Assessment for the module Investigating Research in the MA Curriculum, Pedagogy and Assessment

Dissertation Research Proposal: Year 9 girls' perception of engineers and engineering in attending a school that promotes engineering as a possible career choice.

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Statement of research interest

This master thesis originates from my own experience firstly as a mother with a daughter, and secondly, as a science teacher who is interested in gender equality in science education and careers. My desire is to investigate 'why', despite over three decades of heightened interest and numerous initiatives to improve girls' attitudes and aspiration towards science, technology, engineering and maths (STEM), we are still trying to attract more girls into engineering. Recently, even more attention has been drawn to this issue for the following reasons. Firstly, it is predicted that the UK economy will require 830,000-1.86 million professional scientists, engineers and technologists by 2020 (Engineering UK, 2013). Therefore, the government is keen to meet this demand through funded initiatives such as 'tomorrow's engineers' to challenge the out of date perception of engineering of being 'uncreative, dirty and oily' (Engineering UK, 2014). Secondly, in the field of engineering, women engineers make up less than 10% of the workforce which is the lowest proportion in Western Europe (WES, 2014). Furthermore, feminists have always stated the need for women to make as equal a contribution as men in the fields of technology, decision making and practices which impact on all of our lives. Bearing all these views in mind, the question arises as to whether we have reached a saturation point with engaging more women into engineering and now need to move on from this debate.

The central research question of this study is how year 9 girls' perceive engineers and engineering in attending a school that promotes engineering as a possible career choice.

Literature Review

There is a lack of research focusing solely on girls' perception of engineers and engineering in the UK. Studies have focused on children's attitudes towards science, engineering and mathematics (SET), mathematics and physics. Although examples of research are available exploring the issues that are deterring women from entering the engineering profession, it appears that little research is conducted on how girls in middle school perceive engineers and engineering as a possible career

path. This is an interesting area to study since researchers have found that most girls will choose not to study STEM by the age of 14 (Archers et al, 2013). It is therefore this area that I wish to explore through my research.

Silver and Rushton (2008) set out to investigate children's actual image, attitudes and perception of Science, Engineering and Technology (SET) before taking part in an hands-on SET project which involved students designing, constructing and testing their own electric cars. Silver and Rushton concluded that children had definitive, stereotypic images of SET which were compatible with previous research listed in the literature review. The research also claimed that gender plays a role in determining the perception and image of engineers, with girls being more extreme and negative compared to boys. Although there were differences in the images and attitudes between boys and girls, there was no evidence of gender bias in the enjoyment of science, DT or perceived abilities to do science and engineering as a career. However, more weight would have been added to the findings had the number of girls who confirmed these findings been published. The researchers concluded by generalising that it was not the stereotypic image that was dissuading children from becoming engineers or scientists; rather, it was their dislike of science and DT at school.

These findings were derived from qualitative and quantitative approaches which included: a questionnaire using the Likert scales, drawing a scientist/engineer and interpreting a picture/word image of scientists and engineers. Eighteen schools from large urban schools to small rural/village schools were selected to take part in the research. However, it is unclear how many schools actually took part in the data collection process. This research was conducted using 120 year 5 students, but it is unclear how many were selected from each school. Overall, it would have been helpful to know the context in which the research took place and how the sampling was carried out.

The questionnaire was divided into students, parents and teachers. The student questionnaire, piloted with a small group of students and reviewed by two primary school teachers, was comprised of five sections. Each section covered different

areas of interest which included the student's overall attitudes to school, including science and DT as well as thinking about doing science and design technology inside and outside of school. To help students describe their understanding of SET, they were asked to select three words from a list of words. A critique might be that it would have been interesting here to know how Silver and Ruston selected these words. Finally, students were asked to draw what scientist and engineers might do, which was similar to the work done by Mead and Metraux (1957) and Chambers (1983). Overall, the sections were designed to record students' attitude to SET in the wider context of its place in society. The methodology raises a number of questions relating to the lack of information given about the actual type of questions in the questionnaire or how the drawings were conducted. Improved methodological transparency might have increased the validity of the results. Additionally, the design of the questionnaire might have produced clearer inferences if the students had been asked about the subjects separately rather than grouping them together as SET.

By contrast, Ganesh (2011) conducted a two year qualitative study to explore whether students' conception of engineers at work changed over the course of participation in a two year, year round after school program. The intention of the programme was to introduce students to 'what engineers do' using visual images, descriptions and profiles of the different types of engineering. In this article, Ganesh clearly states the roles of the 14 participants who assisted with the after school programme, all of whom had an engineering background. The study involved one hundred and sixteen students from the 7^{th} and 8^{th} grade selected from four middle schools. Interestingly, the number of female participants was oversampled and the reasons for doing so were justified. However, no details were provided to how sampling was carried out. Similarly, in the methodology used by Silver and Rushton (2008), empirical data was collected using 'draw an engineering assessment' and posing three unprompted questions which are similar to those which I intend to ask my participants during the semi structured interviews. Image elicitation formed an integral part of data analysis through using one to one interviews, which assisted with the understanding and thinking behind the drawings. This approach was not employed by Silver and Rushton (2008), but Ganesh claimed that it would enhance

the validity of the inferences since the drawings were to be interpreted though the researcher's perspective.

The data was analysed using memos, constant comparison and coding by Strauss and Corbin (1998), which generated three phenomena. These included: engineers working with engines, engineers building and engineers repairing technical devices. Ganesh argued that middle students acquire these concepts because they have made the logical English language connection between engines and engineers from the image elicitation approach. In conclusion, Ganesh claims that the conceptions that emerged from students were the literal understanding of adult descriptions of engineers at work.

Overall, the data seem to generalise similar outcomes from all the students. However, it would have been more valid had Ganesh quantified the number of students who made these claims. Furthermore, as girls were over sampled in this research, it would have been interesting to see how gender played a part in influencing the images of engineers.

More recently, Andrews & Clarke (2012) recruited two 17 year old high school female students as interviewers to explore the attitudes and perceptions of young women using participatory Research approach. The aim of this project is similar to my own research, though different in the research design and analysis of data. Using purposeful sampling, twenty participants from two contrasting types of schools were interviewed with questions designed by the researchers and the interviewers. Nonetheless, it would have been clearer, if they had included information about the interviewers' affinity towards engineering, so as to validate the questioning. The inclusion of a few sample questions would have made the interviewing more transparent to the reader and also would have shown how unintended bias was addressed.

The recorded narratives produced three main themes. Andrew & Clarke (2012) found that girls had a negative perception of mathematics and science as they became more challenging from primary to secondary level. The dislike of physics was due to the way it was taught and the fact that it was perceived to be abstract

bearing little or no relevance to their lives. In this case, it would have been more valuable if the methodology in teaching science at the schools was available to increase the reliability of this claim, thus helping the readers to understand the narrative. Of the twenty participants only 5% viewed engineering as a viable career. Moreover, the author stated, some perceived the profession as masculine. A criticism here might be that stating the actual figures would have added strength to this finding. Without having information about the type of interview used, it would have been interesting to have implemented semi structured interviews to extract deeper understanding of these findings.

The authors suggested that educators take a closer look at the school curriculum, stating that if girls need to consider engineering as a potential and viable career then the subject has to become embedded in their everyday language and learning. They further add that this approach could address the gender disparities in the profession and future shortages could be avoided. Given that these suggestions are relevant to my chosen empirical setting, I am interested to see what kind of data will be generated from my own study.

Research Design

By studying how girls in a single sex school perceive engineers and engineering as a possible future career, this research can be placed in the section of educational research. Cresswell (2013) defines qualitative research as an approach to be used when there is a problem or issue to explore. I aim to utilise an interpretative, qualitative design based on interviews which will provide rich data in exploring how girls perceive what engineers do and what impact, if any, engineering initiatives at the school have on motivating the girls' desire in choosing engineering as a future career.

Empirical setting

The empirical setting for this research has been selected on the basis of opportunity. As Dowling and Brown (2010) argue ‘this is unimportant in terms of the quality of the research’ (2010, p18) as long as the empirical setting is heard. My research will take place at an independent day school for girls’ from 3-18 years old in the East

Midlands. This school has been chosen based on its ethos of 'girls can do anything' and a strong academic performance in the national examinations. As part of the wider school curriculum it provides opportunities for the girls to have an equal a chance as boys, in for example, getting an engineering job in the future. Thus, the senior school runs a unique programme called SocEng to help promote engineering, in addition to numerous Science, Technology, Engineering and Mathematics interventions.

I will employ opportunity sampling where the students from a particular year group who have all experienced some of the STEM interventions at the school can opt to take part in this study. The students will be chosen by the Head of Science and will come from three different year 9 science classes who are aged 13-14 years old. Due to the limited time for this dissertation and the possible amount of data to process, I will limit sample size to 8-10 participants.

Dowling and Brown (2010) highlight that gaining access to the empirical setting involves permission from the gatekeeper. This is an individual who is in a position to provide access to the research site, for example the head teacher. As such, I will seek permission from the head teacher by writing a letter detailing the following: the central purpose of my research and the procedures to be used for data collection; their right to voluntarily withdraw from the study at any time; comments about protecting the confidentiality of the respondents following the BERA ethics guidelines (Cresswell, 1998). As my sample will consist of children under the age of 16, I will also seek consent from the parents or guardians in written form.

Dowling and Brown (2010) stressed the need to consider several elements when conducting interviews. These included: restricting sample size due to the quantity of data interview provide, location of the interview, how the interview and interviewer presents themselves, and the relationship between the interviewer and interviewees.

My aim is to capture how students perceive engineers and engineering, and whether they would consider engineering as a potential future occupation. Therefore, using standard questions with a fixed format would be unduly constraining (Dowling and Brown, 2010). For this reason qualitative data will be collected using semi-

structured, face to face interviews to create opportunities for more open interaction in accordance with Ganesh's methodology (Ganesh, 2011). To elicit participants' responses, I intend to use probes which are questions that gain further information, clarification, or seek to access underlying reasons for a particular responses. This is in preference to prompts which involve suggesting possible responses (Dowling and Brown, 2010, p68). In such a case, it could be argued that I was forcing data (Glaser, 1992), thus adding researcher's bias. Using probes, I can start by asking 'what kind of things do engineers do?' leading to further questions, for example, 'what kind of different engineers are there?' and so forth.

Dowling and Brown (2010) highlighted that all interviews involve interaction and warrant close attention such as the importance of location and whether a chaperon will be present, particularly when the students are under the age of 16.

Focus groups were considered as a method to collect data because this would allow more individuals to participate in a limited amount of time and might be useful for individuals who are hesitant to provide information (Cresswell, 1998). Focus groups would also provide the opportunity to investigate any similarities from students who were in the same science group and to contrast responses between science groups who are taught by different teachers. However, Cresswell (1998) highlighted that care must be taken firstly, to encourage all participants to talk and secondly, to monitor individuals who may dominate the conversation. I have thus chosen to conduct one to one interviews as the most suitable method of data collection in that it will allow the exploration of the issues in more depth (Dowling and Brown, 2010).

The interviews will be audio recorded and transcribed. Drawing from grounded theory I will examine the transcription of interviews using open coding-immersing in line by line analysis, closely examining phrases, words and sentences to discover my own categories and labelling them with the most appropriate codes (Glaser, 1992). Whilst employing what Dowling and Brown (2010) identified as key features of Glaser's version of grounded theory; constant comparison of emerging categories and data, I will use memos to understand these categories in order to conceptualise the evidence. It is unlikely that I will have time to 'saturate' the categories as in

classical grounded theory. (Cresswell, 1998, p150) According to Glaser (1992) this is the point at which theoretical sampling of any categories ceases. Similarly, I will ensure that data analysis starts as soon as the first piece of data is collected, even if the former proceeds beyond the process of data collection (Dowling and Brown, p86).

Contingencies

One possible challenge that I may encounter is student's illness or withdrawal during the research interviews. Should this occur alternative students will be selected from the same year group and science class.

Ethical Issues

Ethical issues are of utmost importance of any research. Since my research methods require data collection from human participants, I will need to complete the Institute Of Education ethics application form and be granted permission before I can start any data collection at the school.

During this study, I intend to adhere to the British Educational Research Association (BERA, 2011) ethical guidelines. Before commencing my research, I will gain permission from the school head teacher who will decide whether I will need to obtain informed consent from all the students/parents/guardians involved since the students are under 16 years old. If so, a letter will be sent to all the parents/guardians to inform them of my research, how it will be used, whom it will be reported and providing the opportunity to withdraw if they wish to do so.

All the participants will be given the right to withdraw at any stage of the process, at which point the information gathered will be destroyed. For the purpose of the Data protection Act, the identity of the participants and school will be strictly anonymised (BERA, 2011p7). Following BERA's good practice, all the participants briefed on the conclusion from the research. In addition, the head teacher will be offered to read the findings from my research and a copy of the executive summary for the school to keep.

Transferability of the data, in terms of the quality of the data analysis might be a concern. To mitigate potential issues, the analysis of the data will be carried out in close consultation with a more experienced member of the qualitative research community; namely, my supervisor and a colleague who has a degree in engineering. I am aware she will have will restricted experience of the range of engineering activities such as video game design and production, and other software engineering work.

Professional development

The research will be of interest to a number of people within the school. In particular, this will include the head teacher, Head of Science and Coordinator for Engineering, whose responsibility is to promote 'girls can do science, technology, engineering and maths', through the numerous implemented interventions. Such an investigation will provide the opportunity for the school to reflect on existing practices.

I hope to gain a deeper understanding and knowledge as to how girls perceive engineers and engineering as a future career choice. This could help me to develop strategies in my own practice (as a biology teacher) with the aim of raising the profile of engineering (particularly, among girls) since engineering is not exclusively taught in the Science National Curriculum.

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