An investigation into the concept of science, the scientist, the science lesson, and the science classrooms among secondary school students through metaphors

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I certify that all material in this thesis which is not my own work has been identified and that no material has previously been submitted and approved for the award of a degree by this or any other University.

ABSTRACT

Science education occupies an important place in this era, and this includes improvements in knowledge and innovation. That is why many countries strive to improve the quality of their science education. Uncovering the thoughts, experiences and attitudes of students in terms of the concepts of science are quite significant in determining the level of science education. The thoughts and experiences of students in the UK on these concepts and their descriptions of the ideal science lesson and classroom are uncovered in this research. This research is an example of a phenomenological qualitative study, and the participants were selected using a purposive sampling strategy. Data was collected on the use of metaphor among 140 year eight and year nine students in the 2015-2016 academic year. According to the findings, year eight and year nine students describe the concepts of science with similar wording, but place emphasis on different expressions. Year eight and year nine students experience science as a never-ending book or road, a journey without a map, and a jigsaw puzzle, and also year nine students emphasise more the aspect of the incomprehensibility of science. Year eight and year nine students used similar metaphors to describe scientists as explorers, and also as being like children, or like Google. Whilst year eight students expressed a science lesson as an experiment and a journey, year nine students saw a science lesson as a universe and an experiment, and also they experienced science as a difficult subject. Year eight and year nine students described the science classroom as a room full of knowledge and a laboratory, however year nine students highlighted the aspects of a traditional science classroom. Year eight and year nine students gave descriptions of the ideal science lesson, saying that it should have practical and hands-on activities and group working, should use different ways of learning, should not be restricted to taking notes, and that it should be more fun and enjoyable to learn science, and also the ideal

science classroom should have lots of models, posters, and pictures, enough practical science equipment, and should be well-organised and colourful.

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ROSE: The Relevance of Science Education

Others: The Scientist, the Science Lesson, and the Science Classroom

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CHAPTER 1: INTRODUCTION

1.1 Introduction

In this chapter I will present information about the background to this study, the significance of the study, and the research questions which I will be seeking to answer. This research will contribute to our knowledge, as there have been few studies undertaken in the field of science, scientists, science lessons and the science classroom concept utilising metaphors and describing the characteristics of the ideal science lesson and science classroom in the eyes of secondary school students. This absence of literature inspired me to conduct this research, which I hope will be helpful and illuminating for science teachers, school principals and researchers alike.

1.2 General Introduction

Students are interested in science education, as shown by previous studies in this field. In particular, primary school students are interested in science practices and activities, however as students get older this interest appears to decrease. This continues into secondary school, where the number of students taking science subjects declines (Lyons, 2006). Research into the quality of students' science engagement has demonstrated that before coming to the science classroom, some students have misconceptions about science-related concepts. They associate these notions with science lessons, and this may inhibit their understanding of the subject (Tytler, 2002). Having more explicit thoughts about what science involves helps students to become aware of its relationship with their everyday lives, and this ought to occur at an earlier age. A study conducted by Tytler, Osborne, Williams, Tytler, & Clark (2008) observed that before the age of 14, students have made decisions about their future careers. Tytler et al. (2008) expressed that students' early experience of science has an influence on how they become aware of science, and can influence their career choices. It has been suggested that if students were to obtain real knowledge of science, they would have a better understanding of the different aspects of science.

A research study by ROSE (the Relevance of Science Education), an international comparative programme, was conducted to gather information on how students' interest in science enhances, and how the school science curriculum improves students' opinions on science. Schreiner and Sjoberg (2004) expressed how only a few students from developed countries aspire to become scientists, with girls in particular showing lower levels of interest. The ROSE study also observed how, despite the fact that both boys and girls identified science as an interesting subject that should be learned in school, they were not interested in science in comparison to other subjects. Jenkins and Pell (2006) presented the ROSE project results from the perspective of UK students'. Despite the fact that the students who participated in the project held positive points of view on science, most students, and particularly girls, preferred other subjects to science. Also, most boys and girls do not agree that school science has made them 'more critical and sceptical', opened their 'eyes to new and exciting jobs' or increased 'their appreciation of nature' (p.30). Conversely, both boys and girls considered that their school science education would be helpful in their everyday lives, and was useful in terms of enhancing their career choices. Although a number of studies have focused on this and similar concepts, some other studies have aimed to obtain a deeper understanding of students' experiences and perceptions of science and science-related concepts, which is of significant importance to our attempts to help the development of a richer understanding. It is against the backdrop of that research context that I have organised this current study.

1.3 The Research Project

My previous working experiences have influenced my decision to research the subject of students' interest in and engagement with science. When I was working as a science teacher in a school in Turkey, I started to wonder why some students were interested in science and some were not. I started searching for studies in relation to an investigation into students' perceptions of science, and I found a number of studies that had been conducted using various methods to find out students' perceptions of science and science-related concepts. This qualitative phenomenological research was carried out in the UK, and was designed to investigate year 8 and year 9 secondary school students' experiences and perceptions of science, scientists, science lessons and the science classroom (others) and how they used metaphors to describe the characteristics of science and others, and how they described the characteristics of the ideal science lesson and science classroom. 140 students aged from 12 to 14 participated in this research, and six focus group interviews were conducted. An open-ended questionnaire was used to ask students about the metaphors used to explain science and others, and under which various conceptual categories they can be used in terms of their common features. The questionnaire also asked the students to describe the ideal science lesson and classroom using written descriptions. Focus group interviews were utilised to identify the students' experiences of science and others. This research gave me an opportunity to have a closer look at students' views and experiences in a UK-based context.

The main research questions which I used as a guide for this study were as follows:

1- Which metaphors do secondary school students (Years 8 and 9) use to describe the concepts of science, scientists, science lessons, and the science classroom?

2- Under which conceptual categories can the proposed metaphors about the concepts of science and others by secondary school students be classified in terms of their common features?

3- How do secondary school students identify their experiences of science and others?

4- How do secondary school students describe their ideal science lesson and the ideal science classroom?

1.4 Significance of the Study

A number of researchers have utilised metaphors when obtaining details about secondary school students' ways of thinking, making decisions and their perceptions of different statuses, contexts and subjects. The main significance of this research is that it will attempt to fill a gap in the knowledge about this subject in a UK context. This study will also provide insight into science lessons and the science classroom environment in the UK through the eyes of the students. Putting a 'student voice' into science education by rearranging this research will help me to focus directly on what students think and experience with regards to the themes, concepts, contents and purpose of their school science education. I will provide some information to science teachers and school principals with a view to gaining a better understanding of the level of science learning environments and practices. This study will also help them to enhance their classroom learning environments and find out alternative ways to enhance their students' learning and attitudes. Their understanding of the science classroom will lead to science education being more effective in the eyes of their students.

1.5 Research Study Brief Overview

This research is organised into six chapters. Chapter One has introduced the aim of and background to the study. In Chapter Two I will provide a literature review, and I will discuss students' thoughts and experiences of the concepts of science and others. I will also research the factors influencing this and how secondary school students provide descriptions of the ideal science lesson and classroom. In Chapter Three I will describe the theoretical framework that has been used to guide this study, and the research methodology used for data collection. The sampling process, research instruments, data collection and data analysis procedures will be explained and discussed. Ethical issues and challenges encountered will also considered in this chapter. In Chapter Four I will present the findings of the data from the open-ended questionnaire and focus group interviews. The key concepts that emerge from the research questions will be analysed. In Chapter Five I will discuss the findings in the context of the literature, and will attempt to answer the research questions. The limitations of this study will also be discussed. Lastly, in Chapter Six the implications and recommendations of this study on further research will be presented.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

In this literature review I will focus on how students have described and identified their perceptions of science, scientists, science lessons and the science classroom in a number of studies conducted by different researchers by using various types of instrument. This chapter will contain three sections. In the first section, I will discuss students' perceptions of science and scientists; the second section will be a review of the literature on science lesson and science classroom; and in the last section I will look at studies which have focused on the use of metaphor in science and science-related contexts.

2.2 Literature Review of Students' Perceptions of Science and Scientists

Students' perceptions of science have been investigated by many researchers over the years. Their perceptions are affected by both the indoor learning experience, including conceptual knowledge, peers' and teachers' views, practical work and different kinds of sources, and the outdoor learning experience, which includes family, media coverage, or visits to science museums. Students' perceptions of science could be described as their understanding of the subject, and their attitudes towards science are likely to be influenced by these perceptions (Scherz and Oren, 2006). When students were asked about their personal contact with science, for example as a career choice, the negative image was overwhelming. Whatever they had observed through the media, they reflected upon these images by oversimplifying them. Research was conducted by Scherz and Oren (2006) using two drawing instruments. When the images were analysed, students were found to have drawn dangerous environments related to what they had seen in the media. They lacked any realistic understanding of how scientists work, and so they used stereotypical characteristics. There has been a lot of attention paid to the significance of students' perceptions. Students might have the correct information about what science is and what scientists do, and their views on science are linked to their perceptions of science practices (Finson, 2002). Only a few studies have investigated specifically how students' perceptions make a difference in terms of their grades. However, it is not clear from these resources how grade levels have been influenced by these perceptions (Finson, 2002). Studies conducted by Buldu (2006) investigated if there was a difference in the way primary school children drew scientists, taking into consideration their age and gender. In general, students demonstrated similar stereotypical perceptions, with their drawings displaying fewer indicators of the stereotypical model. The findings illustrated that there are significant differences between students' grade levels and students' stereotypical drawings of scientists. An interesting result of this research was that the perceptions of students differed according to their age. Older students drew non-stereotypical scientist drawings, and they drew more detail than younger students. Perceptions are the first consideration when thinking about future plans in Science, Technology, Engineering and Mathematics (STEM) subjects (Painter, Tretter, Jones, and Kubasko, 2006), and they have an influence on students' interest in learning science (Boylan, Hill, Wallace, and Wheeler, 1992). These kinds of perceptions can affect students' interest in learning and studying science and having a science-related career (Finson, 2003; Buldu, 2006). Stereotypical perceptions might negatively affect students' attitudes towards science-related subjects. Speering & Rennie (1996) carried out a longitudinal study on students' points of view during the transition between primary and secondary school in Australia. When they asked what students like best about science, the most frequently given answers were hands-on activities, experiments, discovering and learning new things. They thought that learning science would be useful to their lives. They also believed that science would be exciting, enjoyable, fun and simultaneously harder and more challenging.

Dikmenli (2010) conducted research with undergraduate students to investigate their representations of science and the scientist by using a free word association test. Students' associations of the term science were categorised under six categories including science-technology-society (STS), scientific methods, scientific knowledge, scientific disciplines, reasons for the emergence of science and scientific environments. Students' associations of the scientist also were arranged into six categories including personal character of scientist, activity of scientist, the names of scientist, workplace of scientist, technological developments, physical character of the scientist. Dikmenli (2010) expresses that students' representations of science and the scientist significantly affect their comprehensions of the natural of science and the interest of science. It was found that undergraduate student perceived both positive and negative associations about science and the scientist. Kaya, Afacan, Polat and Urtekin (2013) studied secondary school students' perceptions of science. They used questionnaires which consisted of open-ended questions, and they found that most students highlighted how they viewed scientists as developing interesting activities, inventing new things and helping people, having boring jobs and spending a lot of time in a laboratory. Students' perceptions of science pointed out that science is important to society and is an interesting activity. It seems that these students had a positive image of science. However, science was still associated to laboratory experiments, which exclude the humanities and social sciences. Most students considered that science can create problems for mankind, and science is more suitable for men and is hard to understand. These misconceptions can be resolved, and some students can be inspired to seek a career in science or at least provide future students with a better understanding. Braund and Reiss (2006) suggested that collaborations within universities, such as student-scientist partnerships or student-teacher-scientist partnerships, can provide opportunities to make more students interested in science.

Turkmen (2008) used the DAST (Draw-A-Scientist-Test), created by Chambers (1983), to analyse how the image of scientists is changing in Turkey. The results demonstrated that there are some relationships among the indicators of the stereotypical image of scientists. Thus data analysis could also be carried out determining the tendencies of students from different grades and cultures. Turkmen (2008) concluded that the impact of science teachers, parents, students' friends and textbooks has shaped the idea of what a scientist is and what a scientist does to students' minds, notwithstanding the influence of the media (movies, magazines and television), which is a significant source of information. This is because the Turkish media does not have a responsibility to educate school students. The media present poor quality science stories and display controversial theories as scientific facts. Ruiz-Mallén and Escalas (2012) assessed children's and adolescents' perceptions of scientists in Spain. An analysis of the perceived image of scientists was conducted using drawings. They agreed that the evidence showed that students in Western societies often have a stereotypical image of science, which is strongly influenced by images at home, at school, and in television programmes and films. The study showed that there is a strong relationship between gender and having a stereotypical perception of scientists, and also older students have more stereotypical views. More efforts can have made by science education institutions to reduce the gap between children's perceptions and scientists' reality.

2.3 Literature Review of Students' Perception of Science Lessons and The Science Classroom

Over the years, students' opinions of science learning have been examined by several researchers (Gomez-Arizaga, Bahar, Maker, Zimmerman, and Pease, 2016). Students' perceptions, attitudes and interests have little influence on the science curriculum, pedagogy, and assessments. Students' views on the learning environment are the main factor in students' achievements and affect their learning results. Some researchers such as Flutter and Rudduck

(2004) have reported that by considering their perceptions of science and their science education, students can improve their science learning and develop a number of teaching methods that can affect their level of attainment in science lessons. On the other hand, research conducted on the classroom environment has shown that academic achievement and other learning outcomes have been examined in the cognitive and affective fields in order to develop a wide ranging understanding of the different variables (Doppelt 2004). When students recognise the classroom environment positively, they have more positive attitudes towards the subject taught, and they perform better. Research into students' opinions of their classroom environment was conducted by Fraser (1998), and it focused on building a bridge between students' outcomes and their opinions of the classroom environment, examining the differences between and within students' and teachers' views, exploring if students perform better in their classroom environment, and investigating the influences of classroom environments on curriculum development.

Research conducted by Seok Oh and Yager (2004) who found that students' perceptions of science lessons were affected more positively when their learning was done in a more constructivist-learning environment. Personal relevancy is the most significant factor which influences students' interest and the level of students' feelings towards science learning. Researchers have suggested that science lessons should utilise students' experiences as a context for learning. According to Osborne and Collins (2001), there are some factors, such as teachers' method, teaching strategies and instructional approaches, which have an important role to play in students' perceptions of science lessons. Students thought that science lessons were a crucial subject for their everyday life, however they complained that teachers only focus on the scientific content, which students cannot apply easily to daily life in general. Another factor was that they did not have enough time to understand the concepts addressed by teachers, as they had little time for reflection. Copying, repetition, reading textbooks, writing-up theories and the use of traditional classroom activities were the unenjoyable aspects of science lessons. Osborne and Collins (2001) suggested that teachers should encourage students to involve themselves in science concepts and activities. Gomez et.al (2016) aimed to investigate students' opinions of their science lessons. Students highlighted that many different activities and tasks, such as group working and experiments, were enjoyable, and also the hands-on activities and projects gave them some opportunities to do fun things. A few students stressed that a lack of time and a lack of cooperation among students affected their ability to finish their projects. Students expressed how passive actions, such as sitting down, responding to the teacher, writing and listening to the teacher's instructions, discouraged students from participating.

Previous studies have examined students' views on their learning settings utilising a variety of instruments that analysed classroom features, including cohesiveness, difficulty, diversity, classroom arrangement, laboratory environment, teaching and learning strategies, and target direction. Doppelt and Schunn (2008) and den Brok, Fisher, Rickards and Bull (2006) sought to investigate students' perceptions of the classroom environment in the USA by using the What is Happening in this Class (WIHIC) questionnaire. A number of different backgrounds such as gender, class size, and socioeconomic status were contained in this study. den Brok et.al (2006) found that girls had a more positive attitude to their science classroom environment than boys. Students' opinions are also affected by class size, because teachers do not have enough time to support students on an individual basis in larger classes, which means that students need to find things out by themselves. According to the students', the most effective features of their learning environment were homework and instructional worksheets (Doppelt and Schunn, 2008). However, the researchers could not explain why this was the case. Another study by Ebenezer and Zoller (1993) aimed to examine tenth grade students' perceptions of science classroom practices, using both Likert-type scales and interpretive interview methods. The results showed that the students did not value the most common contemporary practices in science classes, and they perceived science practices as the copying of the teacher's notes and thoughts. They preferred to take an active part in their science learning. Osborne, Simon, and Collins (2003) reported that 'it is somewhat surprising that so little work has been done in the context of science classrooms to identify what are the nature and style of teaching and activities that engage students.' (p. 1074).

Another study conducted by Bernardo, Limjap, Prudente, and Roleda (2008) used a Perception of Science Classes Survey to examine secondary school and high school students' perceptions of their science classes in the Philippines. Several dimensions of the students' perceptions were revealed in the analysis. These related to aspects of the teacher's pedagogy and the learning environment. The findings showed a decrease in inquiry activities and the use of grades as feedback in the higher grades, but an increase in support for self-learning and effort, and also positive effects on attitudes towards the classroom. Ulker, Yilmaz, Solak and Erguder (2013) aimed to provide a view of students' perceptions through their drawings of their ideal classroom environment and how this research could inform educators as they design their classrooms. They observed that students' images included evidence of traditional classroom design, such as desks facing the board and a teacher's table, a board in front of the classroom, and books, but on the other hand some students drew technological instruments instead of books, the ability to access the equipment easily, and no teacher in the classroom, or alternatively they gave different types of roles to their teacher, including encouraging students to improve their knowledge of the academic content, allowing students to do experiments by themselves in order to learn science better, and creating a group learning environment. Ulker et al. (2013) suggested that to create a non-traditional classroom environment teacher should understand e-learning opportunities, and when designing classrooms in terms of students' perceptions they should allow the students to arrange their own settings. Arranging a classroom environment according to students' views could provide both students and teachers with effective learning environments. This research focused on the assumptions that there is an important relationship between learning variables in a classroom and learning outcomes among students, and that providing an effective classroom environment has a positive influence on students' learning. It was also stated that out of classroom learning practices, such as science museums, science festivals, botanical gardens and science centres can contribute to better attitudes towards science, can provide opportunities for practical activities and collaborative work, and can help develop understanding (Braun and Reiss, 2006).

2.4 Literature Review of the Use of Metaphor

According to Perry and Cooper (2001) the utilisation of metaphor in science education is perceived as a fruitful method, particularly in terms of obtaining opinions on students' beliefs. A metaphor is defined as a figure of speech that can be used to exchange or understand and learn contexts in a new way (Rundgren, Hirsch and Tibell, 2009). It has been established by researchers that metaphors play an important role in the understanding of concepts in science. Perry and Cooper (2001) supported this idea, as they believed that metaphors help us shape what we say and how we form our thoughts. Metaphor seems to be the best way to gather concrete data on this topic.

A few studies into the use of metaphor have been conducted. Cameron (2002) studied year five and six students in a UK school by asking students to describe their experiences using metaphor in classroom discussions and in written text. This study investigated the socio-cognitive procedures included in learning when using metaphor. The data gathered from the think-aloud protocols and the teacher-led classroom discourse was analysed. The results showed that the use of metaphor when learning science works best if the selected metaphor is familiar to the children so that they can find an everyday meaning, the selected metaphor domain offers attributes and relational properties, and the knowledge connected to the metaphor is activated and developed in the discourse. Additionally, using more than one metaphor can help to narrow down possible connections, and visual images can help to support relational connections. This research suggested that textbooks can focus on using pictures with explanatory metaphors to make the subject more understandable. Teachers and researchers need to obtain information on how students make sense of metaphorical pictures, how they link their knowledge to pictures and written text, and how they develop scientific concepts.

There is some research into the use of the metaphor technique, in particular with regards to when students explain science. Karacam (2015a) identified secondary school student's perceptions of scientists, and Karacam (2015b) also conducted further research examining the relationships among middle school students' perceptions of scientists in terms of their gender and grade levels. The metaphor technique was used in both of these studies. Students' perceptions of scientists were brought together under three main categories: social characteristics, personal characteristics, and scientific characteristics. The results showed that students focused on the social and personal characteristics of scientists by utilising positive statements. It can be argued that students need to learn about scientists' roles and their place in society, and this will positively influence their perceptions and therefore their tendencies to pursue a career related to science. It was also found that whilst there is no statistically significant relationship between gender and students' perceptions of scientists, there is one between students' grade levels and their perceptions of scientists. Students used different metaphors to describe the different aspects of scientists, and this differed according to their grade level. It was asserted that students studying in the upper grades had more positive perceptions of scientists than those in lower grades. Soysal and Afacan (2012) analysed primary school students' perceptions of the concepts of science by using the metaphor technique. The sample used in this study was composed of students in the different grades. This research included a survey model, and data was gathered by having the students complete unfinished sentences. It was found that primary school students perceived that science lessons contained different areas of study, informed people, were enlightening and reflecting, were an important and required subject for life, were fun and were difficult. Some students thought that science lessons were more fun for younger grade students, and were more difficult for older grade students. Considering the number of metaphors, the ratio showed that children at this age have a high level of ability for imagination and the use of metaphors. Cilingir (2014) carried out a phenomenological qualitative study focusing on Turkish and Swedish students' descriptions of science. Data was collected via metaphor from seventh grade children, with 167 Swedish and 394 Turkish students involved. The findings showed that Turkish and Swedish students explain these concepts with almost the same wording, but it was found that the different country's students emphasised different expressions. While Swedish students regarded science as fun, discovering life and learning new things, Turkish students also saw science as life, fun and a tool for illuminating their life with knowledge.

Researchers have used various methods to investigate students' perceptions and experiences of science, scientists, the science lessons and science classroom, such as DAST, interviews, Likert-scale questionnaires, drawing instruments and written essays. I found that some studies have explored different concepts through the use of metaphor. However, I did not find any research that has investigated students' perceptions of and experiences of the concepts of science by utilising metaphor. This research is anticipated to direct future studies in the context of making decisions regarding the usability of metaphors as a different method of recognising perceptions of science. I will contribute some information regarding students' perceptions and experiences of science in this research from a UK context. I also did not come across in the literature any study that showed how the characteristics of the ideal science lesson and science classroom are described in the eyes of secondary school students. I will add some information on this to give some suggestions to science teachers and school administers in terms of how to increase students' attendance and how to improve their knowledge by arranging more effective science lessons and science classrooms.

2.5. Summary of Literature Review

Research is required in order to interpret students' perceptions of science and others, and to support the positive development of these perceptions. It is significant that both teachers and researchers need to have knowledge about the factors that shape students' views and experiences of science and others. This may help teachers in establishing how learning environments might be changed in order to stimulate learning.

Based on the results and the literature review, I have identified that metaphors can be used as an alternative data collection tool when investigating students' experiences of science and others. However, there has been no research investigating year eight and nine students' perceptions of science using metaphors to describe the characteristics of the ideal science classroom in the UK. The literature review provided useful insights for designing the methodology of the study. I believe that a qualitative research design using a phenomenological approach is helpful when the purpose of a study is to investigate students' perceptions of a given phenomenon, in this case science. Previous studies drew a clear picture of the use of metaphor (Soysal and Afacan, 2012; Cilingir, 2014; Karacam, 2015a; Karacam, 2015b). In general, studies that utilised a phenomenological approach were more successful.

In the next chapter, the rationale for the research design of my study and an explanation of the research methodology and design will be presented. The sampling process, research instruments, data collection and data analysis procedures will be explained and discussed, and ethical issues and challenges encountered will also be considered.

CHAPTER 3: METHODOLOGY

3.1 Introduction

In this chapter I will start by discussing the rationale for the research methodology and my own philosophical point of view, and how it formed the design of my research. The sampling process, research instruments, data collection and data analysis procedures will then be explained and discussed, and the ethical issues and challenges encountered will be considered.

3.2 Rationale for the Research Methodology

It is crucial to decide on an appropriate strategy for a research project and I have used phenomenology as an approach in this research. There is strong relationship between phenomenology and constructivism (Chiari and Nuzzo, 1996), which considers how the world appears to a person based on his or her personal perspective. The purpose is to obtain an understanding of the individual's lived experience, and to emphasise the uniqueness of experience from the perspective of those who live it as phenomenology attempts to do. The constructivist perspective of inquiry appeals to me, and I believe the ontological assumptions of constructivism, which assume that there are multiple realities that are constructed and can be altered by the knower (Creswell,2013). A further assumption is that individual subjectivities and realities are often understood as an individual's lifeworld. Epistemological assumptions of this framework suggest a relationship between the knower and known, as emphasised by Husserl. As for the epistemology, I have adopted a constructivist worldview, which appears to be best framework for phenomenological design (Chiari and Nuzzo, 1996), through which I can obtain a more in-depth understanding of the phenomenon of how students describe and experience science, scientists, science lessons and the science classroom.

Descriptive phenomenologists are especially interested in the essential features of lived experience, that is, the commonalities within accounts of experience of phenomena. Such essences are taken as objective and true descriptions of a phenomenon, which stems from the realist ontology of the school of phenomenology and Husserl's enthusiasm to ensure that all research in this tradition is scientifically rigorous (Lopez and Willis, 2004). I followed Husserl to seek common features, or to understand the essence of the phenomenon. I have attempted to understand students' thoughts and experiences of science and others through their eyes, and as a phenomenological researcher I wished to gain access to descriptions of life-world experiences and what these experiences can tell me.

Giorgi (1997) argued that the phenomenological approach is richly descriptive and includes three engaging points: the phenomenological reduction, description, and search for essences. The process of phenomenological reduction, or bracketing, and imaginative variation have been described by a number of different researchers (Moustakas, 1994, Osborne, 1994; as cited by Laverty, 2003). Descriptive phenomenology requires that the researcher does this through bracketing, and by using systematic processes when analysing data. Although Moustakas (1994) acknowledged this process of "bracketing" is not perfect, nevertheless the researcher should strive for it. Husserl suggested that researchers are required to bracket out personal past knowledge, experience, biases and prejudgment about a phenomenon in order to see clearly. They also withhold the positing of the existence or reality of the object or state of affairs. Imaginative variation helps them to discover the essential characteristics of the phenomenon being investigated. The main emphasis in the study of phenomena for Husserl was for these to appear through consciousness.

Reflecting on my experience of the research paradigm, I conducted the study because of a wider understanding of the phenomenon. I believe that the end product of this study should be to provide practitioners, administrators and science teachers with solutions to their concerns.

Other researchers have focused on the same area, and there is also support for a phenomenological approach. According to Giorgi (1997), this approach has been largely adopted by understanding lived experience. The phenomenology approach was chosen for this research because it is necessary to understand lived experience, and it was the best approach to investigate the main research questions.

3.3 Research Design

Phenomenological research is descriptive and especially focuses on the structure of experience (Moustakas, 1994; Giorgi, 1997). This approach lends itself to this study because I attempted to use a constructivist approach to make meaning of students' experiences in relation to the concepts of science (Creswell, 2013). Descriptive phenomenology was chosen as the appropriate methodology, as I am investigating year eight and year nine students' thoughts and perceptions of science and others through the use of metaphor, and descriptions of the characteristics of the ideal science lesson and classroom in their eyes. Lopez and Willis (2004) gave an example of a descriptive phenomenologist study by asking general questions such as what it is like to be a working wife and mother, and following up with questions to arrive at common concepts integral to the experience. For instance, I asked students what it is like to be a scientist from their perspective.

This study required a descriptive phenomenology drawn from Husserl (Moustakas, 1994), since very little information was found in relation to my study in the UK context. Consequently, open-ended questionnaires and focus group interviews were used to explore students' thoughts and experiences of science and others that might be crucial in explaining their perceptions. For the first question, I used an open-ended questionnaire to focus on which metaphors secondary school students utilised to describe the concept of science and others. In relation to the second question, I emphasised which conceptual categories can be proposed for metaphors about the science by secondary school students in terms of their common features, and again an open-ended questionnaire was used. The third question focused on how students described their experience of science and others using focus group interviews. The last question sought to find out how secondary school students describe the ideal science lesson and classroom by gathering data from the questionnaires and interviews.

I chose to carry out qualitative research methods, as the premise behind this methodology is that by examining the metaphors that human beings use in describing their experiences and beliefs, students can begin to uncover meanings beneath those directly and consciously. Metaphor is regarded as a way of thinking about or conceptualising the world. Lakoff and Johnson (1980, pp. 232-233) suggested that a large part of self-understanding is the "search for appropriate personal metaphors that make sense of our lives. The process of self-understanding is the continual development of new life stories for yourself".

3.4 Research Instrument

Open-ended Questionnaire

Various instruments are used to explore students' thoughts and images about science and others, such as Likert-type conceptual differences or classification scales, open-ended questionnaires or DAST. Before preparing the questionnaire (see appendix E), previous literature was examined. Metaphors have been utilised in different studies (Soysal and Afacan, 2012; Cilingir, 2014; Karacam, 2015a; Karacam, 2015b). The aim of this research was to investigate students' perceptions of science and its related concepts. Metaphors were presented to the secondary school students in this research using the following statements:

"Science is like ………Because……."

"A scientist is like ………Because……."

"A science lesson is like ………Because……."

"A science classroom is like ………Because……."

I added two more questions to identify how students describe the characteristics of the ideal science lesson and science classroom. The questionnaire included demographic data and a sentence completion section. After preparing the questionnaire, I translated it into Turkish and then I sent it to my colleague, who has been working as a science teacher for six years, in order to control the questions and translation. I could not do a pilot study in the UK, because I could not gain access to a school prior to conducting my research. Concrete experiential descriptions can be obtained from interviews, from written accounts or even from drawings. I used individuals' written descriptions of concrete experience and the focus group interviews. The metaphor technique was used in the current study to examine students' perceptions of science.

3.5 Research Samples

Sampling was considered by Weathington, Cunningham, and Pittenger (2010) as involving a group of participants who show the similar features of the target population and can be easily reached. In this study, purposive sampling (as the most crucial type of subcategory of non-probability sampling) was used to identify the primary participants. I selected the sample based on the aim of the study and my judgement, and I focused on secondary school students from different state schools in the UK. I got in contact with the university's partnership office, which gave me a list of state schools in Exeter. These schools were emailed to request access to secondary school students. Only three schools responded positively to my request, and so I carried out my research in these three schools. A total of 176 students attending year eight and year nine at a secondary school in the city of Exeter participated in this study in the 2015-2016 academic year. 36 students were left out of the data analysis since the metaphoric structures they used were not suitable and they left blank spaces. For this reason, data from 140 (76 year eight, and 64 year nine) students' papers were analysed in the study. Table 1 demonstrates the distribution of students in terms of gender, class and age.

Table 3.1

Percentage of Distribution of the Students' Gender, Class, and Age

Grade	Age	Male		Female		Total	
		f	%	f	%	f	%
Year Eight	12-13	30	39,5	46	60,5	76	100
Year Nine	13-14	31	48,4	33	51,6	64	100
Total		61	43,6	79	56,4	140	100

The focus group interviews were carried out with four or six students at a time from year eight and year nine, who were selected by their science teachers. The students voluntarily wanted to take part in the interviews. Where a high number of students volunteered to participate in the research, their science teachers selected groups of six. In contrast, when fewer students wanted to participate, groups of four were selected.

3.6 Data Collection

The intention of this study was to obtain data on the perspectives of the research participants regarding the phenomenon of science, scientists, the science lessons and science classroom using metaphor, and how students describe the characteristics of the ideal science lesson and classroom.

I utilised two different methods in the study:

- An open-ended questionnaire
- Focus-group interviews

I combined an open-ended questionnaire with focus group interviews, because an open-ended questionnaire is inherently limited by the questions it asks, and so it is an increasingly common feature in academic research to utilise focus group interviews to gather data on how the participants talk about the subject of the open-ended questionnaire. I used focus group interviews as a follow-up method to obtain in-depth understanding of the students' experience of the concepts of science. Focus groups have been defined by Morgan (1996) as a research technique that gathers data through group interaction on a research topic decided by the researcher as a moderator for the group. It is used to reflect upon common experiences, explore students' opinions and experiences, and examine students' different perspectives. Wilkinson (2004) provided the concept of focus group interviews in the framework of phenomenology. She considered individuals' attitudes, information, beliefs and opinions as part of phenomenology, and additionally their experiences, understandings, thoughts, and meanings. The aim is to try to abstract the individual's understanding of the concerns or issues in question. The most popular data collection method in the phenomenological approach is the one-to-one in-depth interview, based on few open ended questions. However, in this research a focus group interview was utilised because of the limited time available, and also my objective was to understand the groups' own construction of the phenomenon experienced. When preparing the focus group interview schedule, previous research was analysed on how students experience science (Ebenezer and Zoller, 1993; Buldu, 2006; Scherz and Oren, 2006). Four main questions were prepared, and then follow-up questions were added in order to obtain rich information about the students' experience of science.

Before starting data collection, I needed to obtain permission from schools to conduct the research. Two information sheets were prepared to inform the schools, teachers, and students (see Appendix B and Appendix C). After getting permission from the schools, I met with science teachers to collect the data. Firstly, an open-ended questionnaire was conducted to obtain data from students. It took roughly 20 minutes to complete. Secondly, I conducted focus group interviews with four or six students at a time from year eight and year nine. I explained how these interviews would be conducted. Interview questions were directed at the participants' experiences and views on science and others. I focused on getting the participants to describe the common features of science and others, as freely as possible.

3.7 Data Analysis

In this study, metaphors produced by secondary school students in the UK about the concepts of science and others were analysed using qualitative data analysis as suggested by Miles and Huberman (2013). The procedure of data analysis consists of three basic elements which are phenomena reduction (data reduction), data display and drawing conclusions. Miles and Huberman (2013) expressed that data reduction begins by removing invalid and inappropriate data, and continues until the end of the data analysis procedure. The main aim of this element is to reduce data without losing important information. The second element consists of the display of data with different tools such as concept maps and graphics. In the last element, the findings are explained and interpreted (Miles and Huberman, 2013). This study, in line with this procedure, was reviewed so as to analyse where data was inappropriate or the questionnaire was left blank. Next, the data was coded according to the identified codes, categories and sub-categories of science, scientists, science lessons and the science classroom, and then the categories were defined according to the students' metaphors and in relation to patterns among the identified categories, sub-categories. I counted the frequency of each metaphor manually. The concepts of generalisation within this framework meant that this qualitative study was not an adequate basis for generalisations. Reliability and validity were reviewed. When the codes were assigned, I examined previous literature on these concepts (Soysal and Afacan, 2012; Karacam, 2015a, 2015b). I sent the codes to an expert, who has been working as a lecturer in science for five years. The evaluation demonstrated that in the data collection from 140 students, nine of the codes for science, ten of the codes for scientists, eleven of the codes for science lessons, and eight of the codes for the science classroom assigned by me and by the expert were different from each other. An approach defined by Miles and Huberman (2013) was utilised to calculate consistency in coding. Consistency is calculated by using the following formula: agreement between coders = number of agreed codes/(number of agreed codes + number of disagreed codes). The consistency coefficient between the first and the second code in the current study was found to be r=131/(131+9)=0.93 for science, r=130/(130+10)=0.92 for scientists, r=129/(129+11)=0.92 for the science lessons, and r=132/(132+8)=0.94 for the science classroom. According to Miles and Huberman (2013), study results are reliable when consistency is 90% or above. Each student was assigned a code, for example "S (student) - year eight students (8) – student 4 (S_{84})."

The nature of the focus group data makes the transcription of focus group interviews more complex than other qualitative methods. There are a number of points to be adhered to in transcription of focus group interview data. Firstly, every effort should be made to transcribe all recorded speech. This includes all speakers and all unfinished and interrupted speech. Secondly, they repeat themselves, hesitate or pause, pick up arguments from each other, and go off track. Finally, it is necessary to identify the speaker. The reason for choosing a focus group interview was that focus groups can provide information about science and the experiences that participants have of certain issues and concerns, as well as illuminating the differences in perspective between a group of individuals. The analysis of qualitative data can be approached in different ways. The analysis must be systematic, rigorous, and reflect the opinions of all cases. Wilkinson's framework was used to analyse the contents and application of the focus group interviews. Wilkinson's (2004) framework analysis has been chosen because personal experience has been illustrated using content analysis. When I was preparing the focus group interview schedule, previous literature on the concepts of science, scientists, the science lessons and classroom was analysed. Before starting the interviews with the students, some notes were taken to identify group members.

I bracketed myself deliberately to understand the phenomenon in terms of the perspectives of the focus group being interviewed. The audio recordings made of each focus group interview, and again I bracketed myself during the transcription of the interviews, further contributed to the truth. I audio-recorded with the permission of the focus group interviewees (Arkley & Knight, 1999). Each focus group interview was assigned a code, for example "A school - year eight students, 27 June 2016." After each interview I listened to the recording and made notes.

3.8 Ethical Considerations

A series of processes were adhered to in order to ensure ethical research, and I made use of informed consent. The Certificate of Ethical Approval was accepted and signed by the Exeter University Ethics Committee (see Appendix A). Then, information sheets were prepared for science teachers and students (see Appendix B and Appendix C). In the information sheet I explained that students are participating in the research, the purpose of the research, the procedures of the research, the risk and benefits of the research, the voluntary nature of research participation, the subject's (informant's) right to stop the research at any time, and the procedures used to protect their confidentiality and anonymity at all times (Pring, 2000). All focus group interviews and questionnaires were accompanied by a teacher. However, the teachers did not interfere in the interview process, although they could hear and see what was being talked about and filled in the blanks in the questionnaire. I considered this as ethical. I developed a specific form in order to gain informed consent from the participants. (See Appendix D) The informed consent form, which included an overview of the research and its purposes and objectives and the researcher's contact information, was explained to subjects at the beginning of each focus group interview and questionnaire. The participant could contact me if they had any concerns or questions or for clarification (BERA, 2004). All of the interviews were tape-recorded with the permission of the group of members. Most potential subjects signed the agreement, and those who did not were not pressured to participate in the research. All who ended up being participants were in agreement with its content. The data collection included information about students' gender, age and year. No personal information such as students' names, numbers or school details was included in the data collection. When I gave some examples of students' statements, I used labels to identify students. For instance, in the label S_{845}, S represented students, 8 represented year 8, and 45 represented the students' number that I gave.

3.9 Challenges Encountered

I encountered two main challenges during my research project. First, I had difficulty gaining access to the schools, and so my supervisor helped me with this. Moreover, I wasted time just trying to contact the schools. The second challenge was the linguistic barrier when interviewing students. To me, as a non-native speaker, it seemed that the key challenge of the research is that for it to be effectively implemented I should possess better language skills when using focus group interviews. Sometimes I did not have control over what the focus group would find interesting, and this might lead them to talk about science-related concepts that are beyond the purposes of this research. I did more reading to familiarise myself with the focus group interviews by using some strategies to control and to get the focus group interviewees back on topic. I should have carried out a pilot study to do better interviews, and it might be helpful for me to develop my interviewing skills.

3.10 Summary of Methodology

In this chapter, I have explained and discussed how and why I chose a constructivist position to the phenomenological approach related to methodology. Based on my constructivist stance, I chose a phenomenological approach to answer the research questions and I have provided a rationale for my choice. The process of sampling, research instruments, data collection and data analysis have been presented. At the end of this chapter, I also discussed the ethical issues and the two key challenges encountered in the study. Chapter four presents in detail the findings from the open-ended questionnaires and focus group interviews.

CHAPTER 4: DATA ANALYSIS AND PRESENTATION OF FINDINGS

4.1 Introduction

In this chapter I will present the results of qualitative data analysis, through which I aim to answer four research questions. The first research question focused on which metaphors secondary school students (from years 8 and 9) utilised to describe the concepts of science, scientists, science lessons and science classrooms in the UK. The second question emphasised which conceptual categories can be proposed for these metaphors about science and others in terms of their common features. The third question highlighted how students describe their experience of science and others. The last question aimed to find out how secondary school students describe the ideal science lesson, and classroom. The qualitative data was obtained from the secondary school students' metaphors as provided in the open-ended questionnaires and the focus group interviews. In the remainder of this chapter I will present detailed findings from of each of the research question addressed in this study.

4.2 The Findings of Open-ended Questionnaire of the Secondary School Students' Perceptions

4.2.1 Students' Perceptions regarding Science

Tables 4.1 and 4.2 illustrate these three main categories: characterised by empirical criteria, study of the natural world, and characterised by sceptical reviews. It was identified that on average 46.3% of the students focused on perceptions characterised by sceptical reviews of science, 38.2% highlighted those characterised by empirical criteria of science, and 15.5% emphasised the study of the natural world of science. Secondary school students (from years 8 and 9) mostly stressed those perceptions characterised by sceptical reviews of science and by empirical criteria of science.

The findings of the research indicated that year 8 students generated 76 valid metaphors about science, and it was identified that students defined science with these metaphors by utilising 29 different concepts. When these concepts were examined in terms of the frequency of the use of metaphors, the results showed that year 8 students utilised the concepts of a never ending road (f=11, 14.4%), a jigsaw puzzle (f=9, 11.8%), adventure (f=6, 7.9%), and discovery (f=6, 7.9%) the most. (See Table 4.1)

Table 4.1

Distribution of Science Metaphor in Written Questionnaire of the Year 8 Students

Category	Sub-Category	Metaphor	f	%
Characterised by empirical criteria	Invention	Adventure (6), Discovering (6), Mystery of life (5), Magic (1), Going holiday without map (1), Never-ending book/road (11), Rubix cube (1), Expedition (1)	32	42.2
	Laboratory Environment	Experiment (3), Magnetic field (1), Have a blast (1), Indoor play area (1), Museum (1)	7	9.2
Reasons for the emergence of science	Benefit of society /individual	Open door (1)	1	1.3
	Access to information	Map (1), Tree (2), Poster (1)	4	5.2
	Understanding the nature of life/matter	World dictionary (2)	2	2.6
Characterised by sceptical reviews	A way of knowing	Universe (1)	1	1.3
	Incomprehensibility	Map with complicated fact (4), Jigsaw puzzle (9), Ocean (3), Cage (1), Roller coaster (1), Space (2), Hard game (3), Big House (2), Jungle (2), Disappointments (2)	29	38.2
Total			76	100

When looking at the findings from year 9 students it can be seen that they generated 64 valid metaphors about science. It was identified that the students defined science with these metaphors by utilising 25 different concepts. When these concepts were examined in terms of the frequency of use, the results showed that year 9 students mostly utilised the jigsaw puzzle (f=11, 17.1%), a journey to a foreign place (f=5, 7.8%), a circle (f=5, 7.8%), and the ocean (f=4, 6.2%). (See Table 4.2)

Table 4.2

Distribution of Science Metaphor in Written Questionnaire of the Year 9 Students

Category	Sub-Category	Metaphor	f	%
Characterised by empirical criteria	Invention	Adventure (2), Discovering (1), Exploring (2), Investigation (2), Journey to a foreign place (5)	12	18,8
	Laboratory Environment	Experiment (2), Board game (2)	4	6.2
Reasons for the emergence of science	Benefit of society /individual	Solution (1), Door (2), Answering all question (1)	4	6.2
	Access to information	Story (1), Tree (3), The biggest workbook (1)	5	7.8
	Understanding the nature of life/matter	World dictionary (2), safe (2), Cheat-sheet (1)	5	7.8
Characterised by sceptical reviews	A way of knowing	Universe (3), Answer (3)	6	9.4
	Incomprehensibility	Black hole (3), Unknown machine (3), The sky (3), Jigsaw puzzle (11), Circle (5), Ocean (4), Hard (1),	28	43,8
Total			64	100

Examination of the metaphors presented by students from years 8 and 9 demonstrated that half of year 8 students mostly emphasised perceptions based on empirical criteria of science, collected under two sub-categories. It was found that 42.2% participating year 8 students stressed the inventive role of science, whereas only 9.1% students focused on the study of the natural world of science. In contrast, only 11% of year 9 students stressed the invention of science. When I looked at year 9 students' perspectives, I saw that the majority of participating year 9 students highlighted the sceptical reviews of science the most. It was also observed that 43.8% of year 9 students underlined the incomprehensibility of science. Students' perceptions are changing in term of their age, and science is an incomprehensible and complicated subject for year 9 students. For instance, S_{84}, and S_{938} used the concept of the jigsaw puzzle to explain the difficulty of science. The example of the concepts of a never ending book was utilised by S_{827}, and also the metaphor of the concept of a journey was used by S_{946} to describe the process of invention. (See Table 4.3)

Table 4.3

Examples from Metaphor Statements of Year 8 and Year 9 Students towards their Perceptions on Science

Science	Metaphor	Statement
Year 8	Never-ending book/road	S_{827}: It is like a never-ending road, because there is always more to learn, when you start understanding and learning about science you do not want to stop and it takes a lot effort to understand, but when you do understand it you feel proud.
	Jigsaw puzzle	S_{84}: It is like jigsaw puzzle. Because when you are trying to get there you know what you are trying to find out but you are not sure how to get there so sometimes you have to take multiple routes or experiments to get there. Also, when you want to try something without knowing the outcomes, it is like having an idea of where you are going but it could all go wrong.
	Adventure	S_{832}: It is like an adventure, because in each new topic, there is something new to learn about, you are never bored or distracted, there is always something to focus on.
Year 9	Jigsaw puzzle	S_{938}: It is like a puzzle, because you have to work hard to get your final results and you have to try different ideas and things to try and get a good conclusion.
	Journey	S_{946}: It is like a journey to a foreign place, because you never know what to expect next and you do not always know where it is going or where it will take you but it is full of exciting new knowledge and experiences.
	Circle	S_{920}: It is like a circle, because it is always adapting, evolving and changing and it will probably never end. Everything involves or uses in science.
	Black hole	S_{934}: It is like a black hole, because it stretches my brain in ways that are very painful and with science we are always in the dark we never have all knowledge

4.2.2 Students' Perceptions regarding Scientists

Tables 4.4 and 4.5 contain the three main categories identified: scientific characteristics, social characteristics, and personal characteristics. It was recognised that 59.3% of the students stressed the scientific characteristics of scientists, 22.2% highlighted the personal characteristics of scientists, and only 18.5% focused on the social characteristics of scientists. In this context, it can be considered that secondary school students pay more attention to the scientific characteristics of scientists than to the personal characteristics and social characteristics.

The results of the study showed that year 8 students generated 76 valid metaphors about scientists. It was identified that students defined scientists in their metaphors by utilising 30 different concepts. When these concepts were examined in terms of the frequency use, the findings illustrated that year 8 students mostly utilised the metaphor of an explorer (f=18, 23.7%), a child (f=6, 7.9%), a computer (f=5, 6.6%), and an adventurer (f=4, 5.2%). (See Table 4.4)

Table 4.4

Distribution of Scientist Metaphor in Written Questionnaire of the Year 8 Students

Category	Sub-Category	Metaphor	f	%
Scientific Characteristic	Scientific Activities	Explorer (18), Adventurer (4) Discoverer (1), Magician (2), Investigator (2), Detective (3), A game designer (1), Under cover cap (1), Child (6), Tree climber (1)	39	51.4
	Scientific Knowledge	Computer (5), Brain (2), Unopen box (1), Book (3), Dictionary (1)	12	15.8
Social Characteristic	Social Roles	Conductor (1), Unlocked key (1), Book shelf (1)	3	3.9
	Social Value			
Personal Characteristic	Personality Characteristic	Wise person (3), Wizard (2), Busy person (1)	6	7.9
	Cognitive Characteristic	Mad as a hatter (1), Clever person (3), Artist (2), A body of intelligence (1), Superhuman (2), Interest with science (3)	12	15.8
	Physical Appearance	Mad human (1), Astronaut (2), Man (1),	4	5.2
Total			76	100

According to the findings, year 9 students generated 64 valid metaphors about scientists. It was identified that students defined scientists in their metaphors by utilising 30 different concepts. When these concepts were examined in terms of the frequency of use, the results showed that year 9 students utilised the metaphor of the explorer (f=11, 17.1%), Yahoo or Google (f=8, 12.5%), and a magician (f=4, 6.2%) the most. (See Table 4.5)

Table 4.5

Distribution of Scientist Metaphor in Written Questionnaire of the Year 9 Students

Category	Sub-Category	Metaphor	f	%
Scientific Characteristic	Scientific Activities	Explorer (11), Discoverer (2), Calculator (3), Memory stick (1), Magician (4), Factory (1), Investigator (2)	24	37.4
	Scientific Knowledge	Computer (1), Brain (2), Book (3), Encyclopaedia (1), Sheet of answer (2)	9	14.1
Social Characteristic	Social Roles	Yahoo/ google (8), Caretaker (2), Medicine (2), Tool (1)	13	20.3
	Social Value	Warm (1), Solution (1), Embodiment of the gateway (1)	3	4.9
Personal Characteristic	Personality Characteristic	Elephant (1), Fisherman (1), Parent (1), Priest (1), Child (1), Beaver (2),	7	11
	Cognitive Characteristic	Mad as a hatter (1), Genius (3)	4	6.2
	Physical Appearance	Einstein (2), Ugly duckling (1), Crazy old women (1)	4	6.2
Total			64	100

Examination of the students' metaphors indicated that students in both years 8 and 9 generally emphasised the scientific characteristics of scientists. 67.2% of year 8 students emphasised the scientific characteristics of scientists under two sub-categories. It was observed that 51.4 % of year 8 students stressed the scientific activities of scientists, whereas they ignored the social value of scientists. In a similar way, 37.4% of year 9 students highlighted perceptions that focused on the scientific activities of scientist, and 20.3 % also stressed the social roles of scientists. In general, students' perceptions about scientists are similar in term of their age. However, they had some stereotypical opinions about scientists. For instance, few students selected the concepts of man, Einstein or the ugly duckling to describe scientists. Both year 8 and year 9 students, such as S_{874}, S_{826}, and S_{94}, expressed a metaphor using the concept of the explorer to form their opinion through their statement. As can be seen from the students' statements, year 8 students, including S_{861}, preferred the concept of the child to explain scientists. On the other hand, year 9 students, for instance S_{933}, selected the concept of Yahoo or Google to describe scientists. (See Table 4.6)

Table 4.6

Examples from Metaphor Statements of Year 8 and Year 9 Students towards their Perceptions on Scientist

Scientist	Metaphor	Statement
Year 8	Explorer	S_{874}: A scientist is like an explorer, because the delve deep into the unknown not knowing what they might find or discover. They also come across that stops them discovering vital. However, if this does happen they find a new route and carry on. S_{826}: It is like an explorer, because they are always trying to discover new things and in the process they are experimenting the best way to get round obstacles and the best wat to act in certain scenarios. They also use lots of special equipment to help them.
	Child	S_{861}: A scientist is like a child, because they always have lots of questions and are trying to understand and explore the wold to get answer and learn new things.
	Computer	S_{876}: It is like a computer, because they have a massive range of knowledge and they can research new experiments about science and create new theories
Year 9	Explorer	S_{94}: It is like an explorer, because they discover new things and are all on different journey.
	Yahoo/Google	S_{933}: It is like yahoo, because they have all the answers, but you have to ask the right questions.
	Magician	S_{910}: It is like a magician, because it seems impossible but when you look deeper there is always a logical explanation behind it all.
	Genius	S_{938}: It is like a genius, because to be able to be a scientist you have to be very smart but able to come up with new things and experiments at the same time.

4.2.3 Students' Perceptions about Science Lessons

Tables 4.7 and 4.8 show that students' science lesson opinions include these four key categories: characterised by procedure and progress, research area, scientific function, and personal relevancy. 31.8% of the students focused on the personal relevancy of science lessons, 26% highlighted the procedure and progress of science lessons, 21.7% emphasised the scientific function of science lessons, and 19.7% stressed the research area of science lessons. Secondary school students mostly identified the personal relevancy of science lessons, and the procedure and progress of science lessons.

The findings of the research indicated that year 8 students generated 76 valid metaphors about science lessons. It was identified that students defined science lessons in their metaphors by utilising 34 different concepts. When these concepts were examined in terms of the frequency of use, the findings showed that year 8 students mostly utilised the concepts of experiments (f=7, 9.2%), a journey (f=6, 7.9%), and learning the unknown (f=5, 6.6%). (See Table 4.7)

Table 4.7

Distribution of Science Lesson Metaphor in Written Questionnaire of the Year 8 Students

Category	Sub-Category	Metaphor	f	%
Procedure and Progress	Enlighten/ Illuminative	Book (4), Brain (3), Explore jungle expedition (2)	9	11.8
	Informative	Information your surrounding (3), Homework (2), An open door (2), The sea (3), A clue (2), Adding information (2)	14	18.4
Research Area	Having different branches	Jungle (1)	1	1.3
	Investigation	Getting glasses (1),	1	1.3
	Invention / Discovery	Experiment (7), Adventure (2), Corner (1), Portal (1)	17	21.5
Scientific Function	Incomprehensibility	Tunnel (1), Mystery (1), Expand your mind (1), Black hole (1), Journey (6)	10	13.1
	Important for human life	Learning the unknown (5),	5	6.6
Personal Relevancy	Fun	Cool (1), A present (1), Fun day (1), Theme park (1)	4	5.2

	Boring	Prison (3), A world of notes (2)	5	6.6
	Difficulty	Maths (3), Locked door (3), Quiz (3), Mountain (1), Confusing hour (4), Mystery room (2), Roller coaster (1)	16	21
Total			76	100

Year 9 students generated 64 valid metaphors about science lessons. It was identified that students defined science lessons in their metaphors by utilising 25 different concepts. When these concepts were examined in terms of the frequency of use, the findings showed that year 9 students mostly utilised the concepts of the universe (f=7, 11%), books (f=6, 9.3%), changeability (f=6, 9.3%), maths (f=5, 7.8%), and experiments (f=5, 7.8%). (See Table 4.8)

Table 4.8

Distribution of Science Lesson Metaphor in Written Questionnaire of the Year 9 Students

Category	Sub-Category	Metaphor	f	%
Procedure and methods	Enlighten/Illuminative	Book (6), Brain (1), Window (1)	8	12.5
	Informative	Key (2), Adding information (3), Answer (1)	6	9.3
Research Area	Having different branches	Different planet (2), Tree (4)	6	9.3
	Investigation	Video-game tutorial (1)	1	1.5
	Invention / Discovery	Experiment (5), Discovering (3)	8	12.5
Scientific Function	Incomprehensibility	Universe (7), Weather (3), Big hill (2)	12	18.7
	Important for human life	Lamp (1), A glass of need (2),	3	4.9
Personal Relevancy	Fun	Rainbow (3), Heaven (2), Mind blowing (1)	6	9.3
	Boring	A detention (4), Plauge (1), Watching paint dry (1)	6	9.3
	Difficulty	Maths (5), Diamond (1), Code (2)	8	12.5
Total			64	100

The above metaphors created by students to identify their science lessons illustrate that year 8 students mostly emphasised the aspects of the informative and inventive nature of science lessons. When I looked at the year 9 students' perspectives, they highlighted the incomprehensibility of science lessons and also the aspects of enlightenment and invention. For instance, S_{848} used the concept of experiment to express their views on this matter. It was observed that both year 8 and year 9 students stressed that science is a difficult subject. They described this difficulty by utilising the concepts of maths, a confusing hour, or a locked door, as seen in the statement of students such as S_{861} and S_{923}. Also, year 9 students underlined the incomprehensibility of science lessons by using the concepts of the universe, weather, and a journey, as can be seen in the statements of S_{844}, S_{96}, S_{953} and S_{923}. Science is an incomprehensible and complicated subject for both year 8 and year 9 students. In addition, students noted that science is an important subject for human life. For instance, S_{820} and S_{937} utilised the concept of learning the unknown and a glass of water to demonstrate their opinions on this matter. (See Table 4.9)

Table 4.9

Examples from Metaphor Statements of Year 8 and Year 9 Students towards their Perceptions on Science Lesson

Science Lesson	Metaphor	Statement
Year 8	Experiment	S_{848}: It is like an experiment, because you find out new things and it helps you with other things in life and generally to understand how things work. It also shows you the best way to go about things.
	Journey	S_{844}: It is like finding somewhere new, because you are bound to get lost somewhere along the way but when you find your destination it is very satisfying and you discover things you have not have before.
	Your learning the unknown	$S_{820:}$ It is like your learning the unknown, because when you walk inside you never know what practical or work you are going to do.
	Confusing hour	S_{861}: It is like a confusing hour, because you never know what is inside or what is going to happen you just know that it is not going to be fun. We do no practical and take lots of notes which ends up being boring.

Year 9	Universe	S_{96}: It is like the universe, because there is always more and endless possibilities with science you can discover and learn.
	Book	S_{929}: It is like a book, because each lesson, you turn a new page and learn something new.
	A glass of water	S_{937}: It is like a glass of water, because you can use it now and learn or you can ignore it and then be thirsty later you can find out that you needed the knowledge
	The weather	S_{953}: It is like a weather, because it is unpredictable and sometimes it is good and sometimes bad.
	Maths lesson	S_{923}: It is like a maths lesson, because it is hard. You have to sit in the class and learn lots of stuff.

4.2.4 Students' Perceptions regarding Science Classrooms

Tables 4.10 and 4.11 show the two key categories of research areas and environmental relevancy. It was identified that 61.6% of the students highlighted the research area of science classrooms, and 38.4% focused on environmental relevancy. In this sense, it can be suggested that secondary school students have a tendency to connect their views with supporting the learning of science in the classroom.

Year 8 students generated 76 valid metaphors about science classrooms. It was identified that students defined science classrooms in their metaphors by utilising 30 different concepts. When these concepts were examined in terms of the frequency of use of the metaphors, the findings indicated that year 8 students utilised the concepts of a room of knowledge (f=6, 7.6%), a laboratory (f=5, 6.3%), a brain (f=5, 6.3%), books (f=5, 6.3%), and museums (f=5, 6.3%) the most. (See Table 4.10)

Table 4.10

Distribution of Science Classroom Metaphor in Written Questionnaire of the Year 8 Students

Category	Sub-Category	Metaphor	f	%
Research Area	Experiment	Laboratory (5), Testing (3), Answer (2), A test tube full of chemical (2),	12	15.8
	Support Learning	Brain (5), A room full of knowledge (6), Book (5), Museum (5), Library (2), Practice (1), Magician's tricks (1), Magnifying glass (2)	27	35.5

	Classroom Feature	The ocean (4), Space (2)	6	7.9
Environmental Relevancy	Positive	Mansion (1), Tunnel of excitement (1), Kitchen (3), Play park (4), Mystery room (3), A way of inspiring students (1), Training camp (3), Maze of curiosity (1)	17	22.4
	Negative	Prison (4), Trap (1), Jungle (2), World of madness (2), Going mad (1), Blank (1), A cage (3)	14	18.4
Total			76	100

Lastly, year 9 students generated 64 valid metaphors about science classrooms. It was identified that students defined science classrooms in their metaphors by utilising 25 different concepts. When these concepts were examined in terms of the frequency of use, the findings showed that year 9 students mostly utilised the concepts of a room full of knowledge (f=8, 12.5%), a traditional classroom (f=6, 9.3%), a laboratory (f=4, 6.2%) and the world (f=4, 6.2%). (See Table 4.11).

Table 4.11

Distribution of Science Classroom Metaphor in Written Questionnaire of the Year 9 Students

Category	Sub-Category	Metaphor	f	%
Research Area	Experiment	Volcano (2), A piece of art work (3), Laboratory (4), Painting (3),	12	18.7
	Support Learning	Brain (3), A room full of knowledge (8), Encyclopaedia (2), Google (1), Internet chatting room (3), Book (2), Museum (1), Library (2)	22	34.3
	Classroom Feature	Rainbow (2), Fire (1), Space (3), Unique (1)	7	11
Environmental Relevancy	Positive	World (4), Jungle (2), Garden (1), Home (2)	9	14.1
	Negative	Traditional classroom (6), Prison (2), Blank (2), Big cave (1), A place of worship (3)	14	21.9

Total		64	100

Analysis of the metaphors demonstrates that students from years 8 and 9 mostly emphasised the aspects of supporting learning in science classrooms. It was observed that year 8 students preferred the concepts of a room full of knowledge and the brain, and year 9 students such as S_{839}, S_{876}, and S_{910} selected the same metaphor to explain their science classrooms. Furthermore, they used the concept of a laboratory when looking at the aspect of the research area of science classrooms. Therefore, they have a similar perspective on their science classrooms. Additionally, they also highlighted negative points of view on their science classrooms. It was found that both year 8 and year 9 students, for instance S_{858}, and S_{963}, selected the concept of the traditional classroom, a cage, or a prison to describe it, as can be seen in their statements. On the other hand, year 8 students used positives metaphor such as a playpark or training camp to describe it. In general, the results showed that year 9 students have more negative opinions than year 8 students about their science classrooms. (See Table 4.12)

Table 4.12

Examples from Metaphor Statements of Year 8 and Year 9 Students towards their Perceptions on Science Classroom

Science Classroom	Metaphor	Statement
Year 8	A room of knowledge	S_{839}: It is like a room of questions, because you can ask whatever you want to gain knowledge and further your understanding, you can raise your hand and express your views or knowledge on the subject.
	Laboratory	S_{819}: It is like a lab, because lots of equipment is inside it. You get to do practical.
	Brain	S_{876}: It is like a brain, because there is always new stuff and it is almost full. It helps you get answers and learn new things.
	Cage	S_{858}: It is like a cage, because you cannot leave, but instead have to learn science for the hour until the lesson is over.
Year 9	A room of knowledge	S_{910}: It is like a room of knowledge, because you learn lots of new things that stay with you for life. Also sometimes teach us things we already know.

	Traditional classroom	S_{963}: It is like a traditional classroom, because you still learn lots of stuff in it.
	Laboratory	S_{945}: It is like a lab, because it has lots of cool interesting equipment in it.
	Brain	S_{933}: It is like a brain, because it is filled with many helpful reminders a bit jumble in places and it serves a purpose.

4.2.5 Students' Thoughts and Experiences about the Ideal Science Lesson and Science Classroom

The open-ended questionnaire also attempted to answer the following research questions: How do secondary school students describe the ideal science lesson and classroom. Table 4.13 shows that year 8 students have some opinions that include these two main categories: supporting learning and environmental relevancy.

Table 4.13

Statements of the Ideal Science Lesson and Science Classroom in Written Questionnaire of the Year 8 Students

	Category	Sub-Categories
The best/ideal science lesson	Support Learning	Practical activities Outside activities Learning why/ how and what happened Supportive teacher Own group working Doing example of previous work Using different way of learning not just theory Not text a book Not rush Not take notes Using Video
	Environmental Relevancy	New exciting opportunities Fun and enjoyable Not boring
The best/ideal science classroom	Support Learning	Lots of model / poster/ diagram / picture Enough science equipment / resource Enough space for everyone to set up a practical equipment Interactive Colourful

	Environmental Relevancy	Safe

Table 4.14

Examples from Statements of Year 8 Students towards their Perceptions on the Ideal Science Lesson and Science Classroom

	Statement
Science Lesson	S_{823}: Being able to learn new things that are not taught boringly such as lots of copying and the teachers not always talking. Having practical and outside experiments and doing things that will broaden your knowledge. Practical which is interesting and trying to figure out what might happen next, and why. Also it may be given more freedom to try things we want to. S_{836}: there would be different ways of learning and lots of new exciting opportunities. Not just theory and practical. But different way of doing theory and writing from our own understanding. Listening to the teacher, talking and doing sheets, going outside, actually doing it by ourselves and partnering and no written work!!
Science Classroom	S_{836}: There would be posters, projects, puzzles that students have made and explain common questions on the wall and enough space and equipment for everyone. Loads of practical going on around the room. S_{810}: It would have a nice clean layout, lots of attractive colours, space, light and safety. It helps everyone learn in the best ways. It also inspires students to continue challenging themselves and thinking outside the box.

Similarly, as seen in Table 4.15, year 9 students have some points of view about the ideal science lesson and classroom that contain the two main categories: supporting learning and environmental relevancy.

Table 4.15

Statements of the Ideal Science Lesson and Science Classroom in Written Questionnaire of the Year 9 Students

	Category	Sub-Categories
The best/ideal science lesson	Support Learning	Practical activities Outside activities Balance theory and practice Interactive with other students and teacher Small group talk Expressing your ideas Not take too much notes

		Testing new knowledge Informative science Using Video
	Environmental Relevancy	New exciting opportunities Fun
The best/ideal science classroom	Support Learning	Lots of model / poster/ diagram / picture Enough science equipment / resource Enough space for everyone to set up a practical equipment Big, well organised, modern Easy access to equipment
	Environmental Relevancy	Colourful Safe Outside classroom

Table 4.16

Examples from Statements of Year 9 Students towards their Perceptions on the Ideal Science Lesson and Science Classroom

	Statement
Science Lesson	S_{952}: It would have some crucial features such as introduction to topic, hands on problem solving, small group talk of what you know, practical that some outside of the classroom and evaluate experiment and knowledge, not too much writing just key points. S_{911}: It would be half practical and half work, some diagram drawing and annotating, puzzles in partners and not too much writing. Also, it would be where the whole class is interacting and would be having fun time. Fun where it is exciting but we do actually learn something.
Science Classroom	S_{961}: Lots of space for practical work very organised and labelled well, tables are laid out so we can all see each other to make it easier to co-operate with other students and teachers and easy access to equipment on the lab branches so you can examine every theory easily. S_{957}: It would be interesting and have computers, a bookshelf of items for practical, and different helpful images, posters, and diagrams that students have made with some information. Make the information big bold and clear so we can read it from a distant. Also, it would be safe because if a practical went wrong something could explode or cause damage.

Analysis of students' thoughts on the ideal science lesson and classroom demonstrated that both year 8 and year 9 students mostly highlighted that they wanted to do practical and outdoor activities in their science lessons to support their learning. They also emphasised that sharing ideas and expressing opinions in a small group discussion is a good way to support their science learning. Also, they did not want to take notes too much or test facts. They thought that there should be a balance between theory and practice. As can be seen from the statements of students such as S_{823}, S_{836}, S_{952}, and S_{911}, the students discussed a number of experiences which they wanted to exercise in their science lessons. Students in both year 8 and year 9, for instance S_{836}, S_{810}, S_{961}, and S_{957}, offered a number of recommendations that can be clustered into these five key points: 1. Lots of models, posters, diagrams and pictures that students have made on the wall, which should be big enough for everyone to see; 2. Enough science equipment and resources to do practical learning; 3. Enough space for everyone to set up practical equipment; 4. Big, well organised, modern science classrooms or science laboratories; and 5. Easy access to equipment to do the practical stuff by themselves or in a group.

4.3 The Findings of Focus Group Interview with Secondary School Students

In this section I will summarise the results of the focus group interviews conducted as part of my research project. In essence, my primary focus in these interviews was on the students' experiences of science, scientists, science lessons and science classrooms in general. In all, six focus group interviews have been included in this study, three of them with year 8 students and three of them with year 9 students. Krueger and Casey (2015) recommended five to ten people per group, with six to eight preferred, a comfortable environment, and circle seating for focus group interviews. I have done four focus group interviews with groups of four students (three with year 9, one with year 8), and two focus group interviews with groups of six students. That is because at that time six students volunteered to take part in this research. I preferred the smaller groups, because it was easier to manage and control the interview. I attempted to arrange homogeneous focus groups in terms of age, gender and class. The interviews lasted roughly 20 minutes, and all of them were recorded. I took some notes during the interviews to identify nonverbal information and key points. I briefly introduced the research aims and objectives, and highlighted the students' privacy and rights, and the process of data collection and analysis. After all of the participants had introduced themselves and given their permission in the first few minutes, the interviews began. Krueger's framework was used to analyse the concepts and application of the focus group interviews. Firstly, I transcribed all audio-recordings into Word format, and I identified the primary content across all transcripts. I analysed the data manually and coded the transcripts. Qualitative data analysis revealed four themes across the six focus group interviews.

4.3.1 Students' Experience with Science

In all of the focus groups, the students discussed a variety of components of their experience of science, in both primary school and secondary school. Among many of the focus group interviews, students reported similar experiences in that they did not do enough science in primary school, however they were doing practical science in secondary school. As noted by three students from year 8 who participated in the second group:

> *S_{8C}: For me we did science not very much in primary school. I think it depends on the curriculum. We did actually have a fun time doing a lot of science in secondary school. One time I remember it being a really great lesson. It was really practical and interesting, because we had not done anything like that before. Throughout the whole of primary school, we did not do this kind of practical stuff, which is a really good start. I think we need to do more practical and hands-on activities in science. Science is a big subject I think we need to learn more.*
> *S_{8F}: Yes… I agree with my friend. We did not do a lot of science in primary school. Year 6 and year 7 teachers were specialised in science. We have really good teachers who bring in some quite powerful equipment. Actually, over the past two years we have been doing much more experiments, whereas in primary school we were just going to the textbook and just reading and writing. (B school - Year 8 - 6^{th} July)*

Some students shared some thoughts about their future plans, stating:

> *S_{8D}: Ammm… I have a future plan based on science - I will be an engineer. That is practical, like S_{8C} said. I like practical lessons rather than looking at the textbook.*
> *S_{8F}: For me, I will probably do something with STEM. I can focus on one of them.*

> *S_{8B}: I will carry on science, especially biology, because it is more personal. What you learn about it can impact on your life in the future as well. (B school- Year 8- 6th July)*

Two students from year 9 in the first group stated that they believed that attending science seminars and watching videos about science help students to understand science.

> *S_{9A}: Actually, I have watched TV shows before about science that I found quiet interesting, where they were doing experiments, like practical ones and this kind of stuff. I remember they did one when they did technological stuff and how they affect our lives.*
> *S_{9C}: I attended a science festival a couple of weeks ago. I observed lots of different types of science. We could participate if you wanted. I like different kinds of science, but the most is biology, like being a biological scientist. I think it is very helpful to understand science. (A school- Year 9- 24th June)*

Many students agreed and reported similar thoughts that science is an "important and useful" subject in human lives. A prominent sub-theme discussed was that many reported that in terms of learning techniques it is much better to be open-minded, understand more natural science, and involve daily life. As noted by three year 8 students who took part in the third group:

> *S_{8C}: I think we are learning facts and formulas but we are better learning the techniques, so when we look at the textbook, we can see that scientists find out new facts in the textbooks we learn. Instead of learning facts we are learning techniques.*
> *S_{8B}: S_{8C} mentioned that we are learning formulas, but do we actually need them for daily life? It is unlikely. Yes, we know formulas but they are less important right now. I think biology is the most related to general life because we did recently drugs and alcohol, this kind of stuff, and how they affect people's lives in the future. It was quite interesting and important to know about that.*
> *S_{8D}: So…We focus on much more detail about science but we need to learn basic knowledge to apply to daily life. In the lessons we are going to focus on something in particular rather than how to apply it in daily life. (C school- Year 8- 7th July)*

4.3.2 Students' Understanding about Scientists

Some students talked about stereotypical images of scientists. They discussed how the media or TV programmes can cause these stereotypical ideas or misunderstandings about scientists. As can be seen from the conversations among students, there are clear similarities in the way the students describe scientists, in that they discover the world around us and learn new things to help people, and open up new ideas to inform human beings.

S8A: There are lots of stereotypes about scientists not just thinking about the facts, but the process which happens behind this. There's lots of practical stuff they find out. They are like a child because they are open-minded for new ideas.
S8D: It is a really interesting job but it is quite difficult. They do not stop until they get the answer. We do not have a responsibility to get an answer, we can learn from the media that can affect this kind of stereotype, we'll never know their responsibility for finding out about everything. I think people do not recognise their work. I think they help people around them like doctors. They can find solutions for diseases. (A school- Year 8- 24th June)

Similarly, another student noted:

S9C: *In fact*, w*hen we think about scientists, the first thing that comes to mind is a stereotypical lab, wearing glasses, not mad. They see everything in different ways, not like everyone. We can say they seem normal people, but they can see functions, everything. (A school- Year 9- 24th June)*

S8C made the same point:

When we naturally think or watch video or clips online or programmes about this kind of stuff about scientists, they always bring optimist scientists, like kind of stereotypes. They can just be specialised in it. It causes this kind of misunderstanding. (C school- Year 8- 7th July)

4.3.3 Students' Experiences with Science Lessons

Across all focus group, the students discussed a number of experiences of science lessons, such as doing experiments and hands-on activities which can help students to learn more and actively interact with the lesson. Many students highlighted that writing down notes and information is not related to active learning. Practical learning is much better. Discussing these experiences, a group of students commented:

S8B: Well…Learning science is not just writing down information and notes. Doing experiments is a more effective way to understand better and learn more. Writing notes does not interact the information with daily life. And also, when we think about a lesson, we can focus on one thing like for three weeks. It is good because this is spending a good amount of time doing stuff, we can understand, not just move on or not get it. We can understand lots of different things and learn more.
S8C: Yesss….I agree, we can learn something every term like a pathway. We can often do one lesson and then combine another, so we can learn a little bit. Next term you have got it a little bit more. We can learn so much. If we see a new thing, we have lots of resources in the library. We can learn by ourselves from these kinds of science books. Teachers also can give good advice to learn more. (C school- Year 8- 7th July).

In the majority of focus groups, students reported a variety of advantages to learning science outdoor:

> *S_{8B}: I prefer an outdoor classroom because it is kind of going to the environment. If you observe something like animals, how they behave, instead of just learning in the classroom, we can learn better.*
> *S_{8A}: It is easy to control inside but it will be better outside, related to the natural world or environment. I think being outside is more understanding. Any science classroom you learn something but it is not quite exciting. When going outside you can make memories, which you can get back and remember when you have an exam. Inside we can get just information. (A school- Year 8- 24th June)*

Many stated that they believed that if you have a nice teacher, you can be more interested in the subject. They believed that discussion, hands-on activities, and easy access to resources are more effective ways to learn better. They reported that if they summarise the last lesson at the beginning of the next lesson, they can understand clearly, remember and learn more.

> *S_{8A}: Well…Discussion is important because everyone can get involved.*
> *S_{8D}: So… One person says something; another person can build up this topic. It is nice.*
> *S_{8B}: And… Having a nice science teacher is also important. If you like the teacher, you can get the subject more. I have got science a lot this year because of this. We are lucky we have too many resources and professional equipment and we can have access to this kind of stuff when we do hands-on activities.*
> *S_{8C}: Yes! I agree with you. We can experiment more and do practical activities with wide range of equipment. Additionally, sometimes we carry on the stuff and then we can come back. If you did not get it, you can learn later. But in science lessons we cannot do this. We have to carry on another subject. It does not matter how many students get it. I think it is important. (C school- Year 8- 7th July)*

In all focus groups, students offered a number of recommendations that can be clustered into these four key points: practical learning, hands-on activities, balance indoor and outdoor activities, and more experiments. Some students offered a number of recommendations for better science lessons, such as having real life experiences, or observing animals or plants in their real environment. A year 8 student who took part in the third group discussed home schooling:

> *S_{8C}: We can build up home school, you can compare everything. We can learn in the classroom; and we can make in home school. We can show the people our*

project. If you study projects with friends, they help us if we do not get it, we can ask them and learn from our peers. (A school- Year 8- 24^{th} June)

4.3.4 Students' Experiences of Science Classrooms

As can be seen from the students' conversations, there are clear similarities in the way the students described their proper science classrooms. In all focus groups, the students discussed different of elements of the science classroom, stating that they should have better and more professional equipment. Many other students agreed:

> *S_{9C}: There should be enough resources and well-made professional equipment. But this equipment should not all be at the same level. We need a wide range of stuff for every level of school. And also we need to get access this material. It should be in the computer and ICT room. We need special windows to make the rooms darker or lighter. There should be fire safety equipment.*
> *S_{9D}: Our last science class did not have a brilliant design. We did not do more work for practical and hands-on activities. We want to display our experiments or work. (C school- Year 9 – 7^{th} July)*

Many students talked about displaying their work such as projects, posters and own or group work in the science classroom.

> *S_{8B}: In fact, having good displays can help good motivation, personally having your own work such as a poster or project. If you put it on the wall, you can share with students how and what you have achieved.*
> *S_{8A}: And… you can understand more. When you see and look at them you can learn more and remember more.*
> *S_{8C}: One word!!! - Colour. It is so brightening and attractive.*
> *S_{8D}: Also, we need a big enough classroom and more space to interact with other students. If we walk around the classroom we can learn more from each other. It is not good just sitting down, writing notes and looking at the board. (C school- Year 8 – 7^{th} July)*

As noted by student *S_{8A}:*

> *We should do more experiments and group activities. When we do experiments, we can predict the results rather than watching the teacher or friends like a scientist. (B school- Year 8 – 6^{th} July).*

One student highlighted a recommendation about science classroom. As stated by S_{9A}:

I think we need to visit more scientific places not just proper science labs. Not too much, maybe one a week is enough. Just experiment a little bit more, see more. Visualisation is more helpful. Sometimes it can get very confusing to talk about it. Physically doing is also helpful to remember what to do more. It is more memorable. (A school- Year 9 - 24th June)

4.4 Summary of Research Findings

In Chapter four, I have presented the findings of my research. Combining two different methods to gather data was appropriate to make sense and provide a better understanding of students' metaphors and experiences in the focus group interviews. Students' perceptions and experiences of science, scientists, science lessons and science classrooms were revealed by using metaphor in the open-ended questionnaires and focus group interviews. In general, the students who participated in this research illustrated more positive views towards science, non-stereotypical images of scientists, and more positive opinions about effective science lessons and classrooms. In the next chapter I will present a discussion on this research in relation to the literature, and will discuss the assumptions of the study.

CHAPTER 5: DISCUSSION ON FINDINGS

5.1 Introduction

In this chapter I will provide a discussion on how the methods used answered the research questions. I will additionally discuss the assumptions in the research and the linkages to literature. This chapter begins with a review of the research questions set out in chapter one. The purpose of this baseline qualitative phenomenological study was to investigate students' perceptions and experiences of the concepts of science, scientists, science lessons and science classrooms by utilising metaphors to describe the characteristics of the ideal science lesson and science classroom in the eyes of secondary school students. In chapter four I presented the results of my research having obtained data from an open-ended questionnaire and focus group interviews. In the following sections I will discuss the findings of each of the research questions.

5.2 Students' Thoughts and Perceptions of Science, Scientists, Science Lessons and Science Classrooms

The purpose of my research was to investigate secondary school students' perceptions of the concept of science, scientists, science lessons and science classrooms by using metaphor. I described the results of the question having gathered data from an open-ended questionnaire. I posed a research question to draw a categorise the students' metaphors. I therefore raised another research question to identify students' views on the ideal science lessons and classroom. Focus group interviews were utilised to understand better the students' perceptions and experiences within these frames.

5.2.1 Students' Perceptions of Science

An examination of the students' frameworks showed that the students' perceptions of science were gathered under three main categories: characterised by empirical criteria of science, reasons for the emergence of science, and characterised by sceptical reviews of science. Dikmenli (2010) used similar categories and sub-categories, and Cilingir (2014) also utilised similar sub-categories to investigate students' representations of science. It was observed that year 8 students mostly emphasised the aspect of invention in science, whilst on the other hand year 9 students highlighted the feature of the incomprehensibility of science the most. When looking at the students' statements on science, they generally used the metaphor of a never-ending road or a journey to describe science's sense of discovering and learning new knowledge. Simultaneously, both year 8 and year 9 students perceived the metaphor of a jigsaw puzzle to identify science's aspects of being confusing and hard. It was found in the focus group interviews that science is an important and useful subject to help us understand general life better, improve our health, and learn more practical stuff. The results of this research showed that students' plans for the future are generally positive. Previous studies carried out by Boylan et.al (1992) and Painter et al. (2006) supported the result that students' perceptions, interests and attitudes towards science can have an effect on their thinking about future plans with regards to science. Previous research carried out by Finson (2003) and Buldu (2006) also supported this result. Consideration of the studies that support the present results illustrated that the students posed similar ideas, including describing their experience of learning science in primary school as limited. When they came to secondary school, they started doing more experiments and practical work in science. The same point was reported by Jarman (1993), who found that when students transferred from primary to secondary school they noted that there was more practical work. Doing experiments and hands-on activities and learning new things might affect students' perceptions of science, and this finding is supported by previous research (Speering and Rennie, 1996).

Another point is that the majority of students identified science as a balance between indoor and outdoor activities and experiments. Kaya et al. (2013) found that science is still associated to laboratory experiments which exclude the humanities and social sciences, although that is a different point to the current research. According to Flick (1990), developing naïve opinions will positively influence students' tendencies to have careers in science. Consequently, science teachers, educators, scientists and policy makers need to take responsibility to improve positively students' perceptions of science. In order to achieve this expedition, science teachers should use more hands-on activities and experiments, balance theory and practice, and provide opportunities to take part in science festivals, science camps and university visits that allow students to work. When interviewed, the students mentioned the same point. By attending science festivals, watching scientific videos, and doing more hands-on activities and experiments, they can increase their interest in and engagement with science. Turkmen (2008) emphasised the same point. Scherz and Oren (2006) stated that students' perceptions of science can impact on their science learning and attitudes towards science. Buldu (2006) and Braund and Reiss (2006) similarly recommended utilising hands-on activities, inviting scientists to the classroom, or going to university to observe scientists in their natural setting in order to impact the students' perceptions of science positively.

5.2.2 Students' Perceptions of Scientists

When examined, the students' conceptual framework displayed how the students' perceptions of scientists were obtained under three key categories: scientific characteristics of scientists, social characteristics of scientists, and personal characteristics of scientists. It was also indicated that students' perceptions were categorised under seven sub-categories. Karaçam (2015a) utilised the same categories and similar sub-categories, and Dikmenli (2010) also used similar sub-categories to investigate students' perceptions of scientists. It was found that year 8 students highlighted the aspect of the scientific activities of scientists the most. Similarly, year 9 students focused mostly on the features of the scientific activities of scientists, and also emphasised the social roles of scientists. When examining the students' statements on scientists, in general they used the metaphor of an explorer to describe scientists' sense of exploring, and explaining new knowledge. Furthermore, year 9 students perceived the metaphor of Google or Yahoo to identify scientists' aspect of knowing everything. Year 8 students ignored the social value of scientists. However, they highlighted their social value in the focus group interview by using expressions like "they are like a doctor", "they can help people to find cures for diseases", and "they can inform human beings of innovations". These results are similar to the findings of the previous research (Kaya et al., 2013). It was found that fewer students had stereotypical views of scientists, and in fact the majority of students perceived non-stereotypical images of scientists. The current research did not find too many instances of these kinds of stereotypical views. Students appear to now have the correct knowledge about who scientists are and what they do. In particular, both year 8 and year 9 students focused their attention on the influence of the media and their parents in terms of their image of scientists. Previous research conducted by Turkmen (2008) supported this result. Ruiz-Mallén and Escalas (2012) and Turkmen (2008) also mentioned the influence of science teachers, schools, parents, TV programmes and textbooks as having shaped students' images of scientists.

Additionally, Buldu (2006) and Karacam (2015b) found that there are significant differences between students' stereotypical images of scientists in relation to the students' grade level. In this current study, there is no difference in the perception of scientists between year 8 and year 9 students. This result might be due to the age of the students being very close to each other. Consideration of studies that support more or less the present results illustrated that both year

8 and year 9 students perceived scientists with similar and non-stereotypical perceptions. Consequently, science teachers, educators, parents and the media should have the responsibility to develop positive perceptions of scientists, and to seek opportunities for students to get in contact with scientists outside of the classroom and outside of the scientists' environment, as this may help students to see science in action outside the school or classroom.

5.2.3 Students' Perceptions of Science Lessons

An examination of the students' perceptions of science lessons showed that the data was obtained under four main categories: procedure and progress of science lessons, research area of science lessons, the scientific function of science lessons, and the personal relevancy of science lessons. It was also indicated that students' views were categorised under nine sub-categories. Soysal and Afacan (2012) used similar categories to analyse students' perceptions about the concepts of the science lesson. It was found that year 8 students mostly emphasised the aspects of invention or discovery and the difficulty of science lessons, whilst year 9 students highlighted the feature of incomprehensibility in science lessons the most, and similarly focused on invention or discovery, difficulty and the enlightening nature of science lessons. When investigating the students' statements on science lessons, I found that generally year 8 students utilised the metaphor of experiments to describe how science lessons promote their understanding of finding out new things, understanding natural life, and discovering the right answers. Furthermore, year 9 students perceived the metaphor of the universe to identify the aspect of science lessons having more and endless possibilities. Both year 8 and year 9 students perceived science lessons as being like a maths lesson, or a confusing hour, to identify the difficulty involved in science lessons. In particular, science is a more difficult subject for year 8 students than year 9 students. Students' personal relevancy can be a more important factor in influencing students' interest in and engagement with science. Data gathered from the focus group interviews showed that science lessons are not just writing down information and notes, but should involve doing more hands-on activities, experiments and active learning, which are more affective for science lessons, and similar findings have resulted from other research (Gomez et al., 2016). This point is confirmed by Osborne and Collins (2001), who said that teachers' educational strategies and instructional approaches have a crucial role in students' perceptions of science lessons. Teachers should encourage students to participate in science lessons actively, and to participate in activities. The findings highlighted that if students like the teacher they are interested in subject, and maybe this is universal. Students reported that peer support, easy access to resources and also teaching assistants are more effective ways to learn more and understand science lessons better. Flutter and Rudduck (2004) considered a similar point that students' science learning and the level of students' attainment in science lessons can be influenced by their perceptions of science lessons. Additionally, they emphasised that learning science outdoors has more advantages in terms of achieving more. They recommended that if a science lesson is association with daily life, students understand and learn better. Providing opportunities for students to see and do science at home or in other non-school areas would be helpful. Classroom discussions, as highlighted by the students, on how science is utilised at home may encourage students to participate in science more. Science educators have an important role in helping in-service or pre-service science teachers to improve and develop their science lessons.

5.2.4 Students' Perceptions of Science Classrooms

An investigation into students' perceptions of science classrooms showed that the data was gathered under two main categories: the research area of science classrooms, and the environmental relevancy of science classrooms. It was also discovered that students' perceptions were categorised under five sub-categories. It was observed that both year 8 and year 9 students mostly emphasised the aspect of the classroom supporting learning. When examining students' statements on science classrooms, in general it was found that year 8 students used the metaphor of a room full of knowledge, a brain or a laboratory to describe the sense of gaining knowledge, further understanding, and expressing views and opinions in science classrooms. Furthermore, year 8 students perceived the metaphor of a playpark or a mystery room to identify the enjoyable and fun aspects of science classrooms. In contrast, both year 8 and year 9 students identified science classrooms negatively by using the metaphor of a prison, a cage or a traditional classroom. In particular, negative environmental relevancy was more prevalent among year 9 students. Students' opinions about classrooms are a key factor in students' achievements and effective learning, and this was highlighted by the majority of students (Doppelt, 2004; Gomez et al., 2016). Students reported that science classrooms should have better and more professional equipment for all levels. Displaying students' projects, posters and own work in the classroom can improve their understanding and help them recall their learning. They recommended that visiting scientific places is a much better way of learning science than staying in a classroom. Students stated that passive activities, including sitting down, responding to science teachers' questions, writing and listening to teachers' instructions and thoughts, do not encourage students to share their ideas and show their work. They expressed that they wanted to walk around, to see other students' work, and share their ideas. Class size is also a main element emphasised by the majority of students. Previous research has supported this point (Doppelt and Schunn, 2008; den Brok et al, 2006). Teachers do not support students on an individual basis in larger classes, and students stated that teaching assistants can help them to learn and understand science more. Students want to do more practical stuff, hands-on activities and experiments, and this point is supported in other research (Ebenezer and Zoller, 1993). The current findings have shown that an increase in science activities affects students' attitudes towards science, and similar results have been found in other research (Bernardo et al., 2008). Students do not want to just write and read textbooks. However, previous research conducted by Doppelt and Schunn (2008) found different results. They found that homework and instructional worksheets are an important characteristic in a learning environment. Students' perceptions of their classroom environment can have an influence on their outcomes and performance, and also curriculum development.

5.3 Students' Thoughts and Perceptions on the Ideal Science Lesson and Science Classroom

Having examined the students' thoughts on the ideal science lesson and classroom, the open-ended questionnaire and focus group interviews were utilised in this research. Examination of students' statements on the ideal science lesson and classroom showed that they are gathered under two main categories: supporting learning, and environmental relevancy. When investigating the students' statements on the ideal science lesson and classroom, both year 8 and year 9 students highlighted similar points in the focus group interviews and written descriptions. They emphasised that in order to learn science better, practical work and outdoor activities should be integrated into science lessons. They thought that studying in small groups or interacting with other students and teachers, and expressing and sharing ideas with other students, are effective ways to learn and understand science better. Theory and practice should be in balance in science learning. They did not want to test facts; predictions, testing and evaluating new knowledge are also important in terms of remembering one's learning. Science lessons should be fun. Science teachers should provide opportunities for students to attempt these kinds of things. Taking notes, copying, listening to teachers' instructions, and learning science in a short space of time discourages students from being interested in and engaged with science. Previous research carried out by Toplis (2012) explored upper secondary school students' views of practical work, including teaching and learning science in England. Toplis (2012) reported that hands-on practical work can further improve learning and recalling science, and can also increase a sense of ownership and involvement. Writing, copying and reading at the exclusion of other science activities contributes to an opinion where science lessons are described as tedious. Osborne and Collins (2000, p.27) reported that "copying" led to a significant reduction in opportunities to engage with practical activities. Abrahams (2008) emphasised a similar point, saying that students' reasons for being interested in practical work are because it is better than other kinds of activities, such as learning facts and theories, listening to the teacher, reading from books or textbooks, or writing activities. Wellington (2005, p.103) stated that when small groups of students were asked about their experiences of practical lessons in science, they said it was "fun to do something, not just writing, all working together and more interesting than reading or listening to teachers." Abrahams and Millar (2008) attempted to find out how practical lessons are effective in teaching and learning science in school. The results of their study indicates that if teachers pay attention to practical works, this mainly develops scientific knowledge rather than scientific inquiry. Practical lessons are effective at helping students to achieve what is intended with physical targets rather than utilising scientific knowledge and reflecting on facts.

When examining descriptions of science classrooms in the eyes of secondary school students, I found that they believe that if their own models, posters and pictures are displayed in their classrooms that will encourage students to participate in science more. Enough equipment and resources, enough space for everyone, and a group of students to set up practical equipment or experimental tools are more productive ways to learn science actively. Students reported that classrooms should be well-organised, with practical tools that can be accessed easily. Science classrooms should also be safe for flammable experiments and colourful to attract students to participate in science learning. Students especially highlighted the outside of the classroom. Learning does not take place only in the classroom, and science teachers should arrange outside classroom environments. Generally, students have some positive perceptions of their science classroom environment. Classroom settings affect students' academic achievements, and this has been described as the "general class atmosphere including attitudes towards learning, norms of social interactions, acceptance of ideas and mistakes, and learning structures set by the teacher." (Urdan and Schoenfelder, 2006, p. 340) However, in general students' perceptions shape their classroom experiences. A positive learning climate can foster students' participation and engagement with science. In general, they do not intend to be in a traditional science classroom design with desks facing a board in front of the classroom and textbooks (Ulker et al., 2013). Teachers should have knowledge of arranging non-traditional classroom settings for their students.

5.4 Summary of Research Discussions

In this chapter I considered how the two methods used answered the research questions. I discussed the assumptions made, and also linked these to the literature. Two different types of method were used to collect data. This research drew on the assumptions that students may have more or less the same perceptions of science, scientists, science lessons and science classrooms. Their perceptions can be directly linked to their experiences of scientific practice in their lessons. Students' perceptions of science are so significant that science teachers and educational programme developers should have some responsibilities to know what students' views are on these themes. This could develop students' understanding and use of science in their daily lives. In the next chapter I will present a discussion on this research in relation to the literature review. I will present the stakeholder implications and recommendations, and the limitations of this study and suggestions for further research will be acknowledged.

CHAPTER 6: CONCLUSIONS AND IMPLICATIONS

6.1 Introduction

In this chapter I will discuss the recommendations of this research and the implications for practitioners, policy makers, science teachers and educators. The limitations of this study and suggestions for further research will be acknowledged. The types of themes identified were concerned with students' perceptions of science, scientists, science lessons and science classrooms, based on the use of metaphor and experiences.

6.2 Implications and Recommendations

The present research has made a useful contribution to students' perceptions and experiences of science by using the metaphor technique and focus group interviews. The main purpose of this research was to investigate the situation in a UK context, and the results of this research have generated implications for practice and policy. Students' voices are significantly important in this area of research and development, with schools discussing their students' learning and teaching, and listening to them (Rudduck and McIntyre 2007).

The implications of this research for science teachers are that science teachers are required to be aware of their students' perceptions of science and science-related concepts. They should design their classrooms in terms of non-traditional classroom settings. Many students highlighted practical and hands-on activities in science lessons, and teachers should listen to their students' opinions when they arrange their teaching and learning.

Some researchers have emphasised the overloaded nature of the UK National Curriculum in terms of content, and how this is the reason for the lack of success in introducing practical work into science classrooms (Osborne & Collins, 2000). The UK National Curriculum is seen as rigid and inflexible, resulting in teachers with little opportunities to design and use innovative practical work in their science classrooms. Although practical work is a fundamental part of the UK National Curriculum, and at Key Stage 4 contributes 20% of the General Certificate in Secondary Education (GCSE) grade, it can very often be relegated to the status of work just for assessment. While most science teachers accepted the UK National Curriculum in principle, many have complained that it restricts the range of laboratory work undertaken and diminishes students' interest in and enjoyment of science (Jenkins, 2006). The utilisation of practical work requires it to be productive and cautiously selected, and evaluated for a particular situation and with specific results (Millar, 2010). Practical work might support the conceptual understanding of science and practical inquiry abilities.

The implication of the results of this research for science educators suggests that they should help pre-service and in-service teachers to understand their students' perceptions of science and science-related concepts, as well as the productive ways of changing them. One implication that consistently became apparent in the research on students' perceptions of science and science-related concepts is that if an individual's views are stereotypical this has a direct link to their selection of science coursework and the likelihood of entering a science-related career. If an individual holds less stereotypical opinions, the more probable it is that that person will participate in more science classes and will consider pursuing a profession in a science subject.

The implication of this research for educational policy makers is that they need to think carefully about policies which affect the primary and secondary science curricula separately. Many students reported the same concern that practical activities are not done in primary school because of the science curriculum. There is a requirement for educational policy makers to consider students' perceptions of science. This research found that students have negative attitudes towards primary school science lessons.

6.3 Contribution to Knowledge

As discussed in Chapter two, previous studies have emphasised students' stereotypical perceptions of science and scientists, and students' views and experiences of science lessons and science classrooms. There is no previous study which investigated students' perceptions of science, scientists, science lessons and science classrooms by utilising the metaphor technique, alongside students' descriptions of the ideal science lesson and classroom in the eyes of secondary school students, using written descriptions and focus group interviews. None of the previous studies were undertaken in the UK. Whilst many studies have been carried out to investigate students' perceptions using a variety of methods, my research has contributed to this field by extending our understanding of students' experiences and views. Moreover, there was evidence from the data obtained in this research that students can be interested in and engaged with science more if they do more practical work and hands-on activities, not just reading and learning facts.

6.4 Limitations of the Study

This research was carried out in a small scale study with a purposely chosen group of students; as a consequence, it has some limitations. Firstly, it was not easy to get access to schools in the UK. This research was also limited in time, and for this reason a smaller population had to be selected so that data could be gathered easily and analysed in the time available. The selection of secondary school students was decided based on which schools responded positively when asked if they wanted to participate in this research. I visited the school twice. The first time, I presented the questionnaire to students, which took 20 minutes, and the second time I hosted the focus group interviews with groups of four or six students who had been selected by their science teacher voluntarily. The interviews lasted between 10 and 20 minutes. The study was also limited by my own experience; I should have been more skilled in order to do the focus group interviews better. I noticed that I needed to do a pilot study before conducting my small scale study for the focus group interviews.

6.5 What next?

In this research, I simply discussed which metaphors secondary school students use to describe science and others, and under which conceptual categories these proposed metaphors can be placed. I attempted to understand in-depth the students' experience of science by utilising focus group interviews. However, this investigation did not shed any light on the rationales for these students' perceptions and experiences, and how these metaphors shaped, prompted and produced the students' perceptions has not been examined. This research pointed to several factors that could be of interest for future research. For example, how secondary school students' view their science learning, their science lessons and classrooms and their ideal science teacher should be explored, as well as differences concerning students' class, gender, family and educational background in relation to the conceptual metaphors used. Such understanding can be obtained through action research projects or classroom discussions. Further research could focus on changing and shaping students' perceptions. Future researchers might consider carrying out this research with a larger sample of students, using similar or different types of methods.

6.6 Final Thoughts

In this day and age, it seems vitally important that all students are required to create a positive relationship with science and science-related concepts so that they can have an engagement with the subject in every part of lives, whether or not they become scientists or choose careers in science or science-related subjects. It is crucial that students have a positive perception towards science and engage with science (Baker and Jones, 2005). Although the students generally have positive perceptions of science, non-stereotypical views about scientists, favourable opinions about science lessons and science classrooms, and they want to learn science more and understand it better in school, with various students wanting to continue their careers in science, in later life they lose their interest and positive perceptions. This study demonstrated that by providing students with enough resources and granting them easy access to equipment, they can be encouraged to engage with science more. Teaching and learning resources are a proactive step towards creating opportunities for students to consider the relevance of science.

APPENDICES

Appendix A

Certificate of Ethical Approval

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GRADUATE SCHOOL OF EDUCATION MODULE ASSIGNMENT ETHICS FORM

When completing this form please remember that the purpose of the document is to clearly explain the ethical considerations of the research being undertaken. As a generic form it has been constructed to cover a wide-range of different projects so some sections may not seem relevant to you. Please include the information which addresses any ethical considerations for your particular project which will be needed by your tutors to approve your proposal. **Please refer to the Graduate School of Education Module Assignment Ethics Form guidance notes.**

Please note that this form and process applies to modular assignments only. Please see https://intranet.exeter.ac.uk/socialsciences/staff/research/researchenvironmentandpolicies/ethics/ for details of the application process for dissertations and theses.

Guidance on all aspects of the SSIS Ethics application process can be found on the SSIS intranet: https://intranet.exeter.ac.uk/socialsciences/staff/research/researchenvironmentandpolicies/ethics/

SUBMISSION PROCEDURE Students and module tutors should follow the procedure below.

1. Send a draft application to your module tutor.
2. Complete any changes requested and re-send to your module tutor.
3. Your module tutor may then forward your application to a second tutor for checking. If so, your application will either be approved or returned for further changes.
4. Your module tutor will email you to confirm approval of your ethics form.
5. Do not gather any data until your ethics form has been approved.
6. This form must be included as an appendix in your assignment.

Applicant details	
Student number	**650053883**
UoE email address	
Programme	**MSc Educational Research**
Module code & title	**ERPM004 MSc Dissertation**
Name of module tutor	**Dr. Nasser Mansour**

Duration for which permission is required		
You should request approval for the entire period of your research activity. The start date should normally be at least two weeks from the date that you submit this form. Students should use the anticipated date of completion of their module as the end date of their work. Please note that <u>retrospective ethical approval will never be given.</u>		
Start date:15/05/2016	**End date: 15/07/2016**	**Date of application:03/05/2016**

Certification for all submissions
I hereby certify that I will abide by the details given in this application and that I undertake in my research to respect the dignity and privacy of those participating in this research. I confirm that if my research should change radically I will complete a further ethics proposal form. **Z** *Submission of this ethics proposal form confirms your acceptance of the above.*

TITLE OF YOUR PROJECT

An investigation into the concept of science, the scientist, the science lesson, and the science classrooms among secondary school students through metaphors

SYNOPSIS OF THE RESEARCH PROJECT

As a guide – approx. 200 words.

Aims and objectives

The aim of this project is to investigate year 8 and year 9 secondary school students' thoughts and perceptions about "science" ,"scientists" ,"the science lesson" and "the science classroom" concept though metaphors use and to describe the characteristics of "the ideal science lesson", "the ideal science classroom" in the eyes of the secondary school students. Within the frame of this general aim, answers to these questions will be investigated. The main target in content analysis is to reach to the concepts and relations that will explain the collected data. The interpreted and outlined data within descriptive analysis will be taken deeply in content analysis and with this way new theme and concepts.

Statement of the problem

1- Which metaphors do secondary school students (year 8 and 9) use to describe the concept of "science", "scientists", "the science lesson", "the science classroom" in the UK?

2- Under which conceptual categories can proposed metaphors about the "science", "scientists", "the science lesson", "the science classroom" concept by secondary school students be classified in term of their common features in the UK?

3-How do secondary school students describe "the ideal science lesson" and "the ideal science classroom" in the UK?

Review of literature

Metaphor is generally defined as describing a phenomenon or a concept by the terms which are more familiar. Yob (2003) points out, metaphor is employed when one wants to explore and understand something esoteric, abstract, novel, or highly speculative. Also a good metaphor should have certain characteristics. Patton (2002) proposes a set of criteria as to what makes a good metaphor which should be understandable, be connected with their real life experience, be meaningful — makes the desired point, should express appropriate values for the intended audience and should be situationally and contextually appropriate. Vadeboncoeur and Torres (2003), referring to the literature, regard metaphors not only as an indispensable part of the education system, from elementary level to higher education level but also added that they are widely used in the education system for making the teaching- learning process more effective and more influential.

Area is observed in many studies about the metaphor is examined. Some of these "school" (Saban, 2008), "students" (Saban, 2009), "teacher" (Saban, Kocbek and Plough, 2006), blackboard mobile learn and iPads (Kinash., Brand., & Mathew, 2012), "mathematic" (Bahadır and Ozdemir, 2012) seems to be like for the concept or phenomenon. However, when examined these publications "science", "scientists", "the science lesson", "the science classroom" , the characteristics of "the ideal science lesson", "the ideal science classroom" have not been found to work on the concept of metaphor.

Research Methodology

In this study, phenomenological pattern, one of qualitative research methods, will be used in this research. Understanding life experiences is primary for phenomenological studies. Phenomenological study provides flexibility to make sense of embedded phenomena with its conceptual structure and to select data collection processes (Munhall, 2007). Phenomenographic research design allows researchers to conduct an in-depth examination of the phenomena (such as events, experiences and situations) that we encounter in our daily lives.

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INTERNATIONAL RESEARCH

This research will be carried out in the UK. A prompt paper will be given to the secondary school students. Students will be asked to write their thoughts by focussing on just one metaphor/simile. 6 focus-group interviews will be conducted with year 8 and 9 students.

The following sections require an assessment of possible ethical consideration in your research project. If particular sections do not seem relevant to your project please indicate this and clarify why.

RESEARCH METHODS

In order to reveal the perception of the secondary school students about the concept of "science", "scientists", "the science lesson", "the science classroom", and to identify "the ideal science lesson" "the ideal science classroom" secondary school students will be asked to complete a prompt paper on which will be written "Science is like……….. Because………" will be given to the secondary school students. Students will be asked to write their thoughts by focussing on just one metaphor/simile. 6 focus-group interviews will be conducted with 4 or 6 students. Focus group interviews are a common method when people's experiences, opinions, beliefs, values and desires are studied. The method allows respondents to generate their own questions and to approach the subject on their own terms and with their own vocabulary.

PARTICIPANTS

The participants of this study are year 8 and 9 students enrolled in secondary schools in the UK during the 2015-2016 academic year. This study requires 200 participants; 100 from year 8 and 100 from year 9 in the UK. Convenient sampling will be taken as the basis to provide speed and practicality to the research activity. Researchers will prefer to study with a group nearby and easy to work on from the UK.

THE VOLUNTARY NATURE OF PARTICIPATION

Participants will be based on voluntary participation.

SPECIAL ARRANGEMENTS

Free environment will be provided in a way to complete the research. Private label will be given to protect and to identify students' papers and their interview.

THE INFORMED NATURE OF PARTICIPATION

Participants will be informed before starting to fill in the prompt paper and to do focus-group interview with students.

ASSESSMENT OF POSSIBLE HARM

Possible harm will be managed and kept under control.

DATA PROTECTION AND STORAGE

Students' paper will be collected via their prompt paper. Focus group interview will be recorded using an audio recorder. These recordings will only be heard by me and my research supervisor.

DECLARATION OF INTERESTS

No interest will be guided in research findings.

USER ENGAGEMENT AND FEEDBACK

Feedback will be provided from an expert and a science teacher.

Appendix B

Information Sheet for Teachers and Schools

Research Project Information Leaflet for schools / teachers

Project title: **An investigation into the concept of science, the scientist, the science lesson, and the science classrooms among secondary school students through metaphors**

Introduction

I am a student in the University of Exeter doing a research project. I am interested in investigating year 8 and year 9 secondary school students' thoughts and perceptions about *"science", "scientists", "the science lesson" and "the science classroom"* concepts though the use of metaphors and to describe the characteristics of *"the ideal science lesson", "the ideal science classroom"* in the eyes of the secondary school students. I would like to ask for your help with this project!

It is also worth mentioning that I have got the approval of conducting this research from Graduate School of Education at the University of Exeter.

Why am I doing the project?

The project is part of my master degree at University of Exeter. It is hoped that the project could provide useful information about students' perceptions and thoughts about *"science", "scientists", "the science lesson" and "the science classroom"* and how they describe the characteristics of *"the ideal science lesson", "the ideal science classroom"*.

Research project procedure

The students will be asked to complete the questionnaire and answer these questions. Filling the spaces in the questionnaire will take 20 minutes maximum. I need to arrange a time to visit schools, which is convenient for the schools. I will be happy to visit to provide the schools with the questionnaire and distribute it to students. This study requires 200 participants; 100 from Year 8 and 100 from Year 9 who are attending state schools. They are not required to write their names and their school details. I can visit the schools to complete the questionnaires between 27th of June and 15st of July.

I need to arrange one more time to visit the schools, which is up to the schools and teachers to choose suitable time to do four focus group interviews with four or five students. The science teachers can select the students for the focus group interview and the teacher should inform the students for the voluntary participation in this project. The focus group interviews is expected to last no longer than 20 minutes. I can do the interview between 27th of June and 15th of July. The purpose of the interview will be exploring the students' perceptions about *"science",*

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"scientists", "the science lesson" and "the science classroom" and descriptions regarding the characteristics of *"the ideal science lesson", "the ideal science classroom"*. I will ask students if I can record our focus group interview using an audio recorder. These recordings will only be heard by me and my research supervisor. Students' names and details will be anonymised and their privacy will be reserved.

Ethical considerations

Before data collection, the ethics of the research will be approved through the Graduate School of Education ethics processes at Exeter University. Pupils' participation will be voluntary and they have a right to refuse or withdraw from the research.

All data collected as part of the study as well as my general experience within the school will be treated as confidential and I will make every effort to preserve students' anonymity. Information about participants and the school will be deleted once the project is complete.

Will students' participation in the project remain confidential?

If students agree to take part, their name will not be recorded on the questionnaires and the information will not be disclosed to other parties. Their responses to the questions will be used for the purpose of this project only. They are assured if they take part in the project they will remain anonymous.

What are the advantages of taking part?

Students may find the project interesting and enjoy answering questions about *"science", "scientists", "the science lesson" and "the science classroom"* and descriptions regarding the characteristics of *"the ideal science lesson", "the ideal science classroom"*.

If there are any questions about this project, please contact me or my research supervisor.

Z.

Research Supervisor contact details:
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Programme Director for the MSc in Educational Research
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Appendix C

Information Sheet for Students

Research Project Information Leaflet for Young People

Project title: **An investigation into the concept of science, the scientist, the science lesson, and the science classrooms among secondary school students through metaphors**

Secondary school students' metaphorical perceptions related to some concepts in science

Hello Everyone,

My name is Z. I am a student doing a research project on "students' perceptions about *"science", "scientists", "the science lesson" and "the science classroom"* and description of the characteristics of *"the ideal science lesson", "the ideal science classroom"* in the eye of the students.

I would like to ask for your help with this project! I would really like to meet you and chat with you.

Why have I asked you to take part?

I want to know about your perceptions about *"science", "scientists", "the science lesson" and "the science classroom"* and how you describe the characteristics of *"the ideal science lesson", "the ideal science classroom"*.

If you take part, what will you be doing?

I will ask you to fill a prompt paper and answer some questions like "Science is like............................... Because........................" Filling the spaces in the prompt papers will be lasted 20 minutes. We will do a group chat with 3 or 4 of your friend. The interview can last 20 minutes. I will ask you questions about perceptions about *science and others* descriptions regarding the characteristics of *"the ideal science lesson", "the ideal science classroom"*. I will not make you say anything about yourself that makes you feel uncomfortable.

Do you have to take part?

You do not have to take part in the interview. It is OK to say no. If you say yes and then change your mind and do not want to do the interview that is OK too. No one will mind if you choose not to take part - it is **your** choice!

Please Turn Over

Do you need to do anything before the interview?

You and/or your parent/carer will need to fill in a consent form saying that you want to take part in the interview. The teachers and your parents can help you read this information sheet and fill in the consent form if you want. On the form, you can tell me what things I can do for you that will make the interview easier.

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How will I use the information about you?

I will ask you if I can record our interview chat using an audio recorder. These recordings will only be heard by me and my research supervisor. Your name, details and your conversations will not be given to anyone else unless you say I can or if you are in danger of being hurt by someone at school/college. I will not use your real name in the research papers and will make sure your comments will not be linked to you in any way.

How will the research help you or others?

The interviews can be a good thing. It can make you feel good knowing that your views have been heard and taken seriously. The interviews will not change what happens at your school or at home.

What do you do now?

Take time to decide if you want to take part in the interviews or not. You can talk to the teachers and your parents/carers for advice.

If you are happy to take part in an interview, please tell your teacher, or you can email me using my details below. I am looking forward to hearing from you.

If there are any questions about this project, please contact me, my research supervisor.

Best Wishes,

Z

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Appendix D

Consent Form

GRADUATE SCHOOL OF EDUCATION

Title of Research Project: **An investigation into the concept of science, the scientist, the science lesson, and the science classrooms among secondary school students through metaphors**

CONSENT FORM

I have been fully informed about the aims and purposes of the project.

I understand that:

there is no compulsion for me to participate in this research project and, if I do choose to participate, I may at any stage withdraw my participation and may also request that my data be destroyed

I have the right to refuse permission for the publication of any information about me

any information which I give will be used solely for the purposes of this research project, which may include publications or academic conference or seminar presentations

if applicable, the information, which I give, may be shared between any of the other researcher(s) participating in this project in an anonymised form

all information I give will be treated as confidential

the researcher(s) will make every effort to preserve my anonymity

....

(Signature of participant) (Date)

....

(Printed name of participant)

One copy of this form will be kept by the participant; a second copy will be kept by the researcher(s)

Contact phone number of researcher(s):..

If you have any concerns about the project that you would like to discuss, please contact:

....

OR

....

* when research takes place in a school, the right to withdraw from the research does NOT usually mean that pupils or students may withdraw from lessons in which the research takes place

Data Protection Act: The University of Exeter is a data collector and is registered with the Office of the Data Protection Commissioner as required to do under the Data Protection Act 1998. The information you provide will be used for research purposes and will be processed in accordance with the University's registration and current data protection legislation. Data will be confidential to the researcher(s) and will not be disclosed to any unauthorised third parties without further agreement by the participant. Reports based on the data will be in anonymised form.

Revised March 2013

Appendix E

Open-ended Questionnaire

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Perceptions of Science Concepts of Open-ended Questionnaire

Dear Students

This survey is designed to find out about how you describe science, scientists, the science lessons, and science classroom. It is about the metaphors you use when you think about science, a scientist, a science lesson, a science classroom. The survey consists of two parts. In the first part regarding your personal information, the second part is concerned about your perceptions of science, scientists, the science lessons, and science classroom, the ideal science lesson, the ideal science classroom. The data collected through this survey will be used only in scientific studies. It is also worth mentioning that there is no need to write your names. Please do not leave blank questions.

Thank you for your interest and your attention.

Researcher

Z

Section I.

Gender: Female ( ) Male ( )

Age:

Year group:

Section II.

Below are some science concepts that you can create a metaphor to explain. The following is just an explanatory example that you could follow.

Example: Maths is like a maze

Because Maths is very complicated, you get lost sometimes, you try your best to solve the equations but you get tired and you cannot make your way out.

1. "Science" is like..

Because………………………………………………………………………………………
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2. "A scientist" is like……………………………………………………………………….

Because……………………………………………………………………………………
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3. "A Science Lesson" is like………………………………………………………………

Because……………………………………………………………………………………
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4. How do you describe the ideal science lesson?

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5. " A science classroom" is like..

Because……………………………………………………………………………………
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6. How do you describe the ideal science classroom?

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Appendix F

Focus Group Interview Schedule

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GRADUATE SCHOOL OF EDUCATION

Title of Research Project: An investigation into the concept of science, the scientist, the science lesson, and the science classrooms among secondary school students through metaphors

The aim of this project is to investigate year 8 and year 9 secondary school students' thoughts and perceptions about *"science", "scientists", "the science lesson" and "the science classroom"* concepts though the use of metaphors and to describe the characteristics of *"the ideal science lesson", "the ideal science classroom"* in the eyes of the secondary school students.

Focus group interview schedules

1. Can you tell me a bit about your experience about science

Would you like to carry on science in your future?

Do you think that knowing a lot about science will help you in the future?

Do you feel that science you study is generally useful to you?

2. What does it mean to be a scientist to you?

Do you think that being a scientist would be fun / boring / make you feel important for you?

How would you see / describe a scientist?

3. What's your favourite activities in your science lesson?

What kind of activities do you want to attend in your science lesson?

How can you describe having science lesson indoors?

4. How do you like your science classroom to be? Why?

How do you describe your science classroom? and what kind of science classroom you want to be in?

What do you think that could help you approach / learn about science more and effectively in the science classroom?

Have we missed anything?

Do you want to add final thought?

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