥΝΣΗ ΜΕΣΗΣ ΓΕΝΙΚΗΣ ΕΚΠΑΙΔΕΥΣΗΣ

Αρ. Φακ.: 7.19.46.11/7
Αρ. Τηλ.: 22800664
Αρ. Φαξ: 22428268
E-mail: circularsec@schools.ac.cy

11 Μαΐου 2018

Κυρία
Αγάθη Προδρόμου
Δρόμος 152, Αριθμός 8
4130 Πάνω Πολεμίδια
Λεμεσός

Θέμα: Παραχώρηση άδειας για διεξαγωγή έρευνας

Αναφορικά με τη σχετική με το πιο πάνω θέμα αίτησή σας στο Κέντρο Εκπαιδευτικής Έρευνας και Αξιολόγησης, ημερομηνίας 15/2/2018, πληροφορείστε ότι το αίτημά σας για διεξαγωγή έρευνας, με θέμα «*Οι στάσεις των Κύπριων μαθητών απέναντι στις Φυσικές Επιστήμες: Πώς και γιατί αλλάζουν κατά τη μετάβαση από το Δημοτικό στο Γυμνάσιο*», στα πλαίσια έρευνας για την απόκτηση διδακτορικού τίτλου σπουδών στο Πανεπιστήμιο Leeds, εγκρίνεται. Νοείται ότι θα λάβετε υπόψη τις εισηγήσεις του Κέντρου Εκπαιδευτικής Έρευνας και Αξιολόγησης οι οποίες επισυνάπτονται και ότι θα τηρήσετε τις ακόλουθες προϋποθέσεις:

1. θα εξασφαλίσετε τη συγκατάθεση των Διευθυντών / -ντριών των Σχολείων τα οποία θα συμμετάσχουν στην έρευνα,
2. η συμμετοχή των μαθητών θα είναι προαιρετική,
3. θα εξασφαλίσετε τη γραπτή συγκατάθεση των γονέων των μαθητών οι οποίοι θα συμμετάσχουν στην έρευνα,
4. δε θα επηρεασθεί ο διδακτικός χρόνος και η ομαλή λειτουργία του σχολείου για τη διεξαγωγή της έρευνας,
5. θα χειριστείτε τα στοιχεία των εμπλεκομένων με τέτοιο τρόπο, ώστε να διασφαλιστεί πλήρως η ανωνυμία τους, και τέλος,
6. τα αποτελέσματα της έρευνας θα κοινοποιηθούν στο Υπουργείο Παιδείας και Πολιτισμού και στα σχολεία που θα σας παραχωρήσουν διευκολύνσεις για τη διεξαγωγή της.

Ευχόμαστε καλή επιτυχία στους ερευνητικούς σας σκοπούς.

Δρ Κυπριανός Δ. Λούης
Διευθυντής
Μέσης Γενικής Εκπαίδευσης

ΒΚ

Υπουργείο Παιδείας και Πολιτισμού 1434 Λευκωσία
Τηλ: 22 800 600 fax: 22 428268 website: www.moec.gov.cy

<u>Appendix III:</u> Letter sent to the headteachers (Greek Version)

Προς: Κυρία ΧΧΧ

Δημοτικό Σχολείο ΧΧΧ

Διεύθυνση: ΧΧΧ

Θέμα: Διεξαγωγή έρευνας και συλλογή δεδομένων από το σχολείο σας

Αξιότιμη κυρία ΧΧΧ ,

Επικοινωνώ μαζί σας σχετικά με την διεξαγωγή έρευνας στο σχολείο σας, κατά τη διάρκεια του τελευταίου τριμήνου της φετινής σχολικής χρονιάς (Ιούνιος, 2018), στα πλαίσια της διδακτορικής μου μελέτης. Τόσο η διδακτορική αυτή μελέτη όσο και ο σχεδιασμός της αλλά και η συλλογή δεδομένων γίνεται υπό την επίβλεψη των Δρ. Indira Banner και Δρ. Matthew Homer, του Πανεπιστημίου του Leeds, Ηνωμένου Βασιλείου. (University of Leeds, UK).

Στη διδακτορική μου έρευνα με θέμα: **«<u>Η μελέτη της στάσης των Κυπρίων μαθητών απέναντι στο μάθημα της Επιστήμης, κατά την μετάβαση τους από το Δημοτικό στο Γυμνάσιο»,</u>** θα μελετήσω τις στάσεις των Κυπρίων μαθητών απέναντι στο μάθημα της Επιστήμης, εάν και πως αλλάζουν καθώς οι μαθητές προχωρούν από το Δημοτικό στο Γυμνάσιο και τους παράγοντες που επηρεάζουν αυτή την αλλαγή.

Κατά τη διεξαγωγή της έρευνας, όσοι μαθητές της Στ΄ Δημοτικού συναινέσουν για τη συμμετοχής τους, θα συμπληρώσουν ένα ερωτηματολόγιο το οποίο διαρκεί περίπου 10 λεπτά, σε σχέση με το μάθημα της Επιστήμης. Με βάση τις απαντήσεις των μαθητών στο ερωτηματολόγιο, μια μικρότερη ομάδα μαθητών (τέσσερις στον αριθμό) θα επιλεχθεί για να λάβει μέρος σε συνέντευξη η οποία θα διαρκεί περίπου 20 λεπτά, όπου θα μου δοθεί η ευκαιρία να συζητήσω μαζί τους περαιτέρω για τις απαντήσεις τους στο ερωτηματολόγιο.

Με τη συμμετοχή του σχολείου σας στην έρευνα αυτή, μας δίνετε τη δυνατότητα να εξερευνήσουμε και να καταλάβουμε τις στάσεις των μαθητών απέναντι στη Επιστήμη. Έτσι θα συμβάλετε στην δημιουργία και την ανάπτυξη μεθόδων οι οποίες θα βελτιώσουν ή θα διατηρήσουν τις θετικές στάσεις των μαθητών για το μάθημα της Επιστήμης στο μέλλον.

Το πανεπιστήμιο του Leeds ακολουθεί αυστηρές διαδικασίες σε ότι αφορά την ηθική και δεοντολογική διεξαγωγή έρευνας, ειδικά όταν συμμετέχουν παιδιά. Για το λόγο αυτό έχω ήδη καταθέσει το Αναλυτικό Σχέδιο Έρευνας μου τόσο στην ειδική επιτροπή του πανεπιστημίου όσο και στο ΚΕΕΑ (Κέντρο Εκπαιδευτικής Έρευνας και Αξιολόγησης) του Παιδαγωγικού Ινστιτούτου Κύπρου και έχουν εγκρίνει την συλλογή δεδομένων στα πλαίσια της συγκεκριμένης έρευνας.

Επίσης, πριν την έναρξη της έρευνας θα σταλεί ενημερωτικό φυλλάδιο στους γονείς και κηδεμόνες των παιδιών, που θα προσκληθούν να συμμετάσχουν, και θα τους δοθεί η ευκαιρία να αποδεχθούν ή να αρνηθούν τη συμμετοχή του παιδιού τους.

Θα ήθελα να σας διαβεβαιώσω ότι όλοι οι συμμετέχοντες, συμπεριλαμβανομένου των παιδιών, του σχολείου και των δασκάλων, θα αναφερθούν με ψευδώνυμο στην τελική μελέτη. Τα δεδομένα θα είναι αυστηρώς προσωπικά και εμπιστευτικά.

Αν χρειάζεστε οποιεσδήποτε άλλες πληροφορίες μη διστάσετε να επικοινωνήσετε μαζί μου.

Σας ευχαριστώ πολύ για το χρόνο και την κατανόησή σας.

Ελπίζω στη θετική σας απάντηση.

Με εκτίμηση,

Αγάθη Προδρόμου

Appendix IV: Letter sent to the headteachers (Translated into English)

To: Mrs XXX, Head Teacher
XXX Primary School
Address: XXX

Subject: Participation in science education research and data collection from XXX primary school.

Dear Mrs XXX,

I am writing to enquire about conducting some research in your school this term, before the end of this academic year. I am a research student affiliated with the University of Leeds supervised by Dr Indira Banner and Dr Matthew Homer. In my research project: **'Cypriot Students' Attitudes towards school science: What are they, what impacts them and how do they change as students move from primary to secondary school'**, I will explore students' attitudes towards school science, how they change as students move from primary to secondary school and what are the factors that impact this change.

The research will take place with the year 6 students who have consent to participate in the study. These year 6 students will have to complete a 10-minute long questionnaire. A smaller group of year 6 students will be invited to participate in a 30-minute long group interview where we can discuss their views about their science lessons further.

By participating in the research, your school would be contributing to a project that will deepen our understanding of students' attitudes towards school science and so contribute towards developing ways of maintaining students' positive attitudes towards science. This could potentially lead to the improvement of the science attainment for similar students in the future.

The commitment from the school would be to allow me into year 6 science lessons to administer the questionnaire during the summer term.

The University of Leeds has strict ethical procedures on conducting ethical research with young people. Please find the ethical approval of my research from both, the University of Leeds and the Ministry of Education Cyprus, attached. Before beginning the research, I will inform parents and guardians about the research and offer the students, parents and guardians the opportunity to refuse to participate. Throughout the research students, parents and guardians will be able to refuse to participate at any time.

All participants, including students, teachers and the school, would be made anonymous in all research reports. The data collected would be kept strictly confidential, available only to my supervisors and myself, and not used other than specified without the further consent of all involved being obtained. I have an enhanced DBS (formerly known as CRB).

If you feel you would like to take part in the study, or need more information about what is involved, please contact me.

Thank you for your time and attention. I look forward to hearing from you.

Yours sincerely,

Agathi Prodromou

PhD Candidate

py06ap@leeds.ac.uk

Appendix V: Participant information sheet (Greek Version)

Ενημερωτικό έντυπο σχετικά με την συμμετοχή του παιδιού σας στην έρευνα:

‘Οι στάσεις των Κυπρίων μαθητών απέναντι στο μάθημα της Επιστήμης. Πως και γιατί αλλάζουν κατά τη μετάβαση από το Δημοτικό στο Γυμνάσιο’

Το παιδί σας έχει επιλεχθεί να συμμετάσχει σε μια ερευνητική μελέτη. Πριν αποφασίσετε αν επιθυμείτε το παιδί σας να λάβει μέρος, είναι σημαντικό να ενημερωθείτε σχετικά και να κατανοήσετε τους λόγους για τους οποίους γίνεται αυτή η μελέτη και τι συμπεριλαμβάνει. Παρακαλείστε όπως διαβάσετε τις πληροφορίες προσεκτικά και να συζητήσετε με το παιδί σας την δυνατότητα συμμετοχής του στην έρευνα. **Σημειώνεται ότι η έρευνα προϋποθέτει τη σύμφωνη γνώμη του παιδιού ανεξάρτητα από το αν εσείς επιθυμείτε να λάβει μέρος.**

Μπορείτε να επικοινωνήσετε μαζί μας αν έχετε σχετικές απορίες για οτιδήποτε ή αν χρειάζεστε περισσότερες πληροφορίες. Ευχαριστούμε που αφιερώνετε τον χρόνο να διαβάσετε αυτό το ενημερωτικό φυλλάδιο.

Ποιος θα διεκπεραιώσει την έρευνα;

κ. Αγάθη Προδρόμου (Διδακτορική Ερευνήτρια, Πανεπιστήμιο του Λήντς, University of Leeds, UK)

Τίτλος της έρευνας:

Οι στάσεις των Κυπρίων μαθητών απέναντι στο μάθημα της Επιστήμης. Πως και γιατί αλλάζουν κατά τη μετάβαση από το Δημοτικό στο Γυμνάσιο.

Γιατί έχει επιλεχθεί το δικό μου παιδί;

Μέρος αυτής της μελέτης αφορά τις στάσεις των παιδιών απέναντι στην Επιστήμη καθώς προχωρούν από το Δημοτικό στο Γυμνάσιο. Ο λόγος για τον οποίο έχει επιλεχθεί το δικό σας παιδί είναι επειδή βρίσκεται στην τελευταία τάξη του Δημοτικού (Στ΄Δημοτικού) και σύντομα θα αποφοιτήσει και θα ξεκινήσει τη φοίτησή του στην Α΄Γυμνασίου. Κατ’ επέκταση θα μας ενδιέφερε πολύ να μάθουμε πως νιώθει για το μάθημα της Επιστήμης.

Τι θα χρειαστεί να κάνει το παιδί μου εάν συναινέσουμε για τη συμμετοχή του;

Αν συναινέσετε για τη συμμετοχή του παιδιού σας θα χρειαστεί να απαντήσει ένα ερωτηματολόγιο, διάρκειας περίπου 10 λεπτών, το οποίο θα περιέχει ερωτήσεις σχετικές με τις εμπειρίες του γύρω από το μάθημα της Επιστήμης. Ακολούθως, μια μικρή ομάδα μαθητών θα επιλεχθεί με βάση τις απαντήσεις τους στο ερωτηματολόγιο, να συμμετάσχει σε μια συνέντευξη η οποία θα διαρκέσει περίπου 30 λεπτά, σε σχολικό χρόνο. Η διαδικασία της συνέντευξης θα ηχογραφηθεί. Είναι σημαντικό να γνωρίζετε ότι σε περίπτωση που το παιδί σας επιλεχθεί για προσωπική συνέντευξη, παρών/παρούσα κατά τη διάρκεια της διαδικασίας θα βρίσκεται και εκπαιδευτικός του σχολείου.

Τι θα γίνει με τα δεδομένα από τα ερωτηματολόγια και τις συνεντεύξεις μετά το πέρας της μελέτης;

Τα δεδομένα θα αποθηκευτούν από την ερευνήτρια για τρία χρόνια μετά το πέρας της μελέτης αλλά θα χρησιμοποιηθούν μόνο για τους σκοπούς της μελέτης αυτής. Κατά τη διάρκεια αυτών των τριών χρόνων, <u>μόνο</u> η ερευνητική ομάδα του Πανεπιστημίου θα έχει ελεύθερη πρόσβαση στις απαντήσεις του παιδιού σας και όχι το κοινό ή το προσωπικό του Σχολείου (Διευθυντής και δάσκαλοι). Εάν θέλετε μπορείτε να ζητήσετε να δείτε τα δεδομένα που θα έχουν συλλεχθεί είτε από τα ερωτηματολόγια είτε από τις ηχογραφήσεις. Είναι σημαντικό να γνωρίζετε ότι, αν σε οποιοδήποτε σημείο αλλάξετε γνώμη και δεν επιθυμείτε να συμπεριληφθούν οι απαντήσεις του παιδιού σας στη μελέτη, μπορείτε να ζητήσετε από την ερευνήτρια να αποσύρει τις απαντήσεις του (μέχρι δύο βδομάδες μετά τη συλλογή των δεδομένων). Σημειώνεται ότι αν μας ζητηθεί να γίνει απόσυρση θα αποσυρθούν όλα τα δεδομένα που μας έχουν δοθεί μέχρι τη συγκεκριμένη στιγμή.

Μπορείτε να μας υποσχεθείτε εχεμύθεια;

Κάποιες από τις απαντήσεις του παιδιού σας μπορεί να χρησιμοποιηθούν σε δημοσιεύσεις ή επιστημονικά άρθρα σε σχέση με την παρούσα μελέτη αλλά ουδέποτε δε θα χρησιμοποιηθούν τα ονόματά τους. Αν χρειαστεί να δημοσιευτούν κάποιες απαντήσεις ή φράσεις του θα χρησιμοποιηθούν με ψευδώνυμο.

Τι συμβαίνει αν αποφασίσω ότι δε θέλω να λάβει το παιδί μου μέρος ή αν αλλάξω γνώμη;

Η συμμετοχή στη μελέτη είναι εθελοντική. Έχετε το ελεύθερο δικαίωμα να αποφασίσετε αν θέλετε το παιδί σας να λάβει μέρος στη μελέτη ή όχι. Ακόμα και αν αποφασίσετε να λάβει το παιδί σας μέρος, μπορεί να αποσυρθεί οποιαδήποτε στιγμή χωρίς να δώσει οποιαδήποτε αιτιολογία και χωρίς καμιά συνέπεια (μέχρι δύο βδομάδες μετά τη συνέντευξη). Όμως, έχετε υπόψη σας ότι τα στοιχεία που θα δοθούν από το παιδί σας στο ερωτηματολόγιο δε θα μπορούν να αποσυρθούν μετά την παράδοση του ερωτηματολογίου στην ερευνήτρια αφού τα ερωτηματολόγια συμπληρώνονται ανώνυμα και δεν υπάρχει τρόπος ταυτοποίησης.

Υπάρχει κάποιο ρίσκο για το παιδί μου; Ποια είναι τα οφέλη;

Δεν υπάρχει κανένα ρίσκο για το παιδί, την οικογένεια ή τους φίλους του εάν λάβει μέρος σε αυτή τη μελέτη. Με τη συμμετοχή του θα συμβάλει στην καλύτερη κατανόηση για τη στάση των μαθητών απέναντι στο μάθημα της Επιστήμης και τους παράγοντες που την επηρεάζουν.

Ποια είναι η διάρκεια της μελέτης

Η συλλογή δεδομένων θα διεξαχθεί τον Απρίλιο/Μάιο του 2019. Οι συμμετέχοντες θα απαντήσουν σε ένα ερωτηματολόγιο το οποίο χρειάζεται περίπου 10-15 λεπτά να συμπληρωθεί. Μια μικρότερη ομάδα μαθητών θα ερωτηθούν αν θέλουν να συμμετέχουν σε μια συνέντευξη διάρκειας 30 λεπτών. Η διαδικασία αυτή θα λάβει χώρο στο σχολείο και σε σχολικό χρόνο. Τα παιδιά δε θα επιβαρυνθούν περεταίρω.

Στοιχεία Επικοινωνίας:

Αγάθη Προδρόμου

Τμήμα Εκπαίδευσης

The University of Leeds,

Leeds, LS2 9JT

email: py06ap@leeds.ac.uk

<u>Σημαντική σημείωση</u>: Αν επιθυμείτε να επικοινωνήσετε με το Πανεπιστήμιο του Leeds σε περίπτωση υποβολής παραπόνου ή καταγγελίας, μπορείτε να επικοινωνήσετε με το πιο κάτω αρμόδιο άτομο το οποίο δεν έχει σχέση με τη συγκεκριμένη έρευνα.

Aisha Walker

Post-graduate Research Tutor

Email s.a.walker@leeds.ac.uk

<u>Appendix VI:</u> Consent form (Greek Version)

Συμμετοχή στην έρευνα:

'Οι στάσεις των Κυπρίων μαθητών απέναντι στην Επιστήμη, πως και γιατί αλλάζουν κατά τη μετάβαση των μαθητών από το Δημοτικό στο Γυμνάσιο.'

	Χρησιμοποιήστε τα αρχικά σας για να αποδεχτείτε τους πιο κάτω όρους:
Έχω διαβάσει και κατανοήσει τις πληροφορίες στο συνοδευτικό φυλλάδιο ημερομηνίας 01/04/2019 (το οποίο βρίσκεται στις επόμενες σελίδες) με τις σχετικές πληροφορίες για την παραπάνω μελέτη.	
Αποδέχομαι να φυλαχθούν και να χρησιμοποιηθούν τα δεδομένα που δόθηκαν από το παιδί μου στην παρούσα έρευνα (με ψευδώνυμα).	
Κατανοώ ότι, τα στοιχεία της έρευνας στην οποία θα συμμετέχει το παιδί μου θα μελετηθούν από την ερευνητική ομάδα του Πανεπιστημίου του Λήντς.	
Έχω ενημερωθεί ότι τα στοιχεία που έχουν δοθεί από το παιδί μου στο ερωτηματολόγιο δε θα μπορούν να αποσυρθούν μετά την παράδοση του ερωτηματολογίου στον ερευνητή γιατί τα ερωτηματολόγια συμπληρώνονται ανώνυμα άρα δε θα μπορεί ο ερευνητής να ταυτοποιήσει τα στοιχεία του παιδιού. Έχω επίσης ενημερωθεί ότι τα στοιχεία που έχουν δοθεί από το παιδί μου στη συνέντευξη δε θα μπορούν να αποσυρθούν πέρας των δύο εβδομάδων από την λήψη της συνέντευξης.	
Αποδέχομαι τη συμμετοχή του παιδιού μου στην παρούσα έρευνα.	

Όνομα παιδιού	
Υπογραφή γονιού ή κηδεμόνα	
Υπογραφή/Μονογραφή παιδιού*	
Ημερομηνία	

*__Σημειώνεται ότι η έρευνα προϋποθέτει τη σύμφωνη γνώμη του παιδιού ανεξάρτητα από το αν εσείς επιθυμείτε να λάβει μέρος.__

<u>Σημαντική σημείωση</u>: Αν επιθυμείτε να επικοινωνήσετε με το Πανεπιστήμιο του Leeds σε περίπτωση υποβολής παραπόνου ή καταγγελίας, μπορείτε να επικοινωνήσετε με το πιο κάτω αρμόδιο άτομο το οποίο δεν έχει σχέση με τη συγκεκριμένη έρευνα.

Aisha Walker

Post-graduate Research Tutor, Email s.a.walker@leeds.ac.uk

<u>Appendix VII:</u> Participant information sheet (Translated into English)

Participation in the study:
'Student's attitudes towards school science'

Information Sheet

Your child is being invited to take part in a research study which is part of a research project. Before you decide if you would like your child to take part, it is important for you to understand why the research is being done and what it will involve. Please take time to read the following information carefully and discuss with your child the possibility to take part in this study. Please ask if there is anything that is not clear or if you would like more information. Take time to decide whether or not you wish your child to take part and discuss it with them. **Please note that it is up to your child to decide if they would like to participate or not and both your child and yourselves need to sign the consent form for the participation in the study.** Thank you for reading this.

Who will conduct the research?

Mrs Agathi Prodromou (Research student, The University of Leeds, UK)

Title of the Research

Students' attitudes towards school science: What are they, what impacts them and how do they change as students move from primary to secondary school?

Why have my child been chosen?

One of the aims of the study is to find out how students feel about school science when they move from primary to secondary school. The reason your child is chosen is because they are in the last year of primary school and they will be soon moving to secondary school and we would like them to tell us how they feel about their science lessons before the transition and what they expect their science lessons to be like after the transition.

What would my child asked to do if they took part?

If your child takes part in this study they will be asked to complete a questionnaire that includes questions related to their school science experience in year 6 and/or in year 7. The questionnaire is 10-15 minutes long. A smaller group of students will be invited to participate in group interviews (about 30 minutes long) to discuss about their school science experience in more detail.

What happens to the data collected?

The data will be archived by the researcher before they are permanently deleted. This archive will not be freely accessible to the general public but the data stored there might be looked at or discussed with the supervisory team of the researcher and/or their colleagues. The data will remain with the researcher (for three years after the end of the research) who will use it for research purposes and in publications. Participants will be unable to withdraw their questionnaire data after the data collection (after they have submitted the questionnaire) as the questionnaires will be completed anonymously and there will be no way to identify the responses of individual students. If your child participates in the group interviews, they can withdraw their responses up to two weeks after the group interviews. If they decide to withdraw their data at any point between the data collection and the end of the second week, they can contact the researcher who will withdraw their interview responses.

Can you promise confidentiality?

Participants' names are anonymised in the data accompanying the questionnaires and pseudonyms will be used to annotate recordings. The results of this study may be used in publications and presentations. If results of this study are published or presented, individual names and other personally identifiable information will not be used.

What happens if my child does not want to take part or if they change their mind?

It is up to them to decide whether or not to take part. If they do decide to take part they will be given this information sheet to keep and will be asked to sign a consent form. If they decide to take part they will still be free to withdraw at any time without giving a reason and without detriment to themselves.

Risks and Benefits

There are no risks this study would pose to your child, their family or friends. By participating, your child will contribute to a better understanding of students' engagement with school science and what impacts it.

What is the duration of the research?

The data collection will be completed in the summer term (April-May, 2019). The participants will be given a questionnaire (which takes 10- 15 minutes to complete) during their science lesson. If they are invited to participate in the group interviews, they will spend another 30 minutes with the research and a group of peers discussing about their science lessons. This will also happen during the school day and there will be no further disruption to their lessons or after school activities.

Contact Information

Mrs Agathi Prodromou
School of Education
The University of Leeds,
Leeds, LS2 9JT
email: py06ap@leeds.ac.uk

****<u>Important notice</u>: If you would like to contact the University of Leeds regarding the present study or in case of a complaint regarding this research project please contact the following person who is not related in any way to the current study.**

Aisha Walker

Post-graduate Research Tutor

Email s.a.walker@leeds.ac.uk

Appendix VIII: Consent form (Translated into English)

School of Education

UNIVERSITY OF LEEDS

Consent to take part in a project that studies students' attitudes towards school science

	Add your initials next to the statements you agree with
I confirm that I have read and understand the information sheet dated 01/04/2019 explaining the above research project.	
I agree for the data collected from my child to be stored and used in relevant future research (using pseudonyms).	
I understand that relevant sections of the data collected during the study, may be looked at by auditors from the University of Leeds. I give permission for these individuals to have access to my child's records.	
I have been informed and I understand that the questionnaire data collected from my child cannot be withdrawn after the questionnaire is submitted to the researcher because the questionnaire is completed anonymously and there is no way to identify the child's responses. The data collected from interviews cannot be withdrawn two weeks after interviews have taken place. If, at any point, between the interview and the end of two weeks after the interview I decide that I want to withdraw the interview data, I will contact the researcher who will withdraw my child's data.	
I agree for my child to take part in the above research project and I will inform the researcher if any of my contact details change.	

Name of participant	
Participant's signature	
Date	
Parent/Guardian's Signature	
Date*	

*To be signed and dated in the presence of the participant.

***** Please note that it is up to your child to decide if they would like to participate or not and both your child and yourselves need to sign the consent form for the participation in the study**

***<u>Important notice</u>: **If you would like to contact the University of Leeds regarding the present study or in case of a complaint regarding this research project please contact the following person who is not related in any way to the current study.**

Aisha Walker
Post-graduate Research Tutor
Email s.a.walker@leeds.ac.uk

<u>Appendix IX:</u> Year 6 Questionnaire (Translated into English)

<u>Section A:</u> Circle the appropriate answer

1. What is your gender?

   Male   Female

2. What is your primary language?

   Greek   English   Russian   Other: _______________

3. What is the highest qualification your father/guardian has completed? Circle all the qualifications you know they have completed.

   - Primary school
   - Lower secondary school
   - Upper secondary school
   - Undergraduate degree
   - Master's degree
   - PhD

4. What is the highest qualification your mother/guardian has completed?

- Primary school
- Lower secondary school
- Upper secondary school
- Undergraduate degree
- Master's degree
- PhD

Section B: Read the following questions and tick the appropriate column. If one of the questions is not applied to you please leave the row blank.

	Strongly disagree	Disagree	Neutral	Agree	Strongly Agree
1. I really enjoy science this year					
2. Science lessons are fun					
3. Science lessons are interesting					
4. I look forward to my science lessons					
5. I would like to do more science at school.					
6. Science lessons are boring					
7. Science lessons are hard					
8. I am good at science					
9. I get good marks in my science tests					
10. Science is one of my best subjects					
11. Practical work in science lessons is exciting					
12. I look forward to doing experiments in my science lessons					
13. I like watching TV programmes about science.					
14. I would like to study science at University					
15. I think that science is an important subject.					
16. I would like to have a job working with science					
17. My parents like science					
18. My parents think that science is important					

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
19. My parents think that I should study science at University					
20. My friends like science					
21. I am really looking forward to doing science in Year 7					
22. I think science in secondary school will be more interesting than primary school					
23. I think science in secondary school will be more fun than this year					
24. I think that we will be doing more interesting experiments in secondary school than this year					
25. I think that we will be using better equipment in our science experiments in secondary school than this year					
26. I think that my science teacher in year 7 will have better knowledge of science than my year 6 teacher					
27. I think we will learn science in more detail in year 7 than in year 6					
28. I think I will really like science lessons in year 7					
29. I don't think I will enjoy science lessons in year 7					

Appendix X: Year 7 Questionnaire (Translated into English)

Section A: Circle the appropriate answer

1. What is your gender?

   Male Female

2. What is your primary language?

   Greek English Russian Other: _______________

3. What is the highest qualification your father/guardian has completed? Circle all the qualifications you know they have completed.

   - Primary school
   - Lower secondary school
   - Upper secondary school
   - Undergraduate degree
   - Master's degree
   - PhD

4. What is the highest qualification your mother/guardian has completed?

- Primary school
- Lower secondary school
- Upper secondary school
- Undergraduate degree
- Master's degree
- PhD

<u>Section B:</u> Read the following questions and tick the appropriate column. If one of the questions is not applied to you please leave the row blank.

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
1. I like enjoy science lessons this year					
2. Science lessons are fun					
3. Science lessons are interesting					
4. I look forward to my science lessons					
5. I would like to do more science at school.					
6. Science lessons are boring					
7. Science lessons are hard					
8. I am good at science					
9. I get good marks in science tests					
10. Science is one of my best subjects					
11. Practical work in science is exciting					
12. I look forward to doing experiments in my science lessons					
13. I like watching TV programmes about science.					
14. I would like to study science at University					
15. I think that science is an important subject.					
16. I would like to have a job working with science					

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
17. My parents like science					
18. My parents think that science is very important					
19. My parents think that I should study something to do with science at University					
20. My friends like science					
21. I like science lessons in year 7					
22. I think science lessons are more interesting in year 7 than in year 6					
23. I think that science lessons are more fun in year 7 than in year 6					
24. I think that we are doing more interesting experiments in year 7 than in year 6					
25. I think that we are doing more fun experiments in year 7 than in year 6					
26. I think we are using better equipment in our experiments in year 7 than in year 6					
27. I think that my year 7 science teacher has better knowledge of science than my year 6 teacher					
28. I think we learn science in more detail in year 7 than in year 6					
29. Overall, I enjoy science lessons more in year 7 than last year					

Appendix XI: Year 8 Questionnaire (Translated into English)

Section A: Circle the appropriate answer

1. What is your gender?

   Male   Female

2. What is your primary language?

   Greek   English   Russian   Other: _______________

3. What is the highest qualification your father/guardian has completed? Circle all the qualifications you know they have completed.

   - Primary school
   - Lower secondary school
   - Upper secondary school
   - Undergraduate degree
   - Master's degree
   - PhD

4. What is the highest qualification your mother/guardian has completed?

- Primary school
- Lower secondary school
- Upper secondary school
- Undergraduate degree
- Master's degree
- PhD

Section B: Read the following questions and tick the appropriate column. If one of the questions is not applied to you please leave the row blank.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1. I like biology lessons this year					
2. I like chemistry lessons this year					
3. I like physics lessons this year					
4. Biology lessons are fun					
5. Chemistry lessons are fun					
6. Physics lessons are fun					
7. Science lessons are interesting					
8. I look forward to my biology lessons					
9. I look forward to my chemistry lessons					
10. I look forward to my physics lessons					
11. My biology lessons hard					
12. My chemistry lessons hard					
13. My physics lessons are hard					
14. I am good at biology					
15. I am good at chemistry					
16. I am just not good at physics					
17. I get good marks in my biology tests					
18. I get good marks in my chemistry tests					
19. I get good marks in my physics tests					
20. We are doing a lot of experiments in science lessons this year					

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
21. Practical work in science is exciting this year.					
22. I look forward to doing experiments in my science lessons					
23. I like watching TV programmes about science.					
24. Science is an important subject					
25. I would like to study science at University					
26. I would like to have a job working with science					
27. My parents like science					
28. My parents think that science is important					
29. My parents think that I should study something to do with science at University					
30. My friends like science					
31. I think my science lessons are more interesting this year than in primary school					
32. I think my science lessons are more fun this year than in primary school					
33. We are doing more interesting experiments this year than in primary school					

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
34. We are doing more fun experiments this year than in primary school					
35. We are using better equipment in our science experiments this year than in primary school					
36. I think that my year 8 science teachers have better knowledge of science than my year 6 teacher					
37. I think we learn science in more detail this year than in primary school					
38. Overall, I enjoy science lessons more in year 8 than in primary school					
39. I liked science more last year when we were only doing Biology in our science lessons					
40. It's more interesting this year that we are learning all the three sciences than last year when we were only doing Biology					
41. It's more fun this year that we are learning all the three sciences than last year when we were only doing Biology					
42. We are doing more interesting experiments this year than last year when we were only doing Biology					
43. We are doing more fun experiments this year than last year when we were only doing Biology					
44. We are using better and more specialised equipment in our science experiments this year than last year when we were only doing Biology					

<u>Appendix XII:</u> Interview schedule- Year 6 (Translated into English)

Question	Probe
<u>Theme 1:</u> Perceptions of secondary school – change of school setting	
1. Do you like primary school?	Why? / why not?
2. What part do you enjoy the most?	Why? Which parts aren't as good?
3. Do you expect secondary school to be different from primary school?	Why yes? / why not? How? Do you think it will be better/worse?
<u>Theme 2:</u> Career Aspirations – Future plans	
1. What are you planning to do when you leave school?	Are you planning to go to University? Are you planning to get a job?
2. What job would you like to do?	Why?
3. Do you know what job your parents would like you to do?	Have you ever discussed this with your parents? What is their opinion?
<u>Theme 3:</u> Attitudes towards school science	
1. Which is your favourite subject this year?	What do you like about it?
2. Do you like science?	Why yes? Why not?
3. Which part of science do you like the most?	Why? What do you like about it?
4. How would you describe your science lessons?	
5. Do you think your science lessons are important?	Why? Important for you? For friends and family? For the world? For your future?
6. Do you think your science lessons are fun?	Why? What makes them fun/boring?
<u>Theme 4:</u> Expectations	
1. Are you looking forward to doing science in secondary school?	Why? Why not?

2. Do you expect science lessons to be different in secondary school compared to primary school?	How? Why do you think this?
3. Do you think you will enjoy science more in secondary school than primary school?	Why yes? Why not?
4. Do you think there will be a science laboratory in your secondary school?	Do you expect it to be similar to the one you have in primary school (if you have one)? Different? How? Why?
5. What do you think about the equipment you will be using in secondary school?	Will it be the same as what you are using in primary school? Different? How?
Theme 5: ***Teacher and approaches to teaching***	
1. Do you think your science teacher will be different to your primary school science teacher?	How? In what aspect? What do you expect them to be like?
Theme 6: ***Impact of significant others (parents/family/peers)***	
1. Do your parents work?	Where? What is their job?
2. Did you attend with your family any science events?	Science fairs, museums. How often?
3. Can you think of anything in your home environment that has influenced how you feel about science?	
4. Do your friends like science?	Do you think the way they feel about science have affected how you feel about science?
5. Do you have any older brothers or sisters? (If you know) Do they like science?	

<u>Appendix XIII:</u> Interview schedule- secondary students (Translated into English)

Question	Probe
<u>Theme 1:</u> Perceptions of secondary school – change of school setting	
4. Do you like secondary school?	Why? / why not?
5. What part do you enjoy the most?	Why? Which parts aren't as good?
6. How is secondary school different compared to primary school?	Do you think it is better/worse? Why?
<u>Theme 2:</u> Career Aspirations – Future plans	
4. What are you planning to do when you leave school?	Are you planning to go to University? Are you planning to get a job?
5. What job would you like to do?	Why?
6. Do you know what job your parents would like you to do?	Have you ever discussed this with your parents? What is their opinion?
<u>Theme 3:</u> Attitudes towards school science	
7. Which is your favourite subject this year?	What do you like about it?
8. Do you like science?	Why yes? Why not? ***<u>Year 8 specific:</u> Do you like biology, chemistry, physics? why? Why not? What do you like (not like) about them?***
9. Which part of science do you like the most?	Why? What do you like about it?
10. How would you describe your science lessons?	
11. Do you think your science lessons are important?	Why? Important for you? For friends and family? For the world? For your future?
12. Do you think your science lessons are fun?	Why? What makes them fun/boring?

Theme 4: ***Expectations/Comparison with year 6 science***	
1. Are your science lessons in secondary school similar to the ones in primary school?	How are they similar/different? What do you think about this?
2. Do you enjoy science more in secondary school than primary school?	Why yes? Why not?
3. Do you have a laboratory in secondary school?	Is it similar to the one you had in primary school (if you had one)? Different? How? Why?
4. What do you think about the equipment you are using in secondary school?	Is the same as what you are using in primary school? Different? How?
Year 8 specific: ***Do you prefer science this year (in year 8) or last year in year 7?***	***Can you tell me more about why?*** ***Do you prefer it that you are doing all the three sciences rather than last year when you only did biology? Why? Why not?***
Theme 5: ***Teacher and approaches to teaching***	
2. Do you think your science teacher is different to your primary school science teacher?	How? In what aspect? Is it what you expected them to be like?
Theme 6: ***Impact of significant others (parents/family/peers)***	
6. Do your parents work?	Where? What is their job?
7. Did you attend with your family any science events?	Science fairs, museums. How often?
8. Can you think of anything in your home environment that has influenced how you feel about science?	
9. Do your friends like science?	Do you think the way they feel about science have affected how you feel about science?

10. Do you have any older brothers or sisters? (If you know) Do they like science?	

<u>Appendix XIV:</u> Sample transcript used in qualitative analysis - Example of the coding process followed

Coding key for the identified themes:

Like science

Science is interesting

Science is important

Fun

Teachers

Experiments

Challenge

Science equipment and laboratory

Impact of significant others

Science as separate subjects

<u>Interview Transcript: School PA – Year 6 students</u>

<u>Group interviews with the following year 6 participants:</u>

PA.B.1, PA.G.2, PA.B.3, PA.G.4, PA.B.5, PA.G.6:

1. Do you like primary school?

PA.G.2: It's really nice here in Primary School. My brother is already in secondary school and he finds it more stressful than primary school. When he got there, he was really stressing. I like it here.

PA.B.1: I like primary school but sometimes it becomes a bit boring after six years so I am really looking forward to a change.

PA.B.3: It is quite nice because we have loads of friends and we have great fun during breaks but sometimes it gets a little bit boring. Our teachers are really friendly; we have good relationship with them.

PA.G.4: It's a daily routine, sometimes it's good and friendly, sometimes a bit wilder.

PA.B.5: I believe that Primary school has both good and bad things about it. Sometimes it's difficult and sometimes it's fun. I like that I learn a lot of things and I have good friends here.

PA.G.6: I really like Primary School because I have a lot of friends here.

2. What do you like more about primary school?

PA.G.2: I like the teachers. We know all the teachers and students really well here.

PA.B.1: Our teachers are really friendly with us and we don't have to stress about homework and we don't have a lot of homework.

3. Do you think secondary school will be different from primary school?

PA.G.2: Yes, I will believe it will be more difficult and we will have more tests and they will be more important. We will also have more content to cover.

PA.B.1: I believe it will be harder but it will also be more interesting. We will learn more interesting things.

PA.G.2: Yes, I think too that secondary school will be more interesting.

PA.B.3: We will have to make new friends and we will have to be more serious in classes and when studying than primary school. In secondary school, if we don't get good grades we might have to repeat the year.

PA.G.4: I think that secondary school will be really different to primary school. We will have double the subjects in secondary school and we will have many different teachers, not just one. I think that it might be difficult for us to adapt to the new school.

PA.B.5: I think secondary school will be so different. Some of our friends will go to different secondary schools so we will have to make new friends, we will be grown-ups but still we will be the new, little students in the secondary school and we will have to adapt to a whole new environment. I think it will be more difficult (the subjects) in than in primary school and the teachers there will be stricter and we will have more homework.

PA.G.6: I think we will have to study hard and we will have to study more independently.

4. Any other differences?

PA.G.2: I think the teachers will be stricter and the subjects will be more difficult. But I think we will learn subjects in more detail than in primary school.

PA.B.1: The teachers will not spend as much time explaining the lesson to us. They will tell us the main things and we will have to learn a lot by ourselves.... independently. Also, I think that secondary school will have better equipment.

5. What are you planning to do when you finish secondary school?

PA.G.2: I am not sure but I want to do something related to medicine. Maybe not doctor but something like a pharmacist or a paramedic or optometrist

PA.B.1: I would like to be a doctor because I really like it.

PA.B.3: I would like to become a doctor. It's an interesting job I think and also it can give you a lot of money.

PA.G.4: I would like to become a lawyer.

PA.B.5: I would like to do something related to Arts. It's something I really like and I am good at. However, there are many different subjects we will do in secondary school which, as we said we never done before yet and these subjects might change my mind.

PA.G.6: Something related to science.

6. Do you know what your parents would like you to do? Have they ever discussed this with you?

PA.G.2: Not really, my parents said they would like us to do whatever we like and make us happy. My brother is now asking them (as he needs to make his choices) 'what do you think?' and they always say they don't mind whatever we choose.

PA.B.1: We never discussed this, they always want me to choose myself what I can do.

PA.B.3: My parents agree with medicine (to become a doctor), they said it's a nice job to do.

PA.G.4: They said that anything I will choose they will support me but we haven't discussed about it in detail yet.

PA.B.5: My parents told me that anything I choose they will support me and they don't really have any preferences and they won't really force me to choose a career they want. They want me to be able to choose freely what I would like to do in the future. However, they told me that in secondary school I might see new different subjects that might change my mind so I must keep my mind open.

PA.G.6: They would like me to become an architect but I am not really sure as I am not very good at drawing.

7. Which one is your favourite subject in primary school?

PA.G.2: Maths. I think it's really interesting. Then science

PA.B.1: Mine is science. We always do very interesting experiments and the lesson is very interesting and I am never bored in my science lessons.

PA.B.3: PE of course because you exercise and maths. Maths, because I like problem solving and using numbers to solve a problem.

PA.G.4: I like modern Greek and history because I like writing.

PA.B.5: My favourite subject is art – as I said I really like it, I am good at it and I want to work with arts in the future. I also like history because we learn loads of interesting things about the History of our country and the world. And PE which is more relaxing.

PA.G.6: Maths, science and PE. I really like maths because they are more about numbers and not writing.

8. Do you like science in Primary school?

PA.G.2: I really like science. We know a lot of things about our life but in science we understand more about it. With science we answer a lot of questions we might have about different things

PA.B.1: It's very interesting and with science we understand more about this world.

PA.B.3: Sometimes it's boring but sometimes I like it. Most of the times it's boring because we learn the same things every time. I like when we watch scientific videos. For example, videos for nature and animals.

PA.G.4: It is very interesting subject and you learn a lot of different things in every science lesson. I like learning the theory behind different experiments.

PA.B.5: I think science is nice, our teacher shows us loads of interesting things every time. I love experiments in science and I learn a lot from them. In science we learn about important things that I will definitely use in the future.

PA.G.6: I like science, but not always. Because sometimes it's really hard. And we need to think about a question for a long time until we get the right answer. I also like the experiments in science. It is my favourite part of the science lesson, especially when ***WE*** [student's emphasis] do the experiments and not just watch them.

PA.B.5: … Yes, but that's the interesting thing, that you need to think about it and it's challenging. I especially like it when our teacher lets us plan our experiment ourselves or think about a problem ourselves to find the solution.

9. What part of your science lesson do you like the most?

PA.G.2: I really like experiments. We don't do them very often but when we do they are all fun and nice. Also, I really like our teacher. She knows us all really well and we have a good relationship.

PA.B.1: I like that we learn a lot of things that we wouldn't be able to learn without our science lessons… For example, about forces.

PA.B.5: I love experiments in science and I learn a lot from them. Like that time when I had no idea what friction was and then we did that experiment where we had to use different materials to see with which one it would be hard for the car to move.

10. How would you describe your science lessons?

PA.G.2: I think the words that would describe our science lessons best are interesting, different and unpredictable.

PA.B.1: I like our science lessons! They are fun and different. …Oh, and very interesting.

PA.B.3: Very boring

PA.G.4: Interesting

PA.B.5: Interesting, necessary and nice

PA.G.6: Interesting

11. Do you think it's important to learn science in school?

PA.G.2: I think it is very important because then we can see if we like it and develop it.

PA.B.1: I think it is really important to learn science in school because you learn about useful things you will definitely use in your life. Also, it gives you more choices for your studies...It gives you access to more jobs.

PA.B.3: I don't like science...But, I think it is very important and will be useful for our lives. Like.... I want to become a doctor so I need to study science in Secondary school.

PA.G.4: Definitely science is important because you will for sure have to use science in your life so our science lessons are like ... 'fuel' for the future.

PA.B.5: Yes, it is very important and next year we will have to take a science exam which we need to pass. But, I also think it will be more interesting next year because we will do loads of chemistry and biology and physics as separate subjects. And after that we will go to the real work where we will definitely need science.

PA.G.6: It will help us in the future; it is an examined subject so we need to take it seriously.

12. Are you looking forward to the year 7 science?

PA.G.2: Yes, I really want to see what it will be like. I heard from my friends that it will be better than primary school. My brother also loves science. He wants to become a science researcher. And I think that because I already like it I will love it in secondary school.

PA.B.1: For the science lessons in secondary school I think they will give us more details for every topic and we will use better equipment in our experiments so it will be even more interesting than in primary school.

PA.B.3: Not really.

PA.G.4: I really look forward to science in year 7. I think I will find it very interesting. I think because it will be three different subjects and each one will be different, I will find it very interesting.

PA.B.5: Yes! I think science in secondary school will be... more interesting next year because we will do loads of chemistry and biology and physics...[pauses] separately... so we will learn more about it. It will be more interesting and fun.

PA.G.6: I can't wait because I think our teacher will do fewer experiments and we will do more. They can teach us for example, how to use a microscope. I think the teachers will be strict but I look forward to it because I think we will do more experiments next year.

13. Do you expect it to be different than primary school?

PA.G.2: Yes, science [in year 7] might be a little bit different from this year; we will learn more information about science.

PA.B.1: I think it will be similar to the science in primary school but for the science lessons next year, I think they will give us more details for every topic.

PA.B.3: I think we will have to do more experiments and we will learn things in detail. We will learn about animals and plants and we might get to dissect frogs.

PA.B.5: I believe that we will do more experiments – most of them we will do them by ourselves and not by teacher demonstration. Teachers will be strict but we will learn more and more interesting things and in more detail.

PA.G.6: The lessons will be the same length I think but science is an examined subject in secondary school so we really need to take it more seriously. Some students might not be so interested- same as in primary school - but they will try harder in secondary school because they will have to take an exam.

14. Do you think science will be more fun in secondary school than primary school?

PA.G.2: I think it will be fun, but it is already fun in primary school too.

PA.B.1: I believe science lessons are more fun now [in primary school] because we can be a little bit naughty and more relaxed. But we won't be able to do this in secondary school – the science teacher will be really strict.

PA.G.4: I think science will not be as fun in secondary school because we will have an exam so at some point we will have to revise for the exams and this won't be as fun.

PA.B.5: I think it will be more fun because we will do more experiments and learn more things.

PA.G.6: I don't think it will be very fun. The teachers will be strict and we won't be able to joke in the class or spend time looking and exploring the experiment equipment.

15. Do you have a lab in primary school?

PA.G.2: We have a science classroom and we use this class in our science lessons. We have a storage room with equipment and things (resources) for each topic and we use them when we do experiments. But a lot of things break and they won't order new equipment for us.

PA.B.5: We don't have a lab here. We have a class and it's like a lab. It has a few things like tabs we can use for the experiments.

16. Do you expect that there will be a science lab in secondary school?

PA.G.2: Yes, they will have a special room. It will be like a classroom but it will also have a special space for us to do all our experiments. Here in primary school, we only have a normal classroom and a storage room where we keep all the equipment and other things for each topic. We use them when we do experiments but a lot of things break.

PA.B.1: For the science lessons in year 7, I think we will use better equipment in our experiments so it will be even more interesting than in primary school. I think there will be a science room similar to our Primary School one but we will have a bigger storage room with loads of equipment in –more equipment than in primary school. I think they will have interesting things for us to see like a skeleton.

PA.B.3: Next year, it will have loads of tools that we will not know because they will be more scientific. The equipment will be better, much better, new tools and we will wear special protective clothes and goggles.

PA.G.4: It [Science lab in the secondary school] will have all the equipment for all the experiments that we need to do not just a few of them like here in primary school.

PA.B.5: Yes, it will be different with loads of equipment and tools on the tables. They class will be bigger and they will have a big equipment store.

PA.G.6: It will have a torso and the students will listen carefully because they will find it interesting

17. What sort of equipment do you expect to use in secondary school?

PA.B.1: I think we will be using a microscope and magnifying lenses.

PA.G.2: Definitely test tubes. We don't use them in primary school. We use normal glasses for our experiments but I think we will use more special equipment for our experiments in secondary school.

PA.B.3: The equipment will be better, much better, new tools, we will wear special protective clothes and goggles.

PA.G.4: I think it will be different than primary school.

PA.B.5: I think the equipment will be similar but we will have more of each equipment so there will be enough for all of us to do the experiment.

PA.G.6: More tools, dangerous tools and microscopes

18. Do you think your secondary school science teacher will be different to your primary school teacher?

PA.G.2: I am a bit worried about my science teacher [in year 7] because I think they will not pay attention to each individual student. I mean...They will care for us but as a class, as a group...Maybe not so much for each one separately.

PA.B.1: I believe the teacher will be different because they will not have time to explain everything to every single student.

PA.G.2: Yes, I agree with this. They will not have time to explain everything to every single student.

PA.B.3: Of course. They will have better knowledge of science because they have studied sience.

PA.G.4: They will be different – I believe that secondary school teachers are specialised in science while primary school teachers learn everything in general. They will also more informed about recent science news and discoveries.

PA.B.5: I think some of them will be strict and some nicer some will be more relaxed. I can't predict if my secondary school science teacher will be different [from my primary school teacher] because each teacher has different style. But I think that in secondary school, because each teacher teaches their own subject they will know more about it and they will teach it better. In primary school they teach everything in a simpler way.

PA.G.6: Some of them can be helpful and some not.

19. Do you think your secondary school teacher will have better/more knowledge than your primary school teacher?

PA.G.2: They will have better knowledge.

PA.B.1: They will have better knowledge to be able to explain everything in detail for us.

20. Do your parents work?

PA.G.2: My mother is a doctor but she worked for many years as a nurse. Now she decided to leave medicine and she works more as a physio or massage.

PA.B.1: My mother is a primary school teacher and my father is a RE teacher.

PA.B.3: My mum is a primary school teacher and my dad works at the port.

PA.G.4: My parents do not work.

PA.B.5: My mum is a Primary school teacher and my dad works at a cava in spirit making.

PA.G.6: My mum is a civil engineer and my dad an electrical engineer.

21. Did you ever get the chance to go to any places or events that are related to Science?

PA.B.1: I went to Science Museum and Natural History museum in London.

PA.G.2: Me too. I went to Science Museum and Natural history museum in London with my parents and in similar museums in other countries. My mum also took us to another science event where you could take bloods from a doll. Also, both of us took part in the National Science Olympiad.

PA.B.3: We went with school to a science trip in Nicosia to a 'Dinosaur Museum'

PA.G.4: I went to the Natural Science Museum in London with my family and I really loved it because I had the chance to look at dinosaurs and their bones.

PA.B.5: I have never travelled abroad so I did not have the opportunity to visit one of these museums but I think my mum would definitely take me to one of these museums if she had the chance. She likes museums. Also, I participated in the Science Olympiad.

PA.G.6: I went to the Science Museum in France and the Natural History Museum in London. Also, I visited the Zoo in Paris and right next to it there was a Natural History Museum which I also visited.

22. Do you ever watch Science TV programms.

PA.G.2: I always watch National Geographic once or twice a week.

PA.B.1: I watch science programmes sometimes but not always. I wouldn't say it's my first choice.

PA.B.3: Not really, I don't like it.

PA.B.5: We don't have satellite tv but when I go to my auntie who she has satellite tv I always watch with interest. Also, we have Science Books for kids at home.

PA.G.6: We watch discovery channel and national geographic

23. Do you think your friends like science?

PA.G.2: I think some of my friends find it boring.

PA.B.1: I think the ones that pay attention like Science.

PA.B.3: Not really

PA.B.5: Not all of them

PA.G.6: Some like it some not

24. Do you think your brothers/sisters like Science?

PA.G.2: My brother is in secondary school now. He loves science, he wants to become a researcher.

PA.B.1: My brother is in secondary school but I haven't discussed with him if he likes science.

PA.B.3: Today it was his last science exam, he said that it's difficult and that he needs to study a lot.

PA.G.4: I have two siblings. My brother loves science, he studied mechanical engineering at university. My sister studied accounting.

PA.B.5: My sister is younger than me but my both my cousins study medicine in the University and they like science.

PA.G.6: My sister really loves biology in secondary school. She said it's interesting. And I have a cousin as well and she really likes science too.

Appendix XV: Additional information about the questionnaire piloting

Rationale for the questionnaire piloting

Oppenheim (1992) remarks that ideally everything about the questionnaire should be piloted; including things such as the type, face or the quality of the paper while Cohen, Manion and Morrison (2007) consider that pretesting the wording of questionnaires is crucial to their success. Among the important reasons for conducting a pilot study to test the questionnaire, highlighted by several authors (Oppenheim, 1992; Teijlingen van et al., 2001; Brooks et al., 2016), the following reasons were the ones for which the questionnaire used in the current study was piloted:

- to check the clarity of the questionnaire items, instructions and layout
- to eliminate difficulties in wording
- to check readability levels for the primary/secondary school students who are in this research, the target audience
- to gain feedback on the type of questions and its format (e.g to test the rating scale and multiple choice
- to gain feedback on the layout and numbering
- to check the time taken to complete the questionnaire
- to identify which items are too difficult, complex or too remote from the students' experience
- to identify commonly misunderstood or non-completed items.

According to Cohen, Manion and Morrison (2007) there are two types of piloting. One that focuses on the generated data and one –like the current piloting- that focuses on matters of coverage and format, gaining feedback from a limited number of respondents.

Selection of the participants for the questionnaire piloting

The pilot questionnaire was completed by 16 primary and secondary school students (8 primary and 8 secondary school students) of mixed gender, science ability (as suggested by teachers) and background and therefore, their profile was as similar as to the research participants as possible. The pilot study was conducted about three months before the first administration of questionnaires (spring term 2019) to allow time for the necessary changes to the instruments.

The children participated in the pilot study were in Year 6 (6 students) and Year 7 (8 students) although two of them were slightly younger (year 5) and they attended different primary and secondary schools from the ones that took part in the study. As the full-scale study aimed to explore the attitudes towards school science of both boys and girls, the pilot questionnaire was completed by both girls and boys (8 girls and 8 boys).

Testing the measurement instruments

On average, the respondents took about 10-15 minutes to complete the questionnaires. During the discussion that followed the administration of the questionnaire, all the students said that the amount of time they spent filling the questionnaire in was fair and none of them said that they found the questionnaire long.

While they all attempted to respond to all questions, there were some items that they missed. This appeared to be because the questions were spaced too close to each other, causing some participants to miss a line. Reformatting the layout of questions enabled to mitigate this issue.

A number of students commented that the way the table of questions was designed and the fact that the boxes were placed too close together made it difficult for them to identify the one they would like to tick. As above, reformatting helped overcoming this.

Another comment by the students was the lack of numbering. The questions were not numbered making it difficult for them to refer to a question when asking for clarification. Questions were numbered in the updated questionnaire.

Finally, a spelling mistake was spotted as well as a few typographical errors which were all updated accordingly.

Testing the clarity of questions and instructions

The first part of the questionnaire included questions about the socio-demographic characteristics of the respondents. The third and fourth question was about the highest degree obtained by their parents. They were given the following options: Secondary School, Undergraduate degree, Master's degree, PhD. A significant number of students commented that they were not sure about what kind of degrees their parents have. Also, the instruction which was on the form of a question ('What is the highest qualification your father/mother has completed?') confused some of the students who commented that they were not sure if they should circle all the relevant qualifications their parents hold or just one. The question was modified to reflect the comments made by the students giving the students the option to tick all the relevant qualifications/degrees they know and an additional choice for 'I don't know what is the highest qualification my father/mother has completed' was added.

The second part of the questionnaire included questions related to the attitudes of students towards school science. Question 6 'I like science better than other subjects at school' was a challenging one for the students. Some of the students have not responded to this question which indicates, according to Verma and Mallick (1999) a misunderstood or non-completed item. Later, the students discussed that they like science better than many subjects but not than all the other subjects at school. Reflecting on students' comments, 'I like science better than other subjects at school' would not provide us with valuable information as students for instance, could hate all subjects and science could just be top of the hating list. To try and overcome this problem, the question was removed and it was replaced by: 'Science is one of my favourite subjects'. Also, a question was added which asked students to write down their three most favourite subjects.

One of the affecting factors that are investigated in this research study is the impact of significant others on students' attitudes towards school science. Therefore, some of the questions were about how much their parents like science, if they find it interesting and if they value science. Some of the students commented that they are not sure if their parents like science or not. Alternative questions were added instead to try and explore attitudes or opinions of significant others towards science. These additional questions cover things such as:

Do you think your parents/carers would like you to study science in University?

Have you ever attended science fairs or events with your parents?

The final version of the questionnaire can be found in Appendixes (Appendixes IX – XI).

Appendix XVI: Additional information about the interview piloting

Rationale for the interview pilot

A potential reason that the qualitative pilot work is inadequately reported in the literature (Teijlingen van et al., 2001) might be that the need for qualitative interviews to be piloted is not relatively obvious because as the interviews progress, the quality of the interview guide improves anyway (Harding, 2013). This idea was expressed by other authors (Denzin and Lincoln, 2005; Marshall and Rossman, 2006) who suggest that most qualitative studies, such as interviews use an emergent design which is subject to change once implemented. Additionally, researchers use their experience of different processes within their study (e.g. previous episodes of interviews, observations, responses to questionnaires) to further develop and improve their subsequent interviews. This, according to Kim (2011) should not automatically imply that conducting a pilot study of the qualitative instrument is not essential when conducting qualitative research; rather, many practical reasons do exist for piloting an interview before conducting the qualitative inquiry (Harding, 2013; Castillo-Montoya, 2016). In Castillo-Montoya's (2016) study, she discusses how the interview protocols are potentially strengthened through piloting the interviews. Dikko (2016), underlines that a pilot study will ascertain how well the interview, as a research instrument, will work in the actual study, by identifying potential problems and areas that may require adjustment.

Piloting an interview can be very useful to the researcher too as it can provide unique opportunities to improve the skills of a qualitative researcher in conducting interviews, including dealing with participants, selecting an appropriate venue for the interview and seizing the opportunities for probing emerging topics in the interview process. The pilot study not only provides a ground for reflection on researchers' preparation and capacity but also enables them to practice qualitative inquire and as a consequence enhance the credibility of a qualitative study (Malmqvist et al., 2019). The piloting of the interview for the purposes of the present study aimed to:

1. Highlight ambiguities and questions that might be unnecessary or difficult for the children taking part in the process and discard or modify them accordingly.
2. Record the time taken to complete the interviews to determine whether it is reasonable and consider any changes that might need to occur to change the length of the interview if required.
3. Determine whether each question leads to an adequate and relevant (to the purposes of the study) response.
4. Establish whether replies can be properly interpreted in relation to the information required (Teijlingen van et al., 2001).
5. Determine whether the researcher has incorporated all the questions necessary to answer all the research questions (Berg, 2001).
6. Allow the researcher to practice and perfect interviewing techniques (Berg, 2001).

Testing the time, place of the interview and the number of students involved

The group interview lasted for about 55 minutes. During the discussion that followed the group interview three students said that the amount of time spent for the interview was fair and two thought it was quite long. However, towards the end of the interview (in the last 10 minutes) I noticed that children started becoming easily distracted (by objects in the classroom), they started looking around at the displays and they asked me a couple of questions about how certain things work in science. This could be an indication that the interview process should be slightly shorter. This process enabled me to reflect on the place selected for the interview. A science classroom, full of science displays did not encourage the students to stay focused on the interview. To overcome this difficulty, in the actual interview, the selection of the interview place was carefully considered; a quiet room in students' school, with minimum distractions was chosen and proved to be more suitable for the interview purposes.

There were 6 students in the pilot and this felt like a good number (as the upper limit) for a group interview with students. It gave everyone the opportunity to express their opinions and I was able to manage the conversations. However, a group of 4 would be ideal in terms of the length of the interview (time-wise).

Testing the group interview process

Another very important outcome of the pilot group interview was about my role in conducting the interview. Practising probing questions was very important. At the start of the interview I would get a lot of 'one-word' answers. For instance, I would ask: 'Do you like science?' or 'Do you expect secondary school science to be different to primary school science?' and students would say: 'Yes' or 'No'. This made it clear that I should use probing questions (Why? Why yes? Why no? Why do you think that?) to gain further information and keep the discussion going.

Once the interview started, I noticed that it was more challenging for me to give all the participants the chance to speak equally as some of them seemed to be too quiet (the year 6 and year 7 girls) while others seem to monopolise the conversation (the year 7 and year 8 boys). As the group interview progressed, I became more vigilant to students who were trying to speak and I tried different techniques to elicit further information from them using comments like: ‘Can you tell us more about that?’, ‘Can you tell us what you mean by that?’, and ‘Can you give us an example? At the same time, I tried to deal with dominant participants by acknowledging their ideas and soliciting other opinions using questions like: ‘Thank you very much. What do other people think? For some questions turn-talking was used to ensure that all the participants were expressing their ideas.

Piloting the interview also gave me the opportunity to test how to act spontaneously if the conversation goes in an unexpected but productive direction. For example, when we were discussing about their science lessons, the year 7 and 8 students started talking about practicals and experiments and how they expected to do more practicals in secondary school. This really helped me to test probing deeper into new topics and ideas, by asking questions that were not on the initial interview schedule, when the information being gained is valuable. Students were asked further questions such as: ‘How do you feel about that (eg not doing a lot of practicals)?’ and ‘Why do you think practicals are important?’

The responses of the pilot group interview were not transcribed but when I listened to the audio after the pilot interview I realised that I wasn’t always sure which student was talking as some of them had similar voice. This reminded me that it would be a good practice to call the name of each student before getting them to share their ideas or if they shared something without being asked make sure that I added a comment where their name could be heard such as: ‘Thank you (name)’. This would help me when transcribing the interviews.

Each group of students might be different to the pilot group as they will potentially have a different dynamic. However, piloting the group interview process enabled me to practice and develop my interviewing skills and thus, to feel more confident using some of the techniques tried in the pilot one if necessary.

Testing the clarification and relevance of questions

The first theme of the interview was a discussion about their perceptions of primary/secondary school and their similarities and differences. The students started discussing about their primary/secondary experiences how they are different or how they expect them to be different and they did not ask for any clarifications.

The second part was about their career aspirations. The questions of the second part were not as straight forward for the students. When they were asked: 'What do you want to do when you leave school?' they did not seem to understand that the question was aiming to lead to a discussion about their aspirations, plans to go to University or career plans. Some of them said things like: 'I will buy a car and learn how to drive' or 'I will buy a big house'. This question was changed to: 'Are you planning to go to University when you leave school? What job would you like to do?' Students seemed to respond better to these questions as they started discussing about their future plans and their dream jobs. The questions were updated on the interview schedule to reflect this. The second question which was: 'What do your parents want you to do?' needed further clarification as well. Four students answered: 'I don't know', one student said: 'They told me that they just want me to be happy and healthy when I grow up' and only one student seemed to understand the context of the questions who said: 'They say that they want me to go to University if I want it too.' The question was changed to: 'Do you know what job your parents would like you to do?'

The third theme was about students' attitudes towards school science. Most of this part went smoothly and students were happy to discuss about science, how they feel about science, how they feel about their science lessons etc. However, two items/questions were removed as, when reflecting to the interview process, they were not found to be relevant to the research questions. ‘Give an example of a science subject that you feel is important to learn’ was removed; students did not find this question clear and they found it challenging to answer. Reflecting on this, as the research questions concern attitudes towards secondary science and how/why they change, this question considered to be not as relevant. Also, the last question of this part: ‘Some people say that only those who want to become scientists should study science. Do you agree with this statement?’ generated similar answers as the question prior to that (‘Do you think science is important? Why?) so it was removed as well.

The fourth part was about students' expectations of secondary school science. The questions lead to a good discussion about their expectations; students seemed confident to answer and discuss all the questions. However, one of the questions was slightly changed as I was not sure whether students responded positively just because they felt this was what I wanted to hear. The question: ‘Do you expect secondary school science to be better than primary school science’ (for which students answered positively) was changed to: ‘Do you expect secondary school science to be different than primary school science? Why? How?’. This would help students in the actual interview to reveal what they really think and feel rather than what they think the researcher wants to hear.

Another question was removed from theme five for a similar reason. The question: ‘Do you like your science teacher? Why?’ was changed to: ‘How do you think a science teacher will be different to your primary school teacher? Why? How?’ This was done to encourage students to give genuine responses rather than simply responses to the interview situation and to enable students to get beyond their school's, teacher's, head teacher's etc. expected 'response'.

The last theme was about the impact of significant others (parents/family/peers) and their attitudes towards secondary school. A few questions did not lead to the expected type of responses so they were altered or removed. For instance, when students were asked: 'What do you do in your free time?' they started discussing about things that were not necessarily relevant to the research focus. This question changed to a few other questions such as: 'Did you attend any science fairs/did you go to science museums? (How often?)', 'Do you watch science TV programs with your family? (How often?)', 'Do your parents have any science books?/Do your parents watch science TV programs? (How often?)'.

Appendix XVII: Additional information about Ethical Considerations

Voluntary Informed Consent and Children, Vulnerable Young People and Vulnerable Adults

The students involved in the study will be asked to give their ‘informed consent’ (Cohen, Manion and Morrison, 2007, p.318) for their participation in the research study. BERA (2018) takes voluntary informed consent to be the process during which the participants understand and agree to take part in an investigation without any pressure. According to BERA, researchers should do everything they can to make sure that the people that will be involved in a study, understand as much as possible, what is involved in the study, why their participation is necessary, what they will be asked to do and what will happen to the information they provide. They should also be informed about how long will the information be retained, how and by whom this information will be used and to whom it will be reported. Thus, an information sheet was prepared (alongside the consent form) which covered extensively these points; this was distributed to the potential participants and their guardians.

BERA’s principles of consent apply to children and young people as well as adults; for children and young people BERA endorses the United Nations convention (articles 3 and 12) on the Rights of the Child (UNCRC) which states that the best interests of the child should be the primary consideration. UNCRC also states, that children who are capable of forming their own views should be granted the right to express them freely in all matters affecting them. This view is taken into consideration in this study, as well as the rights and duties of those who have legal responsibility for children (such as parents, guardians and responsible others). Therefore, the consent form included information sheets for both the students and their guardians and both, students and the guardians had to sign the consent form if they wanted to participated in the study.

Transparency

According to BERA (2018), researchers should aim to be open and honest with participants and other stakeholders, avoiding non-disclosure (unless their research design specifically requires it in order to ensure that the appropriate data are collected, or that the welfare of the participants is not put in jeopardy).

In the present study the voluntary informed consent of the participants was secured well before the start of the research and all the participants were treated with honesty. The research design of the present investigation did not require deception or subterfuge to ensure the collection of appropriate data and therefore, this kind of practices were avoided during the data collection (Bertram et al., 2015).

Principles of transparency also apply to possible reuse of data (BERA, 2018) for both future secondary analysis by the same research team to address new research questions or the sharing of the dataset for use by other researchers. On the information letter given to students and guardians when gaining initial consent, it was made clear that there was a possibility for the data to be reused and it was given to the potential participants and their guardians a clear idea about how long data would be stored if it was to be reused. Furthermore, all the data archived were anonymised so if they would be shared with other researchers in the future there would be no possibility to trace the identity of the participants.

In this study, the researcher's work has no conflict of interest, or self-interest or commercial gain which might compromise the objectivity of the research.

Right to Withdraw

In this study, the researcher recognises the right of all participants to withdraw from the research for any or no reason and at any time. The participants were informed by the researcher that they maintained the right to withdraw from the research at any stage or leave specific parts of the questionnaire or interview questions unanswered if they felt they were not comfortable with any of the questions. The decision of any participants to withdraw from the research was accepted without any duress of any form to persuade participants to re-engage. However, the participants were explicitly informed that they would be unable to withdraw their responses after they have returned the completed questionnaire or two weeks after they have participated in the interview.

Privacy and data storage

Participants' entitlement to privacy (BERA, 2018) was considered throughout the study. Confidentiality of personal details was adhered to throughout the study; this was done by informing the students not to write any form of identification on the questionnaire papers. As there was no need for the study to identify any of the students or the schools involved, everything was kept anonymous. During group interviews analysis, 'fictionalising' approaches such as pseudonyms and codes for the schools involved were used when reporting the results to ensure anonymity. How this is done is fully explained in section 3.7.2.

This study complies with the legal requirements in relation to the storage and use of personal data as specified in the UK by the Data Protection Act (1998) and, from May 2018, the General Data Protection Regulation (GDPR). These two acts, state that citizens are entitled to know how and why their personal data is being stored, to what uses it is being put and to whom it may be made available. These are all fully explained to the participant students and their guardians on the information letter that they were given.

The UK Data Protection Act (1998) and the GDPR also confer the right to the participants to have access to any personal data that is stored and which relates to them. GDPR defines personal data as 'any information relating to an identified or identifiable person' and therefore, potential participant students and their guardians were informed that they would be able to access their interview data (as the students could be identified through their voice and name on the recording but not their questionnaire data as there was no way to identify them due to the questionnaire being anonymously completed.

Finally, it was ensured that data were kept securely and that any publication or reporting did not directly or indirectly led to a breach of the agreed confidentiality and anonymity. Measures were taken to ensure that data were kept securely such as the use of the University of Leeds computer network for storage of the data, the use of password protection and the avoidance of using portable storage devices such as USB sticks. Also, data was not shared via email or other media that are vulnerable to hacking.

Disclosure

EECERA (Bertram et al., 2015) considers as a good practise informing the participants of the outcomes of the investigation. Furthermore, BERA (2018), state that researchers have a responsibility to consider the most appropriate ways to inform participants of the outcomes of the research in which they were involved. Therefore, all the participants will be informed of the conclusions of the research and copies or reports arising from their participation will be available to them. The results will be shared with the participant schools that would made the copies available to all the parents and students that participated in the study. Also, audience-friendly presentations will be arranged where the participant schools, students and guardians will be invited should they wish to find more about the findings of the study.

Use of incentives

There was no use of incentives to encourage people to take part in this investigation. This is due to the fact that incentives, when not commensurate with good sense, can impinge the free decision to participate (BERA, 2018).