Article

Performing Below the Targeted Level: An Investigation into KS3 Pupils' Attitudes Towards Mathematics

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Abstract

This study sets out to investigate the attitude KS3 pupils have towards mathematics and the factors that influence this attitude. A case study approach was used as the pupils were a unit of the school under study and a survey method was chosen to provide scope to the study. Purposeful sampling was employed for the selection of 200 pupils from years 7 and 9 who were from target achiever and non target achiever groups. Attitudes Toward Mathematics Inventory (Tapia, 1996) was administered to the participants to measure their attitude towards mathematics. Data were analysed using Statistical Package for the Social Sciences (SPSS) version 17. The result for the first hypothesis indicated that there is a significant difference on the variable of mathematics attitude of year 7 and 9 target achievers and non target achievers pupils ($t=4.11$, $df=199$, $p<.05$) and for the second hypothesis, the difference in the variety of attitudes is statistically significant in the pupuls from both groups ($t=2.3$, $df=210$, $p<.05$). The results of the research will enable teachers to understand the factors that effect attitude of pupils towards mathematics at secondary level and direct head teachers to establish effective teacher training and support system to help pupils to develop an interest in mathematics.

Keywords: mathematics attitudes, secondary level, target achievers, under achievers

Introduction

In spite of the global downward trend in education, mathematics still maintains a noteworthy position inside and outside the classroom; however, attitude

and beliefs about this subject may affect pupils' understanding of its significance in their lives and may hamper or support their interest and learning of the subject. Be it physics, chemistry, computer sciences, or any other subject, there is a significant chance that pupils who do not acquire an understanding of basic mathematical concepts could be ultimately restricted in their academic achievements; therefore, knowledge of mathematics is an essential tool in the society (Baroody, 1987). Mathematics can be considered as a means that can be used in our daily lives to overcome the difficulties faced (Bishop, 1996) and in the fast paced world, success in mathematics may secure a better placement in the job market and may also prove to be a ladder to success and achievement (Hemmings, Grootenboer & Kay, 2011). Maughan and Cooper (2010) state that good maths education is very important to the success of England's economy and it is a concern that pupils who leave schools are not equipped with the skills needed for the workplace. Hoyle, Harris and Judd (2002) concluded in their study that despite the widespread use of technology, there was a need for maths and literacy skills. Accordingly, the stakeholders have an interest in the factors that influence achievement in maths, which may include attitude; ability, school milieu, gender, prior achievements, and soft skills of the pupils. Several studies have been conducted worldwide in order to investigate the factors that could influence the performance of pupils in mathematics and pupil attitude has emerged as one of the key factors (Ai, 2002; Singh, Granville & Dika, 2002). For example, Samuelsson (2010) noted that whilst children at primary level tended to display a positive attitude towards mathematics, this attitude became less positive to the extent that by the time they reached secondary school, it had become almost negative.

Significance of the study

The study of student attitude towards maths and how these are formed is significant for a number of reasons: Firstly, the pupils can develop an informal interest in mathematics prior to joining the school, which is further cultivated at primary and later at secondary level when the teachers can play a crucial role in the formation of their pupils' attitude towards maths (Philippou & Cristou, 1998; Quinn, 1997). Secondly, since mathematics is a discipline characterized by abstract knowledge, accurate results, and strong logical procedures, attaining a significant level of mastery in mathematics is critical in the lives of pupils and adults (Kilpatrick, Swafford & Findell, 2001), as the workplace will become more number oriented

(Furner, Yahya & Duffy, 2005). Thirdly, emotional responses are an offshoot of the affective domain, which influences pupils' interaction with mathematics (Ruffel, Mason & Allen, 1998). This is supported by Weiner (1992) who states that pupils who fail in maths repeatedly, start having doubts about their own capabilities. This low self esteem proves to be a great barrier in improving their mathematical performance and could have a bearing on their cognitive and affective-emotional levels of motivation.

Many teachers have regarded mathematics as being different from other subjects as it inculcates application of certain logical sequences, that results in the culmination of a desirable solution to a problem. Introducing mathematics to pupils in a context that is meaningful or perhaps linked to other subjects is one way of doing this. This coincides with Nicol and Crespo's (2005) belief that a conducive learning environment for studying mathematics is extremely important to help pupils understand relevant concepts, procedures, and skills and to realize the value and significance of knowing them.

The research reported in this paper is part of a broader research study for which mixed method was used and the objectives extended to find out the reason for a low level of attitude of students towards maths by including the perceptions of teachers and pupils through individual and focus group interviews. This paper specifically focuses on the attitudes of class 7 and 9 pupils towards mathematics, for which the data were culled by administrating Attitudes Toward Mathematics Inventory- ATMI (Tapia, 1996).

Study site

The study was Blue River Girls' School (pseudonym) which is a largely oversubscribed modern girls' comprehensive secondary school located in South London, UK. The vast majority of the girls belong to working class white families with a significant representation of immigrants and ethnic minorities. The teachers of the school are fully trained and hold Qualified Teaching status. Pupils at times seem to lose interest in mathematics, as learning becomes more task and performance oriented. Teachers usually expect pupils to appreciate the significance of maths more as they advance; however, it has been observed that pupils at a higher level lack motivation and do not understand why they must study mathematics and thus

perform below the target level set by the school. The question that often arose in the researchers' minds was whether or not similar factors influenced pupils' attitudes towards mathematics in year 7 as they did in year 9 (Key Stage 3-KS3). Thus, the central question that emerged was:

What attitude do KS3 pupils have towards mathematics and what impacts or influences this attitude?

The following null hypotheses were formed for the study:

1. There is no statistically significant difference in the variable of attitudes towards mathematics between the years 7 and 9 pupils.
2. There is no statistically significant difference in the variety of attitudes towards mathematics among target achievers and those who have not achieved their target in KS3.

Literature Review

Attitude in literal terms means state of mind and its tendency to respond to a certain situation or a person. It is also a predisposition that guides individuals and their responses in the context of education to a certain learning activity. All individuals construct their attitude and hence respond to situations differently (Newbill, 2005). The term attitude has been defined by many educationists and psychologists and even the ordinary man uses this word very commonly (Albarracin, Zanna, Johnson & Kumkale, 2005). Allport (1935; 1954) defines attitude as a psychological and mental state of mind where individual responses are influenced by a person's life experiences and is regarded as a primary building stone in the construction of social psychology. He emphasised the important role that life experiences play in determining attitudes. Goos, Galbraith, Renshaw and Geiger (2003) on the other hand poised that it was not very easy to offer a definition of attitude towards mathematics that would be applicable to all contexts. A pupil with a negative attitude will try to escape any encounter with maths and find ways of avoiding activities, including homework. This affects achievement and inevitably engagement during maths lessons (Chamberlain, 2010; McLeod, 1989). Student attitudes are also influenced by the teaching style adopted by teachers in the classroom. Westwood (2008) describes teaching style as a set of procedures or

methods used by teachers to achieve a desired level of learning and understanding. Thus, it is important to understand what practices and strategies are construed positively by pupils and what is looked upon unfavourably by them The Cockcroft (1982) report of the Commission of Inquiry into the Teaching of Mathematics in Schools laid down suggestions for teaching methods such as problem solving, investigational and practical work, to mention a few, that could be adopted to foster effective learning and achievement in maths lessons. Orton, Orton and Frobisher (2004) opined that it might be suggestible for teachers to use a wider range of teaching methods than those laid down in the Cockcroft Report (1982).

Student attitudes toward mathematics

Ajzen (1989) professed that whereas attitude was a person's disposition towards a subject, beliefs were the information a person held about that subject. According to this perception, pupils who believe that they are not good at maths will bear a negative attitude, whereas pupils who enjoy doing maths will have a more positive attitude. A pupil's attitude towards any subject determines the interest and readiness to appreciate and study that subject. A non-favourable attitude might not result in positive learning outcomes, thus leading to low scores and vice versa.

Reinup (2009) believes that pupils' mathematical image is related to attitudes and emotions. Emotions are negative and positive feelings which are short lived, whereas attitudes are positive or negative affective reactions and are fixed and quite intensive. Reinup (2009) further explains that progress in a subject, attitude towards it, and self-esteem are positively correlated and add to the quality of the learning process. Such an attitude creates a willingness to study, develops positive learning values, enthusiasm, and interest in the learning process. Olatuned (2009) studied the link between pupils' attitude towards mathematics and their academic grades and concluded that poor grades made pupils dislike maths and vice versa. Research conducted by Orton, Orton and Frobisher (2004) identified pupils' attitude towards mathematics as a major contributing factor in their success. Mathematics being one of the core subjects in the curriculum, equips pupils with key life skills and the subject is made compulsory right from the early years of schooling to set a strong academic base. Thus, the school management and teachers strive to provide interactive platforms to the pupils to help them succeed in this subject. What methods and practices teachers implement in the classroom play a major role in engaging them, clarifying and simplifying mathematical concepts in

their mind, thus leading to positive outcomes.

There are multiple factors that can influence performance in mathematics by impacting pupils' attitude; therefore, it is important to investigate what factors promote low performance in mathematics and this is a globally researched phenomenon of study (Pisa, 2003). These factors include those that are relevant to the pupils themselves, the teachers, and those associated with home. Many researchers have also enlisted factors such as pupils' past experiences, pupils' self-efficacy, teachers' support for pupils to overcome fear of mathematics, teachers' style of teaching, content knowledge, demographics of parents, and parental expectations of the pupils (Klein, 2004). All such variables are responsible for influencing their learning desires and abilities.

Mathematics anxiety

Anxiety towards mathematics has been defined by Whyte (2009) as "A worry or fear that causes a negative response, specific to learning or doing of mathematical activities that interferes with performance" (p. 4). Whyte and Anthony (2012) have presented three factors that could produce anxiety and feelings of negativity towards mathematics in pupils: (a) parents who are themselves anxious about maths might transfer such feelings to their children unintentionally, (b) social factors and peer pressure for sowing the seed of discomfort that maths is for the intelligent, and (c) teachers who influence pupils if they are extremely anxious themselves. Studying mathematics is actually problem solving, which requires a highly complex set of skills such as comprehension and understanding, internalizing information, and connecting it to the existing body of knowledge in one's mind to manipulate, work with, develop, refute, and accept information and responses or output and then deciding and suggesting possibilities as solutions. Wood (2012) stresses that maths teachers should introduce the discourse of mathematics at all levels for easy communication of maths concepts in the classroom as well as at the workplace. Yeo (2009) explains that "In order to successfully solve various types of problems, in particular the non-routine ones, a student has to apply four types of mathematical facilities, namely; specific mathematics concepts, skills, processes, and metacognition to tackle the problem" (p. 3). Swanson (2006) in his study noted that the deeper the pupils were immersed in critical inquiry and mathematical problem solving, the greater was their math anxiety. His research participants found it hard to respond to mathematics questions, which became increasingly difficult,

leading to heightened anxiety. Swanson's research recorded solutions he employed in trying to remove feelings of anxiety and he strongly emphasised that difficulty in reading limited the comprehension of mathematical instructions and perplexed most pupils that resulted in underperformance in the subject.

Methodology

Pursuant to the purpose of the study, a survey design was used to collect the necessary data and investigate and measure attitudes, perceptions, and opinions of the participants regarding maths at KS3 level. The study sought to investigate the difference in attitudes towards mathematics among target achievers and non-target achievers, and did not influence or manupilate any variable, that is, pupil attitudes of cleass 7 and 9 towards mathematics. A case study approach was considered appropriate and the school where the primary researcher worked was chosen as the case unit.

Sample size

For the present study, 200 participants were identified through purposive sampling as it suited the demands and rigour of the study (Glaser and Strauss 1967; Mcleod, 1989). This type of sampling can be beneficial when the researcher aims to contact the targeted sample in a short time and proportionality is not one of the aims of the research. The pupils selected were those who were currently studying in years 7 and 9 (KS3) and came from different ethnic backgrounds, such as British, South and East Asians, and Eastern Europeans. The justification to select class 7 and 9 was that these are the entry and exit points at secondry level in the school. There were four sections in each year group making it a total of eight sections who filled out a survey questionnaire. Each year had two target achieving groups and two non target achieving groups; target achievers were required to take the higher GCSE examination in mathematics and the maximum grade that they could achieve was A*, while non target achievers were required to take Foundation GCSE examination and the maximum grade expectation was C. The non target achievers from each year group were identified from the school results database as being those whose end of year levels were one or more sublevels below their target levels for the existing year. The fast track or target achievers' group had an average of 35 pupils per class, whereas the under target achievers' class size had an average of 12 pupils per class. As given in Table 1, the total number of sample size for the study

were 200 pupils.

Table 1
Distribution of Sample per Class

Class	Fast Track	Under Target
7	77	27
9	73	23
Total	150	50

Data collection procedure

For this research study, a survey method was used by administrating Attitudes Toward Mathematics Inventory- ATMI developed by Tapia (1996). Permission was taken from the head teacher of the school to administer the ATMI to level 7 and 9 pupils. An informed consent form was prepared for the participants to sign if they were willing to be part of the research study. Three maths teachers were requested to administer the inventory during their maths lesson as it was impossible to get a common time from the participants outside the class hours and only one day was assigned to collect the data. Research ethics was followed throughout the data collection procedure.

Attitudes toward mathematics inventory (ATMI)

Attitudes Toward Mathematics Inventory (ATMI) consists of 40 items that are designed to measure student attitude towards maths. The tool uses a five-point Likert type scale that varies from strongly disagree to strongly agree and has four factors: (a) self-confidence, (b) value, (c) enjoyment, and (d) motivation. Each factor or subscale has explicitly laid out items for easy understanding when scoring the data. The inventory was initially developed to measure secondary school pupils' motivation towards mathematics and later validated on college pupils as well (Tapia & Marsh, 2000). This tool was best suited for the study in hand as the factors of self-confidence, value, enjoyment, and motivation emerged from the literature review as well.

The data analysis for the current study was carried out using Statistical Packaging for Social Sciences (SPSS) version 17. Inferential statistics were used to test the hypotheses. Independent sample t-tests were applied to explore class wise

(year 7 and 9) differences in the variable of mathematics attitude and difference in the variety of attitudes among achievers of target and those performing at non target levels. The data were entered into SPSS in the form of a data matrix table, which were then coded and each case was given an individual ID number.

Findings and Discussion

The purpose of this study was to recognize what factors determine the learning of mathematics by KS3 pupils, with a focus on their attitude of the subject. The data were collected through the use of ATMI filled in by 200 pupils of years 7 and 9. Two null hypotheses were formulated to verify the data using SPSS version 17.

Hypothesis 1

There is no statistically significant difference on the variable of mathematics attitude between year 7 and 9 pupils.

Table 2
The Mean Difference Between Year 7 and Year 9 Pupils on the Variable of Mathematics Attitude

	Year	N	Mean	Std. Dev	T	Df	Sig
Maths Attitude	7	104	134.8	19.3	4.11	199	.000
	9	96	124.2	18.3			

Note: According to the result, the difference in attitudes towards maths is statistically significant in year 7 and 9 ($t=4.11$, $df=199$, $p<.05$).

Independent sample t-test was administered to explore the null hypothesis: *There is no statistically significant difference on the variable of mathematics attitude between years 7 and year 9 students*. The data analysis as shown in Table 2 above revealed that there was a significant difference on the attitude scores of year 7 ($M=134.8$, $SD=19.3$) and year 9 ($M=124.2$, $SD=18.3$) pupils, $t(210)=4.1$, $p=.000$.

In the study school, a few subjects become optional to pupils in year 9 and they have to make a choice based on the future career prospects that are of interest to them. Maths is a core subject and pupils might realize its significance considering the provision of counseling by the school as they start exploring options for higher education and are aware of the need for a suitable grade in maths. The research results revealed a significant difference on the variable of attitude towards mathematics, as pupils progress from year 7 to 9. However, this does not support or suggest a difference in attitude between target achieving and non target achieving pupils in these years of study. Attitude towards mathematics could be leaning towards being more negative in non target pupils both in years 7 and 9, but pupils in general are greatly concerned and seemingly work hard to achieve good grades in mathematics.

Pupils might show a significant difference in attitudes towards mathematics because as the years advance, they may demonstrate a greater interest in their education. This could be due to stronger awareness of career choices as future prospects become more diverse and the concept of counseling becomes more common. In a research conducted by Kislenko, Barbro and Lepik (2007), pupils acknowledged the fact that maths became more difficult when progressing through school years and its success depended on solving a number of tasks to achieve success. Teachers' attitude and perceptions also play a crucial role in the development of pupils' perceptions about a subject and its importance in the curriculum. They often lack the ability to understand mathematical instructions (Yeo, 2009) and are not able to demonstrate dexterity in choosing to solve mathematical problems in more than one way, which accounts for the growing anxiety and disinterest in mathematics.

The end of year 9 maths outcomes are also the end of KS3 results, which are fed into the main results database for all schools in the borough. Teachers regularly remind pupils that these results will then be used to assign predicted GCSE grades. Studies have shown that as pupils progress through the years, enjoyment and self-confidence decrease and pupils start working harder as examination anxiety builds up (Berger, 2000). Though this might not raise the level of motivation, it does make maths appear more important as a subject and pupils feel they have to work harder to get a place in an institution of higher learning and being accepted in a program of their choice to get a better job placement (Ampadu, 2013). As a result, pupils at

higher level spend countless hours practicing maths in classes, schools, and home to pass their mathematics examinations (Blum, 2002). Year 9 is considered a crucial phase in a student's life as they are required to take some of their modular exams in this year. In the study school, parents are invited to discuss choices of optional subjects in year 9 and are made aware of the importance of the core subjects. This provides a platform where they can come into contact with other parents and discuss what support is being offered by the school. This might serve to make them more aware of the possibilities and prospects that are open to their children and what they could do to help. A higher level of interest by parents will lead to more positive attitudes in children and a willingness to do well.

It was noted during the course of literature review, that less support is available for mathematics to pupils from their parents, simply because the mathematics of their times was very different from the mathematics their children undertake in schools of today (Cline, 2005). While much can be said about parents', teachers', and pupils' attitude towards mathematics, the school's curriculum specifications must also be duly scrutinized. Most mathematics standards set by mathematical associations worldwide assert that the context and content of mathematics must be set in real life circumstances to be able to introduce mathematics to pupils in meaningful and contextual ways. Woodbury (1998) therefore, urges for a greater integration of mathematics in the core curriculum spectrum resulting in experiencing mathematics not only in the mathematics classroom, but also in various aspects of school and home life.

Hypothesis 2

There is no statistically significant difference in the variety of attitudes towards mathematics among target achievers and those who have not achieved their target in KS3.

Table 3

The Mean Difference Between Target and Non Target Pupils on the Variable of Mathematics Attitude

	Grade	N	Mean	Std. Dev	T	df	Sig
Attitude towards maths	Achieving target	150	131.7	20.2	2.3	199	.020
	Not achieving target	50	124.7	16.5			

Note: According to the results, the difference is statistically significant in target achievers and non target achievers ($t=2.3$, $df=210$, $p<.05$).

An independent sample t-test was administered to explore the second null hypothesis: *There is no statistically significant difference in the variety of attitudes towards mathematics among target achievers and those who have not achieved their target in KS3*. The data analysis as shown in Table 3 revealed that there is a significant difference on the attitude of target achievers ($M=131.7$, $SD=20.2$) and non achievers ($M=124.7$, $SD=16.5$) pupils, $t(210)=2.3$, $p=.020$.

Kadijevich (2008) believes that there is a positive relationship between attitude towards mathematics and achievement in mathematics. Pupils with a more positive attitude will demonstrate confidence in tackling maths problems and will be happy to accept challenges as they get more engaged and perform well when they are challenged (Lee & Wilder, 2013). According to the research, there is a relationship between learning outcomes and pupils' beliefs in mathematics (Schoenfield, 1992; Thompson, 1992). Fennema, Carpenter, Peterson and Carsey (1988) support the notion that confidence in maths is closely linked to achievement and is significant in distinguishing between pupils who will opt for maths at a higher level than those who will not. Moreover, pupils develop an interest in maths due to inherent mental capabilities, teacher support, and parental support. Bonner (2014) symbolizes that, "Constructs of mathematical knowledge and an individual's relationship to mathematics are highly interpretive and are influenced greatly by the individual's experiences with mathematics, many of which have been framed by the teachers" (p. 380). If pupils find maths easy, they will be interested in it, which will result in them performing well and in turn have more self-confidence The more pupils improve and excel in mathematics, the stronger will be their self-perception and self-image (Kishore & Ma, 1997).

The t-test result showed a significantly higher score for pupils who were achievers of their targets in mathematics in comparison to those who were not, proving the null hypothesis to be false. Thus, there is a difference in attitude towards maths between target achievers and non target achievers. Kadijevich (2008) considered three dimensions of mathematical success among pupils in a cross-country study: these were self-perceived efficacy, or finding it comfortable to attempt mathematics in classrooms and tests; pupils' own liking and disliking of the subject for any reason;

and how useful pupils found mathematics to be in real life settings or everyday life. These three factors accounted for how pupils responded to the teachers' teaching styles, strategies used to motivate them, support teachers' attitudes, and parents' support and interest in their children's learning. These dimensions also contribute to the conviction that pupils' achievement in mathematics is the result of efforts put into their education by the three influences stated above. Moreover, they support the study hypothesis that pupils who achieve higher in mathematics as compared to pupils who do not are more secure and confident of their capabilities. For pupils who are able mathematicians and achieve well, one cannot ignore the fact that their inherent cognitive abilities are perhaps more responsive to mathematical stimuli than other pupils. That is the usual response from teachers and parents-more of a line of defense than logical reasoning. Research findings also testify that motivation and perseverance or diligence can improve skills and abilities to a great extent; therefore, pupils must develop a positive and resilient attitude towards mathematics to give them space to develop their skills in spite of the difficulties and obstacles they face (Lee, 2006; Lee & Wilder, 2013).

Conclusion

By using the ATMI, this study investigated the question: What attitude do KS3 pupils have towards mathematics and what impacts or influences this attitude? The central research question was developed into two null hypotheses. It was hypothesized that as a student advanced in years in school, there might be a significant change in the attitude and pupils might start working harder as higher classes mostly culminate in public examinations that vie for prospects in higher education placements. The second hypothesis compared the relationship between pupil attitude towards maths and their success at achieving their target grade. The study research indicated that anxiety level and pupils' attitude are crucial in determining how well they performed in maths. A pupil's attitude towards any subject determines the interest and readiness to study that subject. The literature review and the results acquired reflect that positive learning experiences created positive attitudes, which made the pupils enthusiastic about studying mathematics.

This study will not only serve to help the researchers explore pupils' attitudes towards mathematics closely, but it will also help them to understand the role of teachers in establishing or fostering positive attitudes in themselves. The findings of this research may not be generalized to settings in countries outside the UK, but

will help maths teachers in similar systems to ponder over the problems that effect the attitudes of pupils towards mathematics to enable them to provide the pupils with meaningful learning experiences. Ultimately, the head teachers could facilitate the maths teachers' professional development through interest groups or short workshops, where they can listen to each other, share, work together and justify strategies that they use. Parents could also be benefactors of the research findings as it would undoubtedly help them to learn ways in which they could contribute to the academic success of their children in maths. In general, maths teachers could deliberate over the findings and discussions of this paper to pick up similar threads and apply them in their own context nationally or globally.

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