

THE ROLE OF LANGUAGE IN TEACHING AND LEARNING MATHEMATICS

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Introduction

The capability to ‘talk about’ mathematics is of importance for all teachers and learners of mathematics. Language and communication are essential elements of teaching and learning mathematics as it facilitates the transmission of mathematical knowledge and allows for teacher-student interactions. Language permits mathematics learners to work out meanings, to convey their understanding, it helps develop their thinking further and to express their answers with others. For mathematical learners language is twofold in that they are required to have competence in the language of instruction and in the language of mathematics (the mathematics register). The significant role of language in education and learning cannot be ignored. The teaching and learning of mathematics includes oral language (listening and discussing) as well as a written form (reading and writing). It is important that teachers of mathematics are aware of and can incorporate language aspects into the teaching of the subject.

The Mathematics Register

We consider mathematical language as a distinct ‘register’ within a natural language e.g. Gaelge or English, which is described as “a set of meanings that is appropriate to a particular function of language, together with the words and structures which express these meanings.” (Halliday, 1975, p.65). One aspect of the mathematics register consists of the special vocabulary used in mathematics and it is the language specific to a particular situation type. But it is more than just vocabulary and technical terms. It also contains words, phrases and methods of arguing within a given situation, conveyed through the use of natural language (Pimm, 1987). The grammar and vocabulary of the

specialist language are not a matter of style but rather methods for expressing very diverse things. *Each* language will have its own distinct mathematics register and ways in which mathematical meaning is expressed in that language. For example, the mathematics register in English is different to the mathematics register in Gaelge.

Mathematical Language

Within the mathematics register different forms of mathematical language can be found, as demonstrated in Figure 1 (Meaney, 2005).

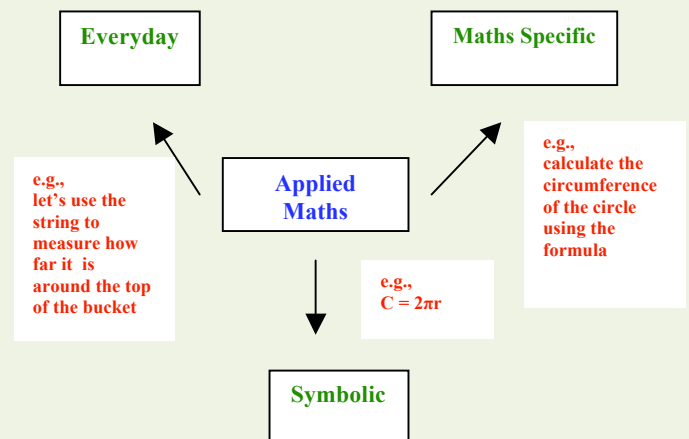


Figure 1 The different types of mathematical language in the mathematics register

This reinforces the view that the content of mathematics is not taught without language. The process of learning mathematics involves the mastery of the mathematics register. This allows students to communicate their mathematical findings in a suitable manner but without this fluency, students are restricted in the ways that they can develop or redefine their mathematical understandings. By developing a student’s mathematical register it provides them with analytical, descriptive and problem solving skills within a language and a structure so that they can

explain a wide range of experiences. Once the register is mastered, learners will have the ability to listen, question and discuss, together with an ability to read and record.

Language features of concern

As is evident from the previous section, mathematics is not “language free” and due to its particular vocabulary, syntax and discourse it can cause problems for students learning it. Some of the language features that may impede mathematical learning are discussed.

Borrowed Words/ Ambiguous Terms

A key issue that causes significant problems for learners is the number of ‘borrowed’ words from everyday English (Pimm, 1987). These words tend to be ambiguous due to having one meaning in the mathematics register, while another meaning in its everyday use. The non-mathematical meanings of these terms can influence mathematical understanding, as well as being a source of confusion. Examples include:

above, angle, as great as, average, base, below, between, circular, collection, common, complete, coordinates, degree, difference, different, differentiation, divide, down, element, even, expand, face, figure, form, grid, high, improper, integration, leaves, left, little, low, make, mean, model, natural, odd, one, operation, parallel, path, place, point, power, product, proper, property, radical, real, record, reflection, relation, remainder, right, root, row, same, sign, similar, square, table, tangent, times, top, union, up, value, volume

Also, research found that:

- Conditions (if, when);
- Comparatives (greater than, the most);
- Negatives (not, without);
- Inference (should, could, because, since);
- Low information pronouns (it, something);
- Lengthy passages

are sources of difficulty and hinder students’ interpretation and understanding of mathematical word problems (Durkin & Shire, 1991).

Specialist Terms

The use of specialist terms can lead to misunderstanding and misinterpretation of mathematical tasks. Students tend to only encounter these terms within the mathematics classroom (for example, “quadrilateral”, “parallelogram” and “hypotenuse”) and they are unlikely to be reinforced outside of it (Pimm, 1987). If learners do not acquire their correct meaning then this can lead to difficulties.

Context

Context is also a key issue. Words can change their meaning depending on their context within the mathematics lesson. Due to the multiple meanings that various words can have, the context is vital in determining the correct interpretation

Symbolism

Symbolism is one of the most distinctive features of mathematics. Mathematical learning requires students to interpret the mathematical text and convert it to an appropriate symbolic representation, and perform mathematical operations with these symbols. Symbols provide structure, allow manipulation, and provide for reflection on the task completed.

Language use in a maths lesson

When using mathematical language, students and teachers not only use everyday English but also symbols (e.g. $<$, $>$, $=$, \pm , \div , \times , λ , \sum , ∞) and highly specialised mathematical language (e.g. hypotenuse, triangle, simultaneous equations, differentiation, etc.). Students use language in a multitude of ways in mathematics lessons. The phrasing of mathematical questions often places a large language demand on students and there are few language clues to help students interpret the questions. Students are then required to solve the problem (using symbols) and clarify

their answers in the context of the original problem. Students need competence in using mathematical vocabulary to explain their efforts to others, to ask or answer questions, and when working in groups. Research has shown that when teachers do not use mathematical language fluently, their students are unable to describe mathematical ideas and concepts using appropriate language.

How can I use this in the classroom?

There are a number of ways in which teachers can incorporate and facilitate the teaching of the language of mathematics in their lessons. Mathematics teachers first need to acknowledge and recognise the importance of language for mathematics teaching and learning, only then can they convey this to their students. A number of activities that can be incorporated into regular mathematics pedagogy are outlined in the following sections.

'Just a Minute' (NCETM)

This is a great activity that you can incorporate into any mathematics lesson, with students of any age. Create laminated cards with specific mathematics vocabulary (relevant to the year group being taught) written on each. Divide the class into groups (4-5 students) and give each group a set of cards. Assign one student from each group to start the task. They describe the word(s) on the card without actually saying them. The group has to guess the word from the information that the describer is providing. The group guesses words for a minute, then the describer collects the words they guessed, counts them and places them aside. Another member of the group becomes the new 'describer' for a minute and this rotates until all students in each group have experienced being a describer. Students can get very competitive and really enjoy the game. It is an excellent way for students to learn and remember mathematics vocabulary. Also, through having to explain the concepts

underpinning the vocabulary it can lead to a better understanding.

The Language of Mathematics

This activity provides mathematics teachers with the opportunity of examining their students' understanding and use of the three types of mathematical language – Mathematics Specific, Everyday Language and Symbolic. The task requires the teacher to provide their students with a list of words (e.g. more, equal, degree, multiply, sum, denominator, product) and ask students to (1) make a statement in Everyday Language, (2) make a statement in Mathematics Specific language, and (3) to give a symbolic/pictorial representation of each word. A combination of any of the 3 can be used also. For example, you can provide students with a list of composite words (e.g. prime number, simultaneous equation) which only have a meaning in mathematics (2) and ask them to describe them and to provide a symbolic/diagrammatic representation (3). This task can alert a teacher to the confusion some students may encounter with the mathematics register.

Encouraging Discussion (NCETM)

The need for mathematics learners to engage in communicative activities is essential if mathematical language is to be developed. Teachers and students need to be encouraged to discuss, to share and to question mathematical concepts. Encouraging good discussion will be relatively new to most students in your mathematics class, and perhaps for you as a teacher. It will take time to foster and persuade your students to engage in this activity and therefore it is essential to slowly begin introducing discussion into your mathematics lessons until the students become comfortable 'talking about' mathematics. By getting students to talk in pairs is a great way of beginning this process. Discussion will usually be generated in response to an answer and therefore provide your students with the guidelines that they have to:

- Explain their thinking and write the explanations,
- Convince their partner, and
- Ask their partner to convince them.

In order for this activity to be successful, mathematics teachers need to replicate similar practices to encourage conversation in their lessons. Phrases that can be used include ‘Convince me...’; ‘How would you convince another student that...’ and ‘Explain why you think that...’. This approach should help improve the quality of mathematical talk within the classroom, as well the benefits for the teacher and student learning.

One kind of activity that works best for generating discussion is those that reflect on common generalisations within mathematics. For example take the statement: ‘**11a > 11** If you multiply 11 by a number, the answer will be greater than 11’. Divide the students into groups and ask them to discuss this statement under the headings ‘always true, sometimes true or never true’ with a requirement that they provide a justification and explanation of their understanding of the statement provided. The mathematics teacher can generate a statement like the example given related to whatever topic is being covered in the classroom at a particular time. There are many examples available on the Cambridge University’s NRIC website (www.nrich.maths.org) which has examples suitable for different ages and levels of ability.

Poster Presentations

This is such a simple activity that can be used to generate awareness about mathematical language as the students have to communicate mathematically in order to create the poster (especially if organised in groups). The students will have to develop precise language in order to express themselves and so as that others can understand what they are displaying. Students can then be encouraged to present their posters to the class and the teacher can create a display area for the work

completed. It serves as an alternative form to assessment, while generating understanding in relation to a particular topic. The topics chosen can be specific to material being taught presently in a lesson or on the development and use of mathematical symbols such as ∞ , \sum , and \prod . This type of task will help develop their understanding as well as their ability to communicate mathematically.

Mathematical Dictionary

This is a great method for students to keep record of the new mathematical terms they encounter throughout their schooling. The dictionary of mathematical terms allows students to explain the terms in mathematics language but also in simple language so as to help their understanding. Students should also be encouraged to draw diagrams/symbols to help their understanding. This provides students with a guide for when they are working on problems at home or when they are unwilling to ask a teacher/other student. Examples of mathematical dictionaries are available at the websites provided below.

Useful websites

- Cambridge University’s mathematics NRIC website www.nrich.maths.org
- Mathematics Dictionaries:
www.amathsdictionaryforkids.com
www.free-maths-dictionary.com
- National Centre for Excellence in the Teaching of Mathematics (NCETM):
www.ncetm.org.uk

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