Further reading

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Effective communication in mathematics

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AIM

To examine the way language is used in mathematics and to help students improve their understanding of maths by giving them the confidence to express themselves in mathematical language.

SUMMARY OF FINDINGS FOR THIS CASE STUDY

✶ When students are communicating effectively in maths they state and restate the problem they are working on, make observations and state theories about the mathematical problem, vocalise the arithmetical workings they engage in, challenge others' observations and theories and answer others' challenges and show when they feel uncertain about the solution to a problem.

✶ Whole-class discussions enable students to learn new vocabulary and become confident users of the new words or phrases.

✶ Group work lessons help students explain, develop and name mathematical theories.

✶ Students should be encouraged to make observations about mathematical patterns.

✶ It is important to have a learning environment that encourages students to challenge their own theories.

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Introduction

Language often gets in the way of students learning maths. Is it the way mathematical language is used? How can teachers help their students make sense of it? Students do find difficulty communicating in maths, but talking about maths helps them remember and use mathematical ideas. What can teachers do that will help students to communicate effectively in mathematical language?

Strategies for generating the use of mathematical language

The research demonstrated the value of using group-work lessons when teaching maths. The students engaged in mathematical discussions that stimulated their thinking and enabled them to come to an understanding of concepts as they worked as part of a group. Among the students' comments on the group-work setting were, "You can share your ideas," "It helps you get on with your work when you're working with friends," and "In groups you get a lot more ideas than you would on your own. Everyone's got a different opinion."

The research also showed that whole-class discussion lessons that were aimed at helping students to learn vocabulary and ways of talking in maths could be useful. One student said, "It was more entertaining and helps me learn." But such lessons must be treated with caution. As one student put it, "When the teacher is working on the board you sometimes have to stop while the concept is explained to everyone else."

"Individualised work schemes do not appear to stimulate discussion, and students find it hard to remember and articulate the work they do from these schemes."

Finding things out for yourself is often regarded as the best way to learn, but the research sounds a warning note here. Individualised work schemes do not appear to stimulate discussion, and students find it hard to remember and articulate the work they do from these schemes. The more students are put in a position where they have to talk about their work, the better they remember it and the better they can explain what they have been learning.

What forms of language enhance mathematical understanding?

I felt that if I thought about an effective conversation I could use this to help students to develop their mathematical ideas. By identifying the patterns of speech in a good conversation, mathematically speaking, this would allow me to develop teaching strategies.

The research identified five components of mathematical conversations that were seen to enhance students' understanding:

- *stating and restating the problem or task – this enabled the whole group to know and endorse the direction in which the work was heading;*
- *observations and theories about the mathematical patterns present in the problem – the more students studied the numerical patterns in the problems, the quicker they reached a solution and the more they came to know about the underlying concepts. Some students did not realise they could state reasoned theories about these patterns. Perhaps they had not known how to express these patterns in words;*
- *working out arithmetic aloud – this served the dual purpose of allowing the group to know what one of its members was doing and allowed it to check the answer;*
- *challenging others' observations and providing answers when challenged – this could be done only when members of the group were listening well to one another, and it was this skill that seemed most effective in enhancing students' understanding. If they could understand someone else's theories enough to say why that theory might not work, the group was interacting in the way that is thought to give access to reasoning that individuals might not otherwise engage in. This is called "scaffolding";*
- *stating their uncertainties – this worked in a similar manner to challenging others' observations; it promoted greater clarity in the thinking and verbalisation of those engaged in working in the groups.*

These five categories seemed to be part of all of the conversations recorded that were effective in developing mathematical concepts.

The implications for teaching

Students of all abilities appear to engage happily in discussions in maths lessons, but some discussions are more successful than others. If the discussion is not progressing well it could be that the students are not well versed in maths discussion skills. Students often do not know that they must focus on the numerical patterns in the problems that have been posed. Some appear to guess at an answer that has little relation to the problem in front of them, which means they need practice in studying a mathematical problem and making an observation. The students need to know what a good observation might look like so they can feel confident in expressing their own thoughts out loud.

"The skill that was lacking in effective conversations was answering others' observations. Some students simply voiced a theory without expecting it to be taken up, tried out and then improved."

The skill that was most lacking in ineffective conversations was answering others' observations. Some students simply voiced a theory without expecting it to be taken up, tried out and then improved. So students need lessons where they work with a critical friend to make observations and then challenge one another to make the theory as clear as it can be. They need to focus on how to challenge without being disparaging and how to answer to clarify the matter. These skills can be practised as part of any lesson. Creating an environment where mathematical discussion is a skill to be learned and valued by the students appears to foster good learning.

It must not be forgotten that maths can be considered as a language, and sometimes the students feel their teacher is not speaking English. Students must be helped to understand mathematicians' language. Sometimes it is necessary to adopt the role of a foreign language teacher to teach the students a mathematical concept and new words or phrases. In the end, students can have access to the mathematicians' world.

There are implications here for further research to evaluate the use of these strategies, singly or in combination, to develop mathematical understanding. Getting students talking effectively means they remember the work and should mean that they can apply the concepts they learn in other situations.

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