Exploring Children's Attitudes towards Mathematics

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This paper explores the behaviour, attitudes and beliefs of primary school pupils towards mathematics in the classroom and the impact that this may have on their mathematical ability. The study focused on year 3 pupils from a local school, some of whom took part in focus groups towards the end of the project. The children completed short worksheets, which were used to stimulate a guided discussion on what aspects of mathematics the children liked and disliked. The aim of this project was to isolate possible causes of negative attitudes towards mathematics and to discuss what their implications might be.

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Introduction

Mathematicians have long held a high level of respect amongst their academic peers. Yet the subject of mathematics, although revered, remains a source of anxiety and trepidation for a large number of people. Widespread negativity towards mathematics appears in many forms, from misrepresentation in the media to the social stigma that seems to surround those who are mathematically gifted. Children often set mathematics aside as a cause for concern, despite their limited exposure to it (Hoyles 1982). It is a subject unlike most others, since it requires a considerable amount of perseverance from the individual in order to succeed. A negative attitude towards mathematics could considerably reduce a person's willingness to persist with a problem. Without the ability to persevere, mathematical development is likely to be difficult. The purpose of this project is to determine the possible root causes of these negative attitudes towards mathematics.

The study focused on Year 3 pupils from a local school, some of whom took part in focus groups. Three focus groups were carried out, each consisting of four children with similar abilities. Children were selected based on observations from previous visits. Subjects were chosen if they displayed strong feelings for or against mathematics, or if they were at the extremes of the ability range. The focus groups lasted for approximately 30 minutes and were broken into two parts. Firstly, the children were given 10 minutes to attempt four questions tailored to their ability range. The questions involved symmetry, arithmetic, a word problem and a problem solving exercise. The remaining time was used to discuss what the children felt about mathematics, using the worksheet as a focal point.

It is hoped that this project will provide significant insights into why many children have a pessimistic outlook on mathematics and indicate where future research is needed.

Mathematics and its apparent lack of purpose

Children may find the nature of mathematics difficult to cope with as its wider reaching implications can be hard to see. Experiments are carried out for the physical sciences, pictures are drawn in art class and language skills are used in everyday interactions with other people. However, mathematics has a very formal written sense about it, where activities remain intangible to the child. From the remarks I witnessed in the focus groups, it seems that children find it difficult to make a connection between the work they do on paper and its practical applications. The following transcript is taken from the high-ability focus group:

Charlie: You need to be good with numeracy, say when you're say, shopping for something – You need to work out how much you're paying. You don't have to be a genius at it, but you have to be quite good at it.

Researcher: You mentioned shopping; do you think you use your numeracy skills outside of school?

Billy: Oh yes, I use it on...

Researcher: What sort of things? Daisy?

Billy: Counting out money.

Daisy: We don't really do numeracy outside; it's just to work on word problems, and multiplication and addition and subtraction, more than doing numeracy skills outside.

Charlie: Yeah, definitely. You couldn't basically live without knowing maths, because like when going shopping you need to know how much money you need. Also if you're going on holiday, you need to know how much money you're spending and stuff.

Similar remarks were made by children in the middle and low-ability focus groups:

(Middle-ability)

Faye: Yeah, maths is important, because it makes you more clever with adding things.

Gilly: Why's adding important?

Faye: Because then like you said you can count all your money and go to the shops and buy stuff.

(Low-ability)

Lisa: If you're a shopkeeper, and someone gave you like about £20, and something was like £15 and they didn't know much how much to give them back. And if you didn't know, you should learn more in your maths.

It was rather surprising to see pupils across the entire ability range unable to make connections between mathematics and its many practical uses. Counting money was the only association that they were able to make, even though it had not been covered in recent work. It is interesting that the high achievers, although mathematically gifted, could not establish any more real world applications than the low achievers. However, the low achievers present more of a concern, as motivation to improve their mathematical understanding cannot be aided by their innate ability. Certainly, the children cannot be expected to make these connections without assistance from a teacher. In fact, some believe that the most effective teachers are connectionists (Askew et al. 1997), although perhaps there is currently insufficient emphasis on the practical uses of mathematics in the curriculum.

Human nature does not favour futile endeavours; if a difficult task appears to have no purpose, then few will continue to follow it through. If low achievers are unable to see the wider benefits of having strong mathematical skills, then they may lack motivation, which is vital in a difficult subject such as mathematics.

Understanding the purpose of mathematics should not only help to improve motivation, but could help in the actual formulation of concepts. In 1991, Harel and Tall discussed the importance of what they called 'the necessity principle':

> This principle states that the subject matter has to be presented in such a way that learners can see its necessity. For if students do not see the rationale for an idea (e.g., a definition of an operation, or a symbolization for a concept), the idea would seem to them as being evoked arbitrarily; it does not become a concept of the students. (Harel and Tall, 1991 41)

They believed that a notion is more likely to be abstracted successfully if the learner can acknowledge the necessity of the concept. In the context of this project, the learner needs to be aware of the purpose behind their work. For young learners, understanding the practical uses of mathematics could be sufficient to both motivate them and allow the necessity principle to be satisfied.

Further research is required on this issue, as its scope may be greater than previously thought. As with all the findings in this project, the data was collected from a small sample group, and so it may be difficult to generalise to a larger population. However, based on the remarkable similarities between responses in this particular classroom and the general attitude towards mathematics in our society, I would suggest that the apparent lack of purpose in mathematics is a sentiment felt by many.

Self-belief and mathematical ability

Nothing was more evident during the focus groups than the lack of self-belief shown by many of the children. Low and middle achievers quickly resigned themselves to failure, without truly attempting all of the questions on their worksheet. There was a consistent association of mathematics with ‘cleverness’, as many of the children felt not only that numeracy was harder than literacy, but that to be clever you had to be good at numeracy. In effect the children were implying that someone who excels in literacy will not be perceived as being clever unless they can display a similar exemplary ability in numeracy. As a result, children who perceived themselves to be weak felt that they would be incapable of solving harder mathematical problems. A girl from the middle-ability group remarked:

> Faye: I’m just going to do a simple answer, which is probably wrong.

While some would say that any answer is better than no answer, Faye’s decision to give up and guess occurred before she had given any real consideration to the question. This example was typical of her low confidence in mathematics; an attitude which I believe greatly misrepresents her ability.

Many of the children showed signs of anxiety whilst attempting the worksheets, shuffling awkwardly in their seats, glancing at their peers with worried expressions and making negative comments about the difficulty of the current task. Previous research into anxiety and mathematics (Hoyles, 1982) indicates that a connection may lie between an individual’s perceived ability and their level of success. The absolute nature of mathematics, where there is normally only one right answer, could add considerably to a negative attitude towards mathematics.

Overall, girls expressed much lower confidence than boys, even among the high achievers. They frequently attributed success and failure to external factors, such as luck and the perceived difficulty of a question. In comparison, most boys recognised that success was due to their own ability, and that failure was caused by either a lack of effort or understanding on their part. Whilst this distinction was not absolute it did apply to the vast majority of pupils that took part in the focus groups. The difference in attitudes towards mathematics between genders has been researched in depth by many, notably Stipek and Gralinski (1991). Although girls and boys are roughly equal in the league tables at GCSE level, there is a remarkable difference in A-level and University uptake. It is quite possible that primary school experiences are alienating girls from the subject, to the detriment of their long term mathematical development. The reason for this is currently unclear and warrants further research, as early childhood experiences could be discouraging many gifted female mathematicians from advanced study.

Difficulties with the language of mathematics

A lack of confidence was not the only cause of problems in the focus groups. Many of the children from the middle and low-ability groups appeared to struggle with the language of mathematics, often expressing nonsensical ideas. The following question and transcripts are taken from the middle-group:

Put the numbers 1-4 in the circles below so that each side adds up to 9.

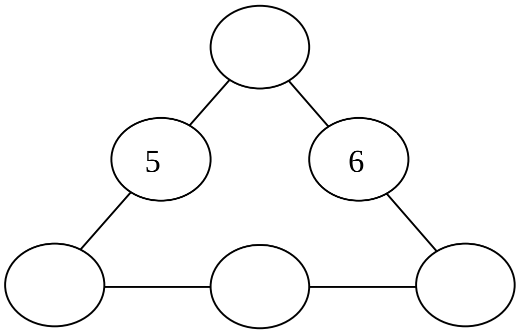

Figure 1 – Problem solving question for the middle group

Harry: 4 add 6 is 9; 4 add 5 is 9. So what's in the middle?

Harry has either forgotten the basic principles of addition and conservation, or he is getting confused with the language. Some children found it difficult to read a question and understand it at the same time, even though all the information that they required was written in front of them:

Faye: Does it have to add up to 9?

Researcher: Each side has to add up to 9.

Faye: Only 9?

Researcher: Yes.

Faye: So what's the biggest number you can go up to?

This was a common problem for Faye. Yet, if the question was read aloud to her, she was able to come up with the answer much faster than her peers. On reflection, she remarked:

Faye: That was only hard because I didn't understand it, but now I do understand it, it's sort of not hard.

Much of Faye's frustration seemed to stem from her failure to consistently and successfully understand questions that she was tasked with, and apply the correct procedures to solve them. This weakness somewhat masked her true ability, as she was clearly a stronger pupil than she first appeared.

Mathematics can appear as a foreign language to many people. It has its own alphabet, comprised of numbers and symbols, and is constructed with a complicated syntax. Just like a foreign language, it is easy to misinterpret. The children in the focus groups showed that they have significant problems translating this language into something useful that they can work with. For some children, it seems that the mathematical processes themselves are not problematic, it is instead a communication issue, and how they are able to interpret mathematical language.

Recent advances in affordable interactive technology for the classroom could go some way to easing this problem, as it enables mathematics to be communicated in new and interesting ways. However, examinations are almost entirely in written a format, which does not bode well for those who find written mathematics difficult to interpret. It would be interesting to see whether there is an increase in attainment when questions are read aloud.

The importance of reflection

The final point that I wish to discuss is the importance of reflection in the learning process. Time constraints were obvious during my visits to the school and several children commented about how they often felt rushed during numeracy lessons. We need to consider how this may hinder their mathematical development.

Educational researchers such as Beth, Piaget and Dubinsky developed ideas about constructivism as a theory of learning (Beth and Piaget 1966) and reflective abstraction (Dubinsky 1991), which may prove useful in determining the best course of action for today's young learners. The theory of reflective abstraction is aimed at older learners, who are engaged in advanced mathematical thinking, but we can take some lessons from this theory and apply it to primary education. It was suggested that reflective abstraction is a key step in understanding advanced mathematics. Before the learner can successfully use a concept, he must reflect and abstract properties from it in such a way that he can internally coordinate it. Then he can manipulate the concept for his own purposes. Older learners can be expected to conduct this process with little outside intervention, but the same cannot be said for primary school pupils. If they are to reflect in a similar way, then they need guidance from the teacher, which is extremely difficult in a rushed environment.

The plenary is effectively the reflection period in the three part lesson. However, many would argue that it is also the weakest section of the current lesson format. It comes at the end of the lesson, so children are more likely to lose interest and be distracted by thoughts about recess or the next activity. If this is the case, then a separate reflection period after the lesson may serve the children better. A separate reflection period would hopefully allow the children to challenge the ideas that they have recently learnt and overcome erroneous concepts. Encouraging reflection at an early age may even have long term benefits by improving children's general attitudes towards learning. Highlighting the links between topics may also help to enhance reflection, as well as creating a wider sense of purpose about mathematics.

Implications

For the researcher

This project has given several indications as to the causes of negative attitudes towards mathematics. The first priority should be to explore the link between children's perceptions of practical mathematical uses. This is an area that has seen little research in the past, but could provide significant insights into how to improve children's perceptions of mathematics. This problem is not restricted to any particular age group (it is displayed by many adults as well), so the scope of the research could be expanded across a much wider age range.

The second priority should be to investigate the differences in attitudes between genders. The difference was already apparent in this year 3 class; it would be interesting to see whether the roots could be traced back to earlier experiences in primary school, or influences from the home or media. Anxiety and difficulties with the language of mathematics are well known problems in the subject. However, it may be wise to reignite these points of discussion in the light of this project. It was clear from the focus groups that these two issues are causing more negativity towards mathematics than any others, and so should be taken very seriously. Deeper research into the origins of these issues could highlight ways to tackle not only the symptoms, but the causes too.

Finally, it may well be worth exploring what impact a separate reflection period would have on children's attitudes towards mathematics, as well as their ability. However, this project would be the hardest to plan and implement, due to restrictions on the school timetable and the impact that it may have on the children's learning.

For the teacher

Undoubtedly, the teacher faces an uphill struggle trying to balance a diverse range of abilities and attitudes, an ever changing curriculum and strict time constraints. However, there are several outcomes of this project that should be considered by the education community. For example, it may be worth exploring how the children perceive mathematics and its uses outside of school. By improving the understanding of the uses of mathematics, pupils will hopefully see the benefits of developing strong mathematical skills for more than just academic purposes. Likewise, low self-belief is an issue that all teachers can attempt to address. We need to dispel the notion that mathematics is a subject limited to geniuses and that children of all abilities can be successful in the subject.

The structure of the lesson and the time constraints of the school day should also be up for revision, as the current lesson format may not be the most efficient. The school curriculum is often subject to repetition, some of which may be avoidable with a subtle shift in lesson structure.

Conclusion

It is clear that children's attitudes towards mathematics can be influenced by a wide variety of factors. This project has gone some way to identifying what a few of these factors might be, but there is still plenty of scope for future research. In particular, children's views on practical uses of mathematics and the difference in attitudes between genders require further study. Additionally, the importance of reflection in primary education needs to be discussed in much greater detail.

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