The challenge of underachievement in mathematics

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Introduction

Unfortunately, underachievement seems to be a widespread phenomenon in mathematics education. And it is not confined to low achievers. However, to lump all underachievers together as if they were one group of learners is to ignore the wide disparities that exist between them. For example, some underachievers, perhaps many, develop avoidance or dependency strategies as a means of coping with their anxiety and negative feelings towards mathematics (Dossel, 1993; Hagg, 1994; Wells, 1994). The present small investigation was undertaken to explore some of the dimensions of underachievement, and to try ways of helping children overcome it.

What I did

This was a small-scale, action research case study involving three 11-year-old boys, two of whom (I shall call them Lindsay and Geoff) were considered by their class teacher to be underachievers in the low achievement category, and a third (Richard - not his real name) who was considered 'average' but also thought to be underachieving.

I worked with these boys for four sessions, one per week, of about 45 minutes each. In the first session I used an open, exploratory investigation requiring the children to design their own school uniforms, fitting them according to their own individual sizes, as a means to diagnosing the children's current mathematical needs. My role during this initial session was primarily to observe the children's strategies and ideas. The following needs were revealed:

Social Learning needs: All three boys had difficulty working co-operatively. Their ideas often conflicted, and they would not value what others in the group were contributing.

Mathematical learning needs:

- Lindsay: Had little perception of size and space, and was not willing to estimate.
- Geoff: Had difficulty with the relationship between centimetres and millimetres.
- Richard: Seemed disinterested, and also had difficulty seeing the link between centimetres and millimetres.

It was obvious that a programme of learning would have to accommodate these varying needs, for instance, enable the boys to move at their own pace. Accordingly, an open and expansive investigation was provided for the next three sessions. I gave the boys the following scenario:

A local Hamilton school has recently been infested with hundreds of mice. The principal called me last night and said that what the school needed was a trap that could catch as many of the mice as possible but be small enough to be inconspicuous so that the children and parents wouldn't really notice it. The boys' task was to help me design a trap for this principle.

Then followed

- a discussion about types of traps, their size, height, shape and so forth,
- the boys making quick sketches of possible trap designs in 3-dimensional style,
- a consideration of likely measurements (which involved estimation),
- drawing nets (flat shaped) of their traps, taking into account the considered measurements, and
- constructing (and, if necessary, subsequently modifying) cardboard models of their trap designs.

I should add that in the midst of these three sessions I made a special effort to value the boys' ideas, and also help them see that there is frequently more than one route to a solution. My monitoring of their developing ideas and strategies was continuous - as it can be when you are working with a group of just three.

How the boys responded

In this part of the paper I highlighted three features of the boys' responses which seemed to me to be significant and which have relevance for teaching. These have to do with avoiding mathematics, meaningful contexts and balance of power between teacher and students.

Avoidance of mathematics

I expected from my reading of the literature that these boys might use various strategies to avoid engaging with the mathematics, so I was very surprised to find that during the course of the four sessions I worked with them, the boys rarely used any tactics to avoid the tasks at hand. It was not until our final session when a problem posed a challenge for the boys that avoidance became clear. When Lindsay was faced with a difficulty he would either begin drawing cartoon sketches, or direct his attention to others in the group, offering them his assistance when clearly they did not need it. At various times of difficulty he also expressed his desire to find the easy way out. This led to a conversation about Lindsay's perceptions of and participation in the

classroom programme.

Vanessa: So, do you like maths in your classroom?

Lindsay: Not really; it's boring and all we ever do is just worksheets and textbook stuff. But I'm in the bottom group, and that's really good.

Vanessa: Why is that?

Lindsay: Well, if I can't do it, I just find one of my brainy friends in the class and get them to do it for me.

Vanessa: And what happens if they can't?

Lindsay: Oh, they usually can 'cause they're brainy at maths, but if they can't I just draw or scribble or pretend I'm doing something else.

This conversation suggested that Lindsay not only used avoidance tactics constantly in his classroom, relying on his peers to do his work for him, but also possessed the symptoms of what Gentile and Manaco (1986) call "learned helplessness". He assumed that he did not have the brains to succeed in mathematics, and that only an elite few (his brainy friends) in the classroom did.

Richard, also a member of the 'bottom' group, displayed no signs of avoidance during the four sessions, yet confirmed that avoidance was the best strategy to use in his classroom, and stated several times that almost everybody in the 'dumb' group did this - "you'd have to be really dumb if you didn't!" he said.

It seemed that these children who had been labelled 'underachievers' had learned that avoidance is the best way to cope with mathematics. Although the boys showed a certain acceptance of belonging to the 'dumb' group I detected them developing negative beliefs about their learning. Given this, we must question whether labelling particular children as 'underachievers' and grouping them accordingly is in their best interests educationally speaking.

In contrast to their stated classroom methods of coping with mathematics, Lindsay and Richard very rarely felt the need to avoid the mathematics during our weekly sessions. Nor did they feel negative towards the investigative work we were undertaking. Indeed they would frequently comment on how enjoyable the activity was. So why was it that these boys who said they constantly avoided mathematics in their classroom environment remain largely engaged in the problem-solving activities during this study? There are two possible explanations, which I explore in the next two sections.

Meaningful contexts matter

At times during the four sessions of this study the three boys commented on the structured nature of their classroom mathematics programme and how the diet of facts, figures and formulas made little sense and held almost no relevance for them. It seems to be the case that traditional methods of teaching mathematics pressure children to

memorise strategies and concepts far removed from reality and alien to their natural world. Children who find themselves in this situation often find mathematics too abstract, too irrelevant, a subject that only an elite few can master, and they experience debilitating feelings of apprehension, lack of control and helplessness (Dossel, 1993; Gentile and Monaco, 1986; Glasser, 1986; Tobias, 1995).

In contrast, learning is more effective when children are immersed in a natural, spontaneous environment (Tizard, 1985). Providing open, expansive mathematical problems within a rich context not only presents children with a purpose for their learning, but also acts as a powerful motivator, evoking natural curiosity. Learning mathematics in this way becomes meaningful and spontaneous (Dossel, 1993).

When I presented the boys with the seemingly real issues of designing their own school clothing and a mousetrap and making them the ultimate problem-solvers, they saw themselves shifting into a new and dynamic role. They were no longer the memorisers of facts and formulae but the active solvers of real life issues. The transition enabled them to perceive a purpose for their learning. Furthermore they did not see themselves as 'underachievers' belonging to a 'dumb' group but felt they were individuals with unique ideas and creativity that could be applied to the tasks at hand. They were aware that the activities were often challenging, but their enthusiasm prevented them from giving up altogether.

In my role as teacher I was further able to work with the unique needs of each child, attempting to lift their individual understandings. It is easy to assume that 'underachievers' collectively possess identical needs, but all children differ in their thoughts and needs. It seems important to use interesting, meaningful and mathematically rich investigations to cater for the individuals that children are.

A balance of power

Power relations between teacher and learner contribute to the way children perceive mathematics (Tobias, 1995). An authoritative teacher imparting mathematics as a fixed, preordained body of knowledge usually results in children believing that mathematics is primarily about knowing the concepts and procedures delivered by the dominant, authoritative figure (Hagg, 1994; Wells, 1994; Winograd, 1991). Consider the following conversation with Lindsay:

Lindsay: Maths is really boring ... I can never get it.
Vanessa: What can't you get?
Lindsay: I don't know ... the whole thing.
Vanessa: What do you mean?
Lindsay: I mean the brainy kids know what to do, and they always get it right.
Vanessa: What happens if you don't get it right?
Lindsay: Oh, I just give up.

Clearly, Lindsay has come to see mathematics as getting the right answer by the correct method, and when he can't he goes into survival mode.

During the four sessions I spent with the boys I found it interesting that they would frequently ask whether their procedures and strategies were correct. "Is this right?" was perhaps the most common question asked during the sessions by all children.

By deconstructing the power relationships between myself and the learners, emphasising the value of their ideas and strategies, the boys began to see many routes to a solution. Lindsay, who had earlier said that mathematics is about "getting it right" became less concerned about the 'right' answer and more focussed on the task of designing an effective mousetrap. The outcome was an observable lift in the intellectual thinking of the boys.

Conclusion

This study has revealed perhaps three things: (i) several barriers to learning in mathematics experienced by at least some children who are labelled 'underachievers', (ii) the effects that the barriers have on children, and some of the strategies they use to survive in the classroom, and (iii) how such children might be helped to develop their mathematical potential. As Dossell (1993) has stressed, mathematics taught in a traditional transmission-type way seems like a system of authoritarian rules which are difficult to understand. Not knowing the rules results in a feeling of lack of control which in turn creates anxiety. As educators we must consider our roles and the detrimental effects that inappropriate roles can have on learners (Young-Loveridge, 1994). What seems to be required is a mathematics curriculum that offers all children the opportunity to investigate open, meaningful problems in their individual ways. The classroom environment needs to be safe and encouraging, children's ideas and strategies need to be valued, and children need to have a sense of control over their own learning.

Depending on the prior experiences of our children, and our own beliefs as teachers, this may be something we have to work towards gradually rather than something that can be achieved overnight.

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