

Understanding Attitudes Towards Mathematics (ATM) using a Multi-modal Model: An Exploratory Case Study with Secondary School Children in England

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Abstract

This paper reports on a multi-modal exploratory case study within the realm of pragmatism to study the attitudes of 11 and 15-year-old students towards Mathematics (ATM). More than 200 secondary school children from the East Midlands, England, participated in this research. The aim of this research was to understand students' emotions, perceptions, beliefs and vision about Mathematics and to investigate the factors which influence their attitudes. This study employed a multi-modal research design to elicit data from the young learners by engaging and involving them through different media of communication. Four different kinds of data were collected namely aural or spoken data (audio recorded in focus group interviews), scale data (from Likert scale style items in the questionnaire), textual/written data (collected through open ended questions in the questionnaire), and visual data (in the form of pictures drawn by the participants). Since the favoured mode of expression varies from person to person, multiple modes of data collection can include a larger number of respondents by providing them the opportunity to orchestrate their perspective in their preferred mode of communication. This research suggests that gender and attainment level have a significant impact on attitudes towards Mathematics. Boys and high ability learners have a more positive attitude towards the subject as compared to girls and low ability students. Age, socio economic status and linguistic background also seem to influence ATM but the effect is statistically insignificant.

Keywords: attitude, affect, cognition, gender, attainment

Introduction

Mathematics is taught as a core subject in school curricula all over the world because mathematical knowledge and skill are considered to be essential tools not only for the economy to thrive but also for the society to flourish. However, students' aversion to Maths (National Numeracy, 2012) and deteriorating performance of young people in Maths at secondary level estimated through international standardised tests like PISA (Programme for

International Student Assessment) and TIMSS (Trends in International Mathematics and Science Study) has become a cause of concern for teachers, educators and policy makers in the UK and other countries (OECD, 2013). The purpose of this research was to get an insight into students' perceptions and to understand their attitudes regarding Maths. This study was conducted in a major city in the East Midlands, England, which is well known for its cultural and ethnic diversity. The participants of this study were secondary school children attending Year 7 (11 year olds) and Year 10 (15 year olds). These two year groups were selected for this study because they mark the start of Key Stage 3 (KS3) and Key Stage 4 (KS4) respectively. This research also explored the role of teachers in shaping learners' attitudes towards Mathematics. This paper, however, will focus on the multi modal methodology of this research and will discuss the impact of age, gender, socio-economic status, linguistic background and attainment level on "affect" and "cognition" components of ATM using quantitative as well as qualitative data.

This paper is presented in three main sections: the first part includes the introduction, the theoretical framework of the research and a brief review of relevant literature. The second section describes the multi-modal research design for this study and the final section reports on the findings of this study followed by discussion.

1. Theoretical Framework

Attitude is defined as "a settled way of thinking or feeling about something" (*Oxford Dictionary*, 2016). It is also referred to as the "sum total of a man's inclinations and feelings, prejudice or bias, preconceived notions, ideas, fears, threats, and convictions about any specific topic" (Thurstone, 1928, p. 532). Attitudes are an integral component of human character, comprising of the proclivities and predispositions that guide an individual's behaviour (Rubinstein, 1986). Attitudes can change and develop with time (Rubinstein, 1986) and can be evaluated as positive or negative (Fishbein & Ajzen, 1975). Attitudes are not overtly visible but can be inferred from observable and evaluative responses expressed as approval or disapproval, approach or avoidance and attraction or repulsion (Eagly & Chaiken, 1998).

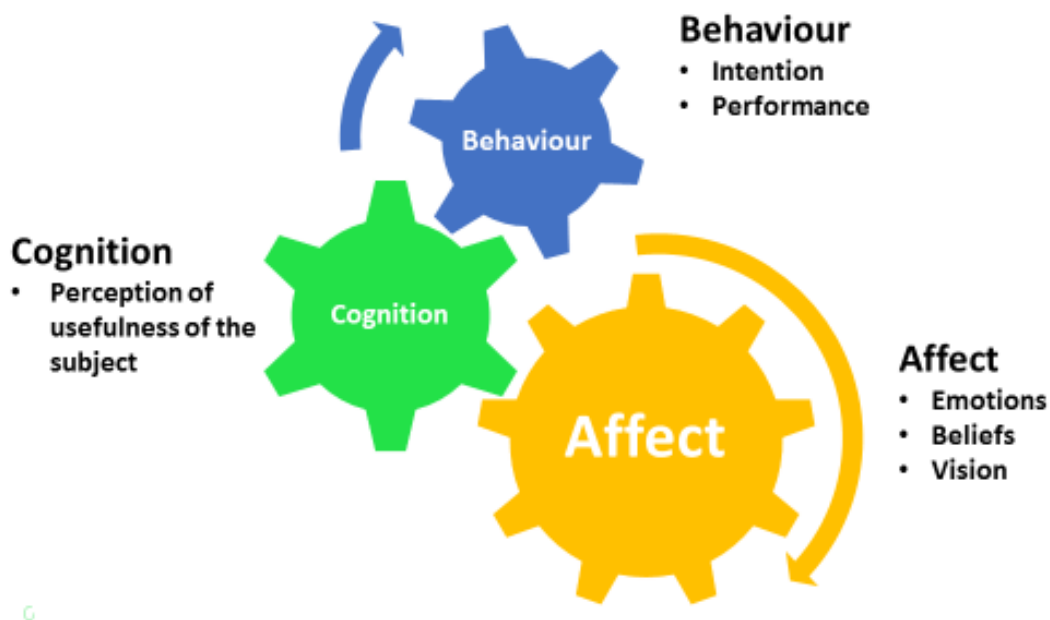


Figure 1. Components of attitudes

The construct “attitude” has been defined in a host of different ways such as uni-dimensional, bi-dimensional, multi-dimensional, making the term vague. For this research, a framework for ATM has been developed in the light of the different definitions. It is based on the multidimensional model taking affect, cognition and conative or behaviour aspects into account (as shown in Figure 1). Affect, for this research is supposed to encompass emotions, beliefs and vision of the subject. Emotions can be described as the feelings of enjoyment or pleasure in learning the subject or conversely finding it boring and dull. Beliefs are self-concepts of pupils as mathematical learners and their confidence in their mathematical abilities (Bandura, 1994, 1997) whereas vision is their perception about the subject. Cognitive component represents students’ perceived usefulness of the subject in everyday life at present and its applicability for future life and career (Adelson & McCouch, 2011). Conative or behaviour component in itself is multi-faceted and therefore difficult to describe. It can pertain to learners’ actions, commitment and performance in the class. The components of attitude are not mutually exclusive; they intersect and overlap and form clusters (Neuman, 2005). They have common attributes and they influence each other.

1.1 Factors Influencing ATM

There is a multitude of personal, instructional and environmental factors that may influence ATM but for this paper we will take into account the following five factors namely achievement, gender, age, socio economic status and linguistic background.

1.1.1 Achievement.

Research suggests a positive relationship between academic attainment and attitude towards Maths (Bramlett & Herron, 2009; Nicolaidou & Philippou, 2003; Papanastasiou, 2000; Ma & Kishor, 1997). Children's ATM develops over time and may affect their self-concept and behaviour in class. It is believed that students who enjoy Mathematics and have high self-concepts and self-esteem about their mathematical abilities pay more attention, participate actively in class and are more involved in the learning process. They are also more likely to persistently try hard without losing interest while confronting a challenge (e.g., Bandura, 1977, 1986, 1997; Meyer et al., 1997; Pajares & Miller, 1994; Pintrich & Zusho, 2002; Stipek, 2002). A negative attitude towards the subject can impede learners' progress and affect their self-confidence and morale. Students' enjoyment (affect) while learning and their perceived usefulness of Mathematics (cognition) can influence their behaviour or conative aspect of attitude. Learners having positive emotions towards Maths show a higher level of commitment and increased capacity of exerting efforts which result in better achievement (Stipek, 2002). A case study conducted by Renninger and Hidi (2002, p. 187) maintains that "a student with a well-developed interest for subject matter might be expected to have high achievement whereas a student with a less well-developed interest is less likely to experience high achievement". The IEA's Third International Mathematics and Science Study (TIMSS, 2011) also found widespread positive correlation between liking mathematics and mathematics achievement.

Achievement in Mathematics is also related to the rational thoughts (cognitive domain) of the learners and according to TIMSS (2011) 85 per cent 14-15 year old students internationally (belonging to 63 different countries) believe that maths is useful in their daily lives and in securing a good job in the future. The students who valued maths had the highest average achievement, followed by the ones who somewhat valued the subject. The students who did not consider Maths to be important (15% of the sample) were among the lowest achievers. This suggests that understanding the significance of the subject can motivate the

students to strive harder and improve their learning (grades). Students' perceived value for Maths can influence their attitude towards the subject. If they understand the significance and application of Maths in their lives, they are inspired to study, practice and learn it (Pajares & Miller, 1994). There are many students who do not particularly enjoy mathematics and report a disliking for the subject (negative affect), nevertheless they still respect the utility and importance of Maths in their future lives and careers (Klinger, 2004). Another research also reports a strong relationship between participation/ achievement in Maths and learners' perception of the usefulness of the subject, both at present and in the future (Meyer & Koehler, 1990).

1.1.2 Gender and Age.

Another notable factor regarding ATM is gender. Maths is perceived to be a masculine and male dominated field (Ernest, 2004). Girls demonstrate lack of confidence in their mathematical abilities and feel reluctant to participate in class activities as compared to boys. In most countries, girls on average underperform as compared to boys in similar age groups and this gap in performance is wider among the highest achieving students (PISA, 2012). The same trends can be seen in UK as well. Boys exhibit a high level of self-concept regarding their mathematical abilities and consider themselves more able than girls (Ireson et al., 2001). Girls, on the other hand, have high levels of anxiety and significantly lower level of confidence in comparison to boys (Rogers, 2003). ATM also seems to be related to age. Research on primary school children suggests that ATM deteriorates with age (Dowker, Bennet & Smith, 2012) and by the age of nine children have made up their minds whether they like or dislike Maths (Bloom, 2008).

1.1.3 Socio Economic Status and Linguistic Background

The impact of socio economic status on students' performance (not on attitude to Maths) was examined by PISA (2012) and mixed trends were found. Pupils in some of the highest achieving countries in Maths come from socio economically deprived backgrounds; but their family status does not seem to obstruct their performance in the subject. In the UK, however, allowing for some variations in the different regions, socio economic status of a family can have a 10 to 20% impact on the academic achievement of 15 year old learners in Maths (National Numeracy, 2012). Children from economically disadvantaged families (measured on the basis of their eligibility for a free school meal) have a much smaller chance

of achieving a good grade in Maths in the GCSE (General Certificate of Secondary Education) exam (Warren & Paxton, 2013) as compared to the children who do not receive free school meals. However, the relation, (if any) between socio economic background and ATM has not been established.

Similarly, the effect of linguistic background on ATM has not been explored. This research was based in a multicultural city where a sizeable proportion of the population belongs to ethnic minorities. This provided an opportunity to draw diversified samples and to compare the ATM of bi/multilingual children with those who speak English only.

2. Research Design

This research is a comparative case study within the realm of pragmatism designed to investigate “a set of multiple case studies of multiple research entities for the purpose of cross unit examination” (Berg, 2009, p. 328). Thus participants of this research are compared in terms of age, attainment, gender and ethnic and socio-economic back ground to look for similarities and differences. This study adopts a mixed-method exploratory sequential approach and both qualitative and quantitative data collecting instruments are employed to address the research questions. The purpose of employing mixed method strategy is to gather complex and comprehensive information to better investigate and understand the case. Use of mixed methods also improves the reliability and authenticity of the research due to triangulation.

2.1 Sampling

Selecting the research participants to give representation to all different sub groups was a crucial aspect of this research. Thus an intricate multi-layered purposive sampling technique was used. The aim of purposive sampling is to study specific characteristics of interest in a population (Cohen, Manion & Morrison, 2007) and to explore the intricacies of the issue in a quick and simple manner. The purposive sampling strategy was employed to pick:

1. Schools on the basis of FSM (free school meals), ESL (English as a second language) and average attainment in KS4.

2. Year and ability cohorts within schools to represent students from different age groups (pupils from year 7 & year 10) and attainment levels (high ability cohorts and low ability cohorts).
3. Students from each age and ability group to represent both the genders.

2.1.1 Sampling Frame

There are 38 secondary schools in the city listed on the Department for Education website (DfE, 2014). The target population of this research was boys and girls of year 7 (beginning of KS3) and year 10 (beginning of KS4) between the age cohort 11 – 15 years. Thus, to keep the sample fairly similar and practical all the middle schools (for 11 – 14 year old students only), high schools (for 14 – 18 year old students only), single sex schools, independent schools and special schools were eliminated. The remaining 13 schools and some relevant data about them e.g. percentage of pupils speaking English as a second language, percentage of pupils eligible for free school meals and KS4 results are shown in Table 1.

Table 1

Sampling frame for schools

Schools	ESL (%)	FSM (%)	KS4 Results - LAA/NA
BB	57.1	43.1	Below/Below
BL	17.5	24.9	Below/Below
CH	54.3	23.7	Above/Below
FH	25.4	36	Below/Below
HC	32.5	28.4	Below/Below
JC	44.5	16.2	Above/Above
MC	90	30.1	Below/Above-Below
RM	68	17.6	Above/Above
SV	72.5	19.9	Above/Above
EM	28.2	11.8	Above/Below-Above
NC	11.5	36.5	Below/Below
SP	36.6	12.6	Above/Above
CL	62.9	22.1	Above/Below

Data from Department for Education (DfE) website: <http://www.education.gov.uk/cgi-bin/schools/performance/group.pl?qttype=LA&no=856&superview=sec>

- FSM data provides the percentage of students eligible for a free school meal and is commonly used as an indicator of socio economic status of a family.
- ESL data shows the percentage of students speaking English as a second language.
- Average attainment in KS4 gives data on pupils attaining 5 A* - C in GCSE for the last 4 years in comparison to LAA (local authority average) and NA (national average).

These schools were then grouped according to their FSM and ESL percentages and attainment level (Table 2). The red colour in the ESL and FSM columns indicates that a high band of students in the school speak English as a second language and are eligible for free

school meals (40% and above), yellow indicates a medium band (20% to 39% students) and green indicates a low band (below 20% students). In the attainment column red colour shows a high attainment level (mostly above LAA and NA), yellow shows a medium attainment level (above/below) and green shows a low attainment level (mostly below LAA and NA).

Table 1

Grouping schools according to attainment level, ESL % & FSM %

Schools	ESL (%)	Attainment	FSM (%)
BL & NC	Low	Low	High
FH & HC	Medium	Low	High
BB, MC & CH	High	Low/Medium	High
CL	High	Medium	Medium
JC, SP, EM	Medium/High	High	Medium/Low
SV & RM	High	High	Medium/Low

A quick look at the table shows a negative correlation between academic attainment and free schools meals. Schools with high ratio of pupils eligible for free school meals typically perform below the local authority average /national average in the GCSE exam. On the contrary, schools with high achievement in GCSE have low FSM ratio. This data suggests that academic attainment is related to socio economic background of the student. ESL ratio displays mixed trends and does not seem to be related to either FSM or school attainment.

2.1.2 Sample Selection.

A sample is “a small group of research participants or a subset from which a degree of generalization can be made” (Carey, 2011, p.41). The sample for a research study has to be selected keeping in mind the time and resource constraints. For this project, it was planned to include three schools in the main study (and one in pilot study) in such a way that one school from each of the sub groups [low ESL, low attainment and high FSM group (top rows in the table), medium/high ESL, high attainment and medium/low FSM group (bottom rows) and

high ESL, medium attainment and medium FSM (middle row)] could get representation. All the 13 schools were contacted one by one; however only two schools agreed to allow access to their students. These schools will now onwards be referred to as Cedar School [from the high ESL, medium attainment, medium FSM group (middle row in the table)] and Juniper School from the medium/high ESL, high attainment and medium/low FSM group (bottom row)]. Thus the perspective of the students from schools with low ESL, low attainment and high FSM could not be included in the research as no school from this group agreed to participate in the research study due to their other commitments. Within schools, individual students were handpicked by the Maths teachers/head of the department according to the selection criterion (mentioned in the sampling section on p.6) already negotiated with them.

2.2 Research Instruments

For this study two types of research instruments were used.

1. Focus Groups Interviews – to collect aural or spoken data which was audio recorded (n=4x4=16).
2. Questionnaires (n=187) to gather
 - Scale data - from Likert scale style items
 - Textual or written data - through open ended questions
 - Visual data - in the form of pictures drawn by the participants

2.2.1 Focus Groups

Focus groups are small scale group discussions addressing a particular topic of interest or relevance to the group and the researcher with the aim to draw information about the “conscious, semi-conscious and unconscious psychological and socio cultural characteristics and processes” (Berg, 2009, p. 158). For this research, focus groups were considered to be the most suitable data collection tool for qualitative data because of a number of reasons. This was an exploratory mixed method sequential research and the data collected in focus groups, besides being used in its own worth, was used as a stimulus to develop questionnaire for the second part of the research. Focus groups are lively interview style discussions held in an informal atmosphere which encourages the respondents to speak openly and freely about attitudes, opinions and behaviours. These discussions allow the participants to explore and clarify their views, taking the research in new and sometimes

unexpected directions (Kitzinger, 1995) and bringing to the fore issues that are important for them.

Focus group interview is an efficient technique of data collection as compared to individual interviews because more people can be included in a single session saving time and resources. Focus group interviews seek to generate qualitative data “by capitalising on the interaction that occurs within the group setting” (Sim & Snell, 1996, p. 189). The interviewees get the opportunity to hear other people’s views which can stimulate their thinking and help them rethink and develop their opinion. Group discussion is also an effective quality control measure as the group members can challenge and curb extreme or false views and provide check and balance on each other (Patton, 2002).

The plan for conducting focus groups was discussed with the heads of the departments in the selected schools and dates and times were finalised. The maximum time allowed for each focus group was 30 minutes. In total four focus groups (involving 16 students) were arranged. The size of the focus group was kept small so that each student gets enough time to express his/her opinion. To give equal representation to both gender and ability, the schools were asked to allow one girl and one boy from the higher ability (HA) cohort and another pair from the low ability (LA) cohort to participate in the focus groups. Thus in each school two focus group discussions took place and from each school four pupils from year 7 and four pupils from year 10 participated. The focus groups were conducted within the school premises in a vacant classroom so the environment was familiar and comfortable for the students. The participants of the focus group were homogeneous in the sense that they belonged to the same age and year group. However, they were from different ability groups, gender and ethnic/linguistic backgrounds which could provide dissonance and add richness to the data. It’s natural for group members to possess varying level of confidence, expression and vigour but the moderator needs to ensure that the “thought leaders” (Henderson, 1995) do not dominate the proceedings and the “less articulate voices” do not get suppressed. Nevertheless, the tendency of some weaker participants to acquiesce to the opinion of the more assertive ones remains. Asking the respondents to write down their thoughts beforehand can encourage them to disclose their views (Carey, 2001). For the same purpose, before the start of the focus group discussion a few written questions related to the topic were given to the participants individually to read through and note down their responses. These questions were also used as a starting point for the discussion and as a tool to stimulate their thinking. Generally, the focus groups went well and helped in collecting

useful qualitative data. Keeping in mind the fact that the total contact time allowed with the children was only 25-30 minutes for each focus group, after transcribing the proceedings of the focus groups which were audio recorded, data equivalent to 1100-1400 words was collected from each cohort.

Despite being an efficient tool of data collection, focus groups have some drawbacks which can be minimized by using a combination of data collecting instruments. Focus groups bring forth a more collective position of the group, where individual stance of each participant is not clearly distinguishable. They disclose the nature and scope of the contributors' views but do not inform about the strength and intensity of their opinion. Also, it's problematic to generalise data gathered through focus groups (Henderson, 1995).

2.2.2 Questionnaire

The second phase of the research consisted of questionnaires which were designed in consonance with the epistemological framework of the research and the stipulated research questions. The content of the questionnaire was developed after carefully reading available literature on attitudes regarding Maths, questionnaires previously used in research on measuring attitudes (e.g. Fennema-Sherman, 1976) and the data accumulated through focus group discussions. The questionnaire was paper based and was administered in four different cohorts in each school. It was an anonymous questionnaire and collected three kinds of data: Scale, textual and visual data.

2.2.2.1 Scale Data

Likert scale and its modified forms are widely used as a rating scale to measure attitudes and opinions. Likert scales ascertain attitudes by presenting a list of statements and asking the respondents to rate them. They are ordinal scales used to gauge the likelihood, frequency, importance or opinion about a subject on a five or seven-point scale, often ranging from "strongly agree" to "strongly disagree" (Burns & Grove, 1997). For this research, Likert scale was adopted to prepare 12 Likert scale type questions for measuring the attitudes on a three point scale. The number of options on the scale was reduced to make the questionnaire simple to answer for the young participants of the research. Emoticons were also added on the three point scale, with a smiley face ☺ signifying agreement, a straight face 😐 indicating indecisiveness and a sad face ☹ denoting disagreement (Sun, 2009). The purpose was to elaborate the options pictorially for visual learners and to make the questionnaire look appealing. Although a high number of items on the Likert scale improve the reliability of the

instrument in assessing attitudes, the number of items was kept low keeping in view the short concentration span of young learners and the limited time allowed to them for answering the questionnaire. Two terms with negative connotation were also included to test the alertness of respondents and to improve the reliability of the results. The questionnaire also included some factual questions to gather demographic data.

2.2.2.2 Textual and Visual Data

The second part of the questionnaire was open ended and asked the learners to write a paragraph or draw a picture (Smith, 2011) about their perception of Maths and how it impacts their life under the title “Maths and Me” (Adelson & McCoach, 2011; Di Martino & Zan, 2010). The idea was to provide an opportunity to the young learners to express their views about Maths in their own words or illustrations in the absence of peer judgement. Drawing is a much liked activity among children and provides an alternative medium of expression. It is a useful tool to elicit data from children and is considered to be relatively more reliable as compared to “the deceptive world of words” (Collier, 2001, p. 59) quoted in Denscombe, (2010). Nevertheless, drawings are quite difficult to interpret, therefore the participants were asked to label their images.

3. Data Analysis and Findings

Aural data gathered through focus groups and textual data from questionnaires were analysed thematically. Quantitative data was analysed statistically using simple descriptive statistics and t-tests with the help of Excel and SPSS. To analyse visual data, a holistic approach was employed taking into account the content as well as the context of the image/drawing within the theoretical framework of the research. Each kind of data was analysed on its own as well as in combination with other forms of data to better understand the subject. Overall the different types of data complemented each other, however there were some variations.

Aural/spoken data from focus groups was transcribed and major themes were identified (attached as appendix 1). Broadly speaking, students from Juniper School (high attainment, medium ESL, low FSM) were more positive as compared to Cedar School (medium attainment, high ESL, medium FSM). Participants of two out of four focus groups (one from year 7 and the other from year 10) had mixed opinions about Maths. Of the remaining two groups, Year 10 clearly showed negative affect but mixed cognition while

Year 7 were positive for both components of attitudes. Overall pupils in year 7 expressed favourable attitudes and were more approving of the subject whereas pupils in year 10 showed aversion. This seems to indicate that the “spoiling” of attitudes occurs between the age of 11 and 15 at KS3 level.

3.1 Statistical Analysis

3.1.1 Scale Data

The first part of the questionnaire consisted of Likert scale items with three options to choose from. To analyse the data each option was assigned a number such that agree = 1, indifferent = 2 and disagree = 3. The data was organised and questions about “emotions”, “cognition” and behaviour were grouped together. The data was then entered into spread sheets for statistical analysis using SPSS software. The mean scores and standard deviation for affect and cognitive components of attitude were calculated. For this data, a mean value close to 1 indicates a positive attitude whereas a higher value approaching 3 suggests a negative trend.

The total number of students who filled in the questionnaire was 187. Out of them 89 were from Juniper School and 98 were from Cedar School (for detail on sample sizes please see appendix 2).

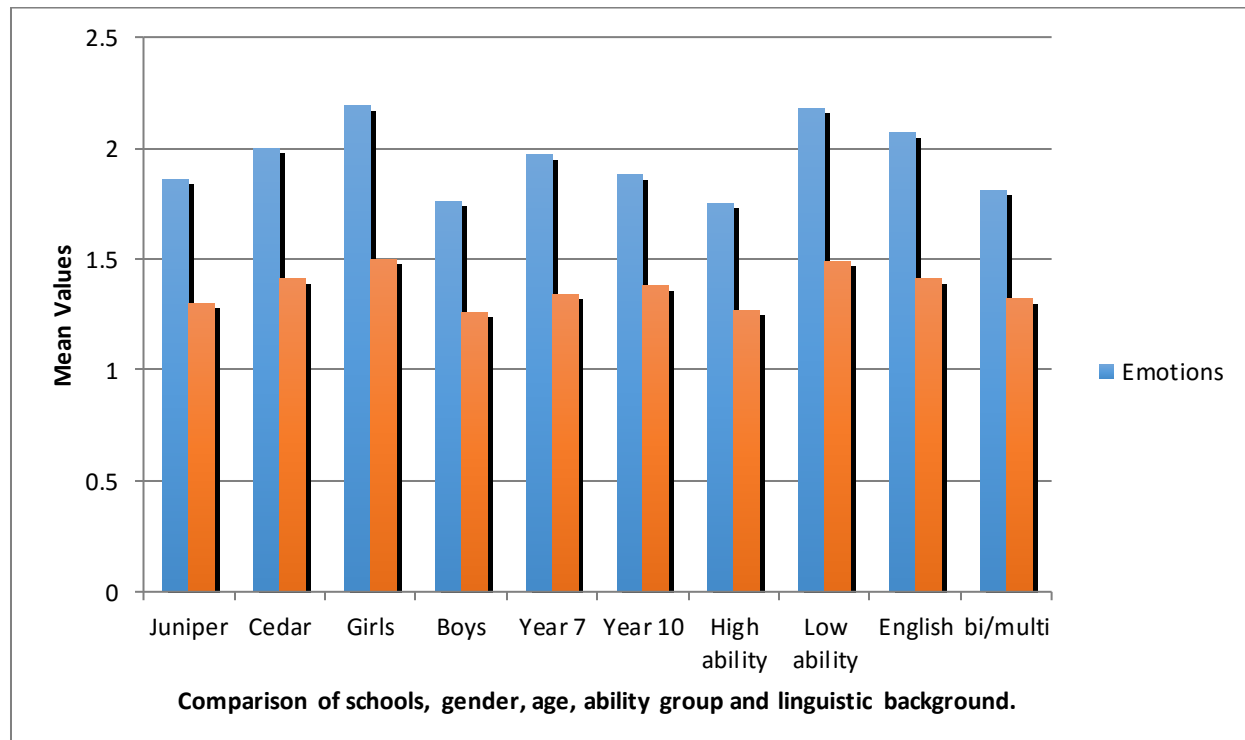


Figure 2. Mean values for affect and cognition

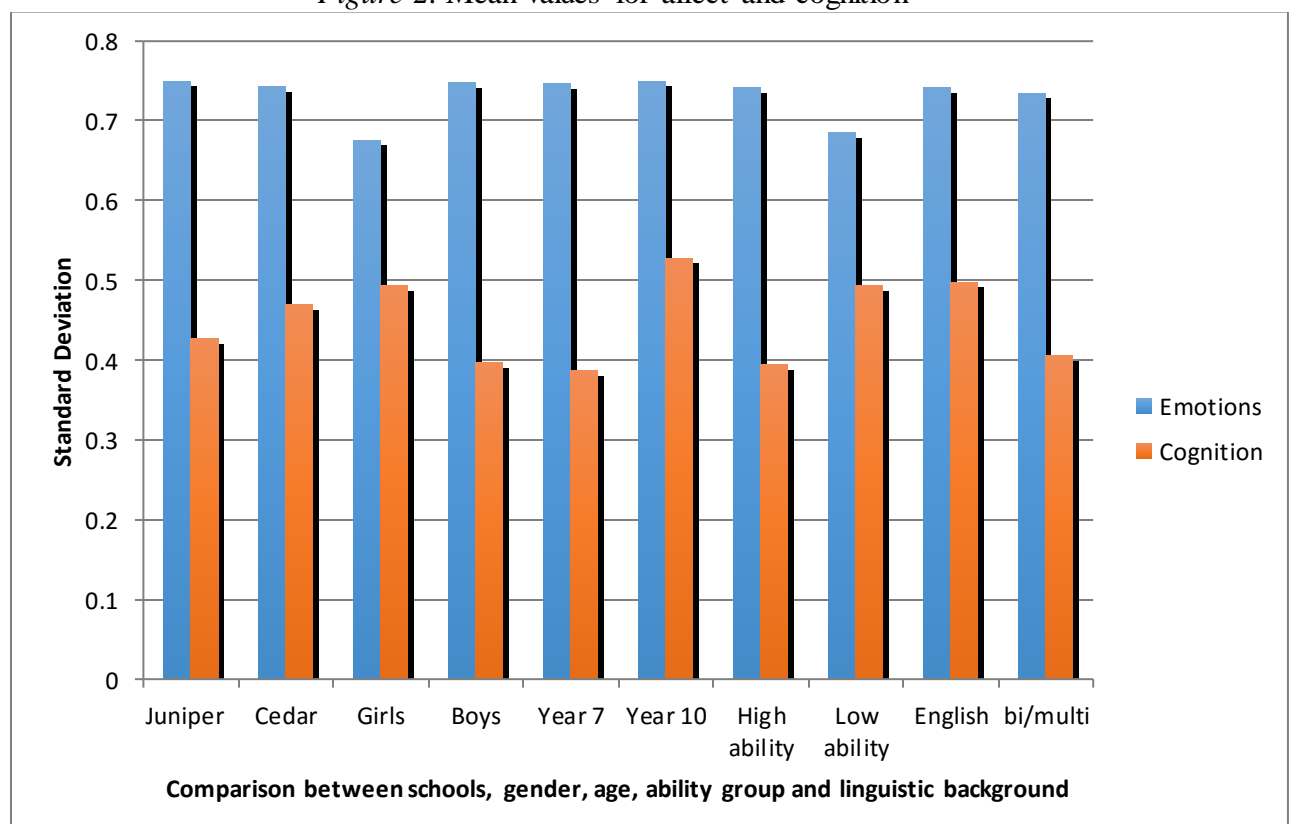


Figure 3. Standard deviation for affect and cognition

The data shows some difference between the affective and cognitive components of attitudes. The cognition about the usefulness of Maths for all sub groups is much more

positive than affect or emotions towards Maths (Figure 2). Similarly, the value for standard deviation or dispersion of data around the mean for cognition is smaller which shows limited variation in students' opinion (Figure 3). This indicates that students understand the value of Maths even though they dislike it. Observing the sub groups, we can see that for Juniper school (low FSM), the mean values for affect ($M=1.86$) as well as cognition ($M=1.30$) are more positive as compared to Cedar School (medium FSM) with ($M=2.0$) and ($M=1.41$). In terms of gender, girls have a mean affect value of ($M=2.19$) which is quite high and indicate a tilt towards unfavourable emotional disposition. On the contrary, boys have a relatively positive attitude with a mean value of ($M=1.76$). Likewise, the cognitive component is positive for boys ($M=1.26$) than for girls ($M=1.50$). Between the two year groups, pupils of year 10 have a more positive affect ($M= 1.88$) as compared to year 7 ($M=1.97$) in contrast to data collected through focus groups; however the cognitive element of attitude for year 7 is better. Between attainment groups, we can see a sizeable difference in affect with a mean value of ($M=1.75$) for high ability and ($M= 2.18$) for low ability students. The difference in cognition is smaller though (1.27 & 1.49 respectively). Comparing the samples in terms of language, bi/multilingual students have more positive affect ($M=1.81$) than speakers of English only ($M=2.17$) however there is hardly any difference in cognition.

3.1.2 The *t*-Test

To assess whether the difference in attitudes among the various subsets was statistically significant, two sample t-tests were carried out. The t-test is a useful statistical method that compares the actual difference between the two means in relation to the variation or spread in data expressed as standard deviation. It is a robust tool and can be used even if the number of data item in the samples is different. For this study ten t-tests were conducted to assess whether there was any significant difference in the affect and cognitive component of attitudes between:

- a. Juniper School (low FSM) and Cedar school (medium FSM)
- b. 11 year olds (year 7) and 15 year olds (year 10)
- c. Pupils who speak English only and bi/multilingual pupils
- d. Girls and boys
- e. High ability and low ability pupils

The null hypothesis was that the means of the samples are equal and there is no significant difference between the two samples against the alternative that the means of the samples are not equal and differ significantly. The tests were conducted at the confidence interval of $\alpha = 0.05$.

The results indicate that the mean values in the first three samples i.e. Juniper/Cedar Schools, year 7/year 10 and English/multilingual pupils are equal with a 95% confidence level. Thus there is no significant difference in affect or cognitive component of attitude between these sub groups. However, the mean values in sample (d) girls/boys and sample (e) high ability/low ability learners are not equal. This implies that we are 95% confident that the difference in the mean attitudes (affect and cognition) between girls and boys (gender) and high ability and low ability (attainment) is statistically significant.

3.2 Textual Data

The qualitative data also supports these findings and shows similar trends. However, it's more revealing and enlightening. The high ability (HA) students (for instance, the Gifted & Talent cohort in Juniper School) exhibited a highly positive attitude towards Maths expressed as: "I love Maths", "I enjoy Maths" and "it's one of my favourite subjects". These students found Maths to be "intriguing and challenging" and felt "rewarded" after tackling and understanding the tasks. They considered themselves "good at Maths" and were confident of achieving a high score in exam. They have talked about the relevance of Maths in their future education and the profession they wish to pursue. They were enthusiastic to study Maths further and believed that it was important for their future careers and also in understanding how the world works. Many of the high ability students show a high level of motivation and commitment and their attitude is positive for affect, cognition and behaviour (measured in terms of academic achievement).

However, a few of the high ability students commented that lessons were typically based on textbook work and lacked creativity. There was more emphasis on practising the questions and striving to score a high grade than exploring and enjoying learning. According to a Year 10 high ability boy (Y10HA – B):

I feel the way Maths is imposed on school life with constant repetitive exams and teachers only teaching you what Michael Gove wants while squeezing all the enjoyment out, makes people of my age swarm away from Maths like a flock of birds.
-Y10HA - B].

Most of the low ability students (LA) show unfavourable emotions towards Maths. They find it boring and confusing. Their aversion to Maths is related to finding the subject difficult and not being able to grasp. But they do like it “if” and “when” they understand, make progress and get good marks in exam. Affect seems to be closely related to achieving a high score in exam. Despite their aversion to Maths, they appreciate the importance of the subject.

The data signifies that quite a few low ability students lack confidence in their abilities and have low self-esteem for themselves. They believe that some people are naturally good at Maths. They view competence in Maths as an in born talent which cannot be acquired. It leads them to think that it’s impossible for them to progress and move to a higher grade and they feel dejected, as evident in the following examples:

“I am never going to achieve a C or above and it’s depressing” - [Y7LA – B].

“No matter how hard I try I cannot get the correct grade” - [Y10LA – G].

“I dread coming to the Maths lesson as I don’t understand anything” - [Y10LA – G].

“You need a good brain and memory for maths; something I am not good at”- [Y7LA – G].

Girls, even in the high ability cohorts, appear to be apprehensive about the subject and are unsure of their abilities. They seem to be under a lot of pressure to perform well. The expectations from the high ability students are really high which stresses them out. Teachers expect the high ability students to understand everything quickly and “rush ahead” without ensuring whether they have grasped the topic. The pupils are reluctant to ask the teacher to explain again if they don’t understand, in order to avoid the embarrassment of being labelled “thick and dumb in set 1” [Y7HA – G]. They feel as if they are imposters in the high ability cohort although they get good grades. “I don’t think I should be in set 1.....every time there is a test I wonder how I got that level” [Y7HA – G]. Boys, on the other hand are more optimistic, “I like Maths even though I am in the baddest set. I am really confident that I am going to move up sets so people don’t say you are dumb” [Y7LA – B].

3.3 Visual Data

Visual data also demonstrates a favourable ATM among high ability students and boys as seen in the following images (for details on visual data see Syeeda, 2015). The first two images (figures 4 & 5) are drawn by students from the low ability groups (a girl and a boy) and the next two images (figures 6 & 7) are drawn by higher ability boys.

Questionnaire for Year 7

Please write a paragraph (about 100 words) or draw a picture on the topic
'Maths and Me'.



Thank you very much for your time and contribution ☺

Figure 4. Drawn by a Year 7 low ability girl

Questionnaire for Year 7

Please write a paragraph (about 100 words) or draw a picture on the topic
'Maths and Me'.



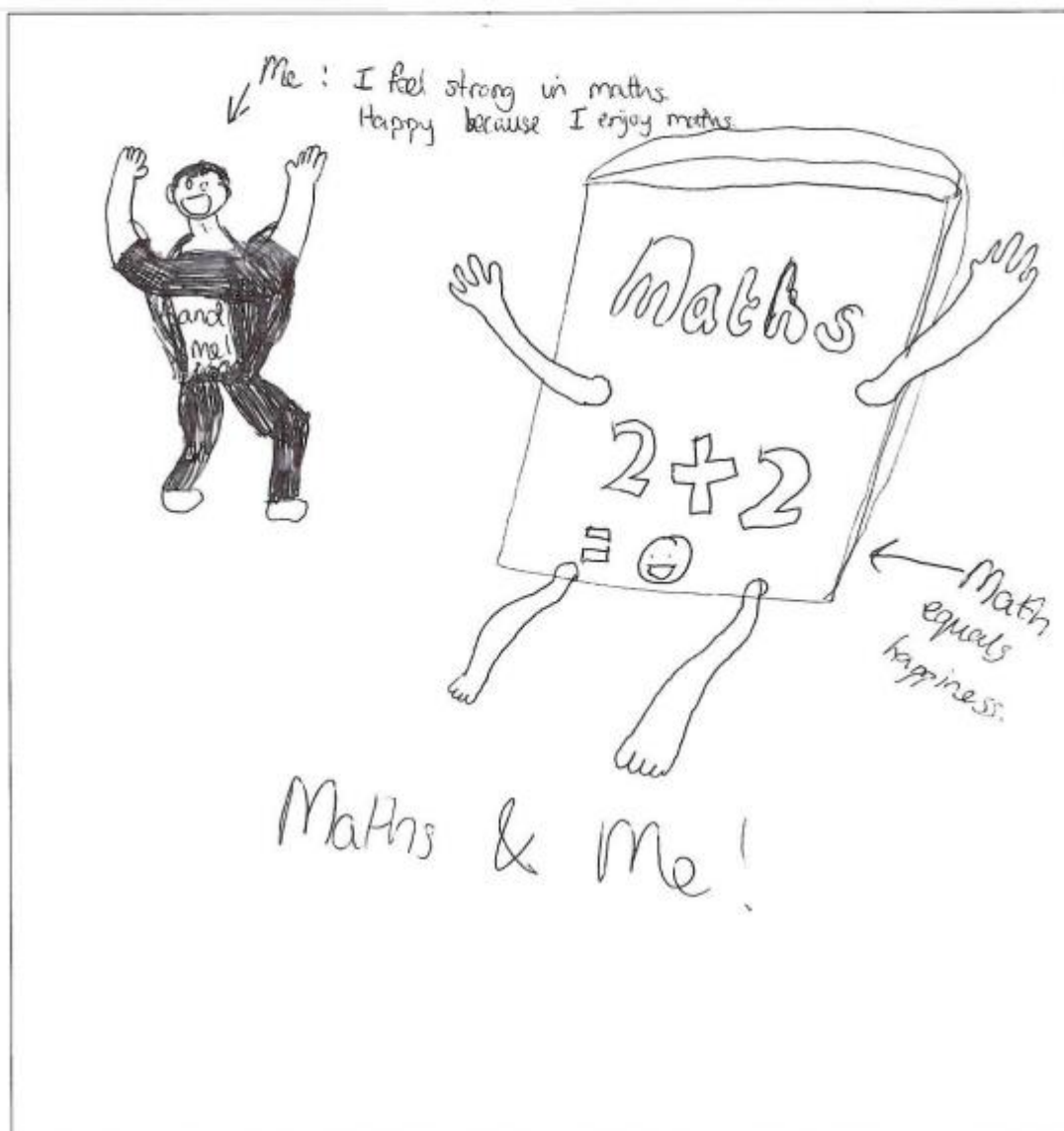
Thank you very much for your time and contribution 😊

Figure 5. Drawn by a Year 7 low ability boy

Questionnaire

Year 10

Please write a paragraph (about 100 words) or draw a picture on the topic
'Maths and Me'.



Thank you very much for your time and contribution ☺

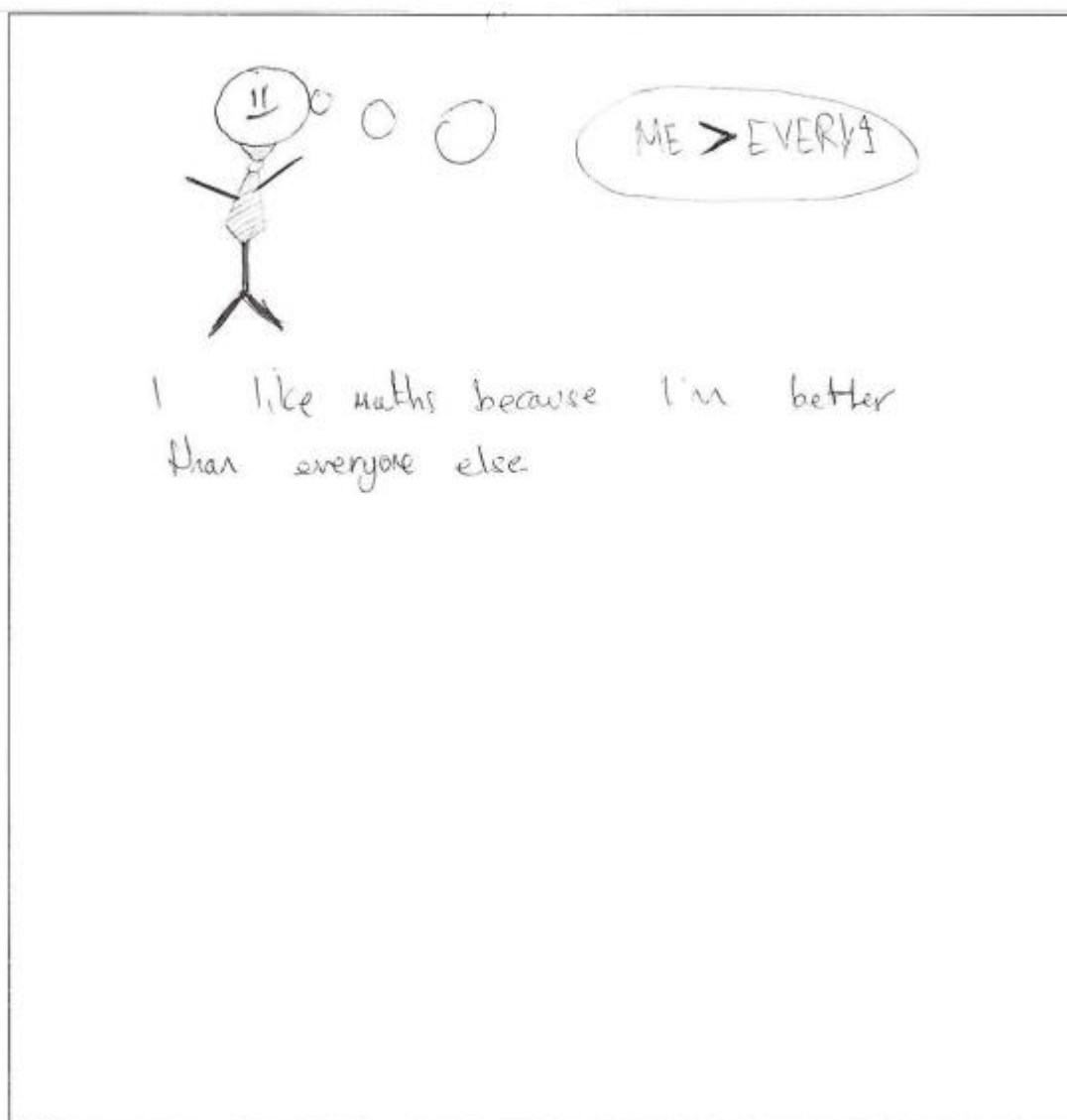
TS

Figure 6. Drawn by a Year 10 high ability boy

Questionnaire

Year 10

Please write a paragraph (about 100 words) or draw a picture on the topic
'Maths and Me'.



Thank you very much for your time and contribution 😊

TS

Figure 7. Drawn by a Year 10 high ability boy

4. Discussion

The findings of this research show mixed strands in attitudes towards mathematics in secondary school children in the East Midlands. A vast majority of learners have positive cognition towards the subject which indicates that they acknowledge its importance in their lives and future careers. However, a large number of students demonstrate aversion to the subject and have a negative emotional disposition towards Maths. The mean scores for cognition for all sub groups are more positive than affect with a smaller value for standard deviation. Although the components of attitudes affect (emotional disposition), cognition (belief about the importance and usefulness of the subject) and behaviour (in terms of academic achievement) are not mutually exclusive and overlap, they seem to be independent of each other. Pupils can have a combination of positive and negative attitudes at the same time. This research corroborates the findings of previous studies and shows that attitudes are strongly related to gender (e.g. Ernest, 2004; Mendick, Epstein, and Moreau, 2008) and attainment level (TIMSS, 2011). High ability learners and boys generally have positive attitudes towards Maths. However, it's not clear whether positive attitude towards Maths is the cause of high achievement, or results as an effect of high achievement. Low ability learners are desirous to learn Maths but have low self-concept which dampens their morale. They need constant motivation and reassurance to build up their confidence level. Girls, even in the high ability sets included in this research, lack faith in their capabilities and seem to be under the impact of imposter syndrome. They appear to be apprehensive about the subject and are unsure of performing well.

According to the quantitative analysis for this data set, ATM does not seem to be affected by the age of the learner. There is no significant difference in ATM between 11 year olds and 15 year olds. However, in focus groups, year 7 students demonstrated a more favourable attitude towards Mathematics as compared to year 10 students. Attitudes to Maths are also related to learners' socio economic status and linguistic background as seen in the differences in mean values of affect and cognition component of attitude. Children belonging to comparatively well off families are more positive towards learning Maths. Similarly the attitudes of bi/multilingual students are positive in comparison to those who speak English only. The differences in means, however, are statistically insignificant. Nevertheless, this area needs to be further explored as this research could not include students from low ESL and low FSM schools.

There are many limitations which could have affected the findings of this research. It was a small scale research conducted over a period of 3 months in the summer term. Because of limited time available and difficulty in getting access to schools, the data collection tools could not be piloted as initially planned. To address this limitation, each focus group interview session was critically analysed after completion and future sessions were modified and improved so that maximum data could be extracted. However, this caused some variation in data collected earlier and later. Similarly, the questionnaire could have been improved if piloted and a couple of factual questions could have been eliminated, allowing more time for the open ended part of the questionnaire which provided rich data. Finally, this research was a case study; therefore, the findings of this research cannot be generalized.

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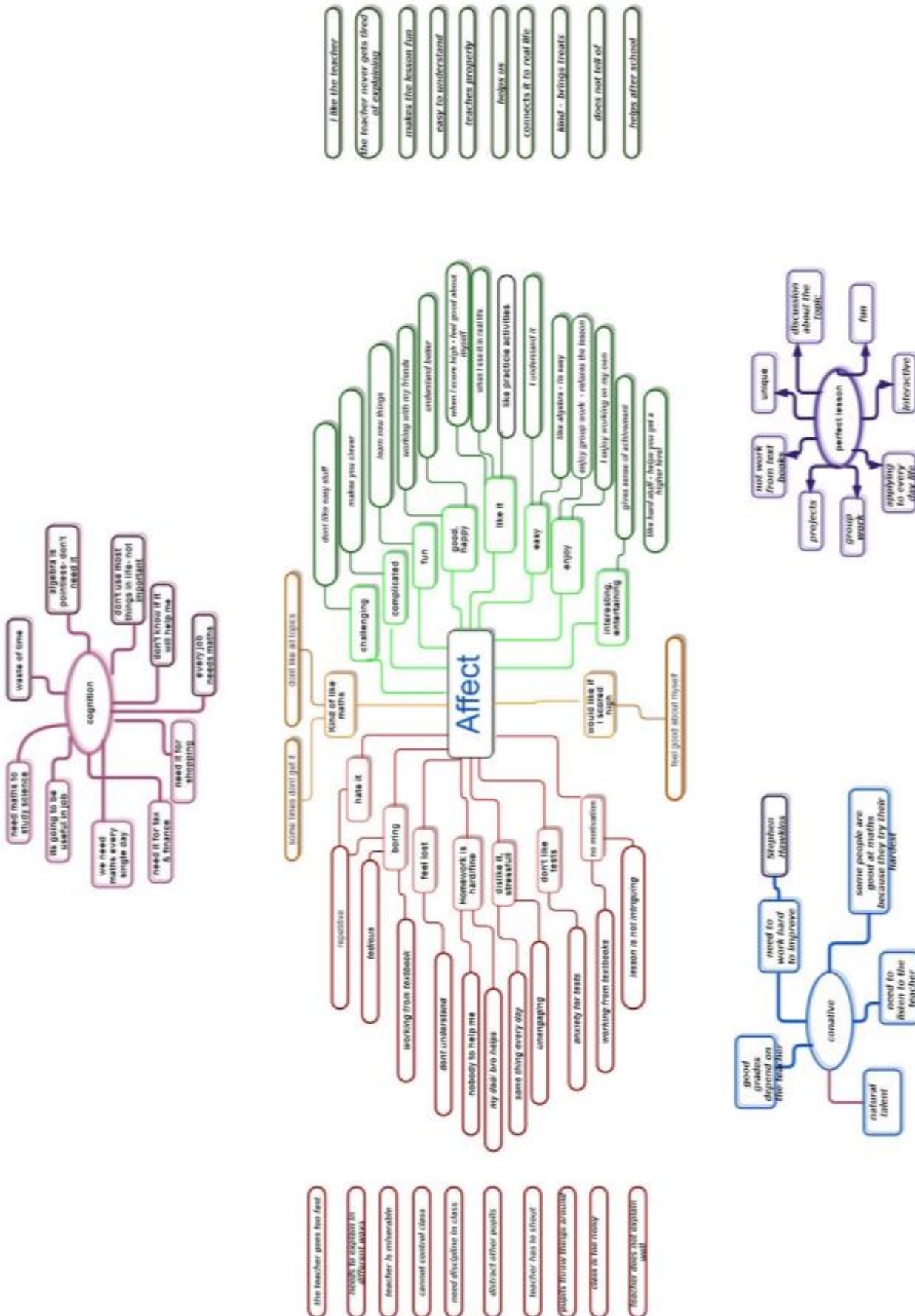
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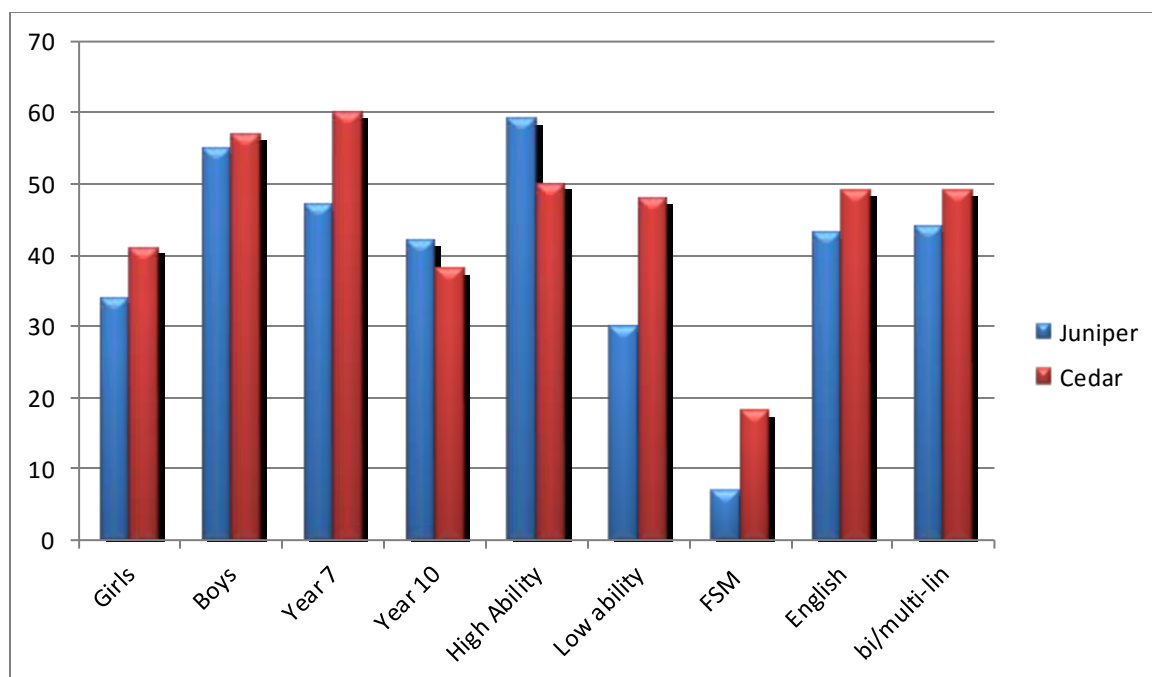
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Appendix 1: Themes from Focus group data



Appendix 2: Sample Sizes



y-axis shows the number of students in each sub group.