FaSMEd

Raising Achievement through Formative Assessment in Science and Mathematics Education

Algebraic expressions

Subject:	Mathematics
Age of students:	13 - 14 years
Hardware:	iPads and IWB
Software:	Nearpod
Functionalities:	Sending and Displaying
Time:	1 hour
FaSMEd partner:	University of Nottingham
Short Abstract:	The lesson focused on developing students' understanding of simple algebraic expressions through connections to the areas of rectangular shapes.

1. Content

In the lesson, students were expected to apply and extend their prior knowledge of algebra in order to write appropriate algebraic expressions for the areas of rectangular shapes. The purpose of the lesson was for students to improve their understanding of simple algebraic expressions (of the type and complexity indicated by the examples) using connections to area (of simple and compound rectangular shapes) to provide meaning for the algebra, to aid understanding and to demonstrate equivalencies.

Students were expected have some prior understanding of algebraic expressions involving those with several terms, a single variable and numerical coefficients. They were expected to understand the normal conventions for writing operations such as adding, subtracting, multiplying, dividing and 'squaring' in algebraic form, including the use of brackets. Students also needed to know how to calculate the areas of rectangles and squares. During the lesson there were opportunities to address misconceptions and develop deeper conceptual understanding, as well as extend students' knowledge of common conventions in writing algebraic expressions.

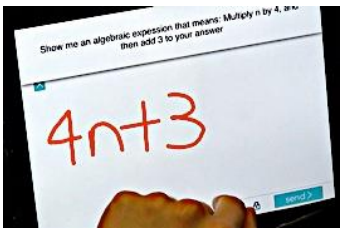
1.1 Aims

The aims of the lesson were:

- To enable students to apply their knowledge of algebra to questions involving other mathematical concepts;
- To extend students' understanding of the meaning of a range of algebraic expressions using connections to area;
- To develop students' understanding and use of common conventions when writing algebraic expressions;
- To extend students' ability to identify equivalent algebraic expressions.

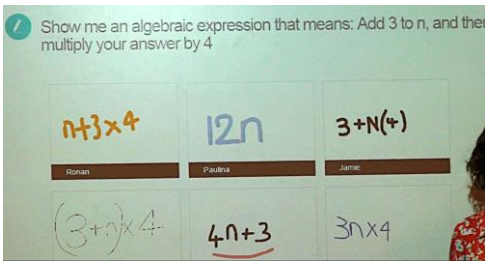
1.2 Structure / Methodology

The lesson was based on a task developed at the University of Nottingham as part of a Mathematics Assessment Project[1]. Students first had to write algebraic expressions to match descriptions of expressions in mathematical language (e.g. write an expression for the following: add 5 to *n* and then multiply the answer by 4). Two teachers planned this activity as a pre-lesson diagnostic task and one used the tasks during the first part of the lesson for a similar purpose. When used in the lesson, questions such as the one below were sent electronically for students to complete on their iPads. Similar questions were used for the pre-lesson task.



[1] http://map.mathshell.org/download.php?fileid=1726

The 'in-lesson' assessment involved students then sending in their individual solutions to the teacher who displayed a full set of student responses on the interactive whiteboard (IWB). The teacher selected one or more responses each time and asked questions to expose and discuss common misconceptions. For example, the responses displayed here were in response to the question "Show me an algebraic expression that means: Add 3 to n then multiply your answer by 4". Pre-lesson assessments also led to some teacher-led class discussion and explanations to expose common misconceptions identified from the diagnostic work.



In the second part of the lesson a similar method of sending questions and sharing responses was used by all the teachers but students were provided with a diagram of a rectangle, square or composite shape with a combination of algebra and numbers to indicate the length of each side. Students were asked to write down an algebraic expression for the area.

The software *NearPod*[2] was used to perform the 'send and share' function, transferring questions to students and student responses to the teacher.

1.3 Technology

In this lesson the *NearPod* program, used on iPads, performed a 'send and display' function that allowed teachers to send questions to students, receive their responses, view these responses simultaneously and display the array of responses on the IWB. The teachers were able to draw the attention of the class to certain responses for students to assess, compare, comment and discuss. In this way the technology provided timely and accessible information for teachers that could be used in a formative assessment process.

Although there was the potential with the *NearPod* software to help teachers expose and address common misconceptions, the effectiveness was however dependent on decisions made by the teacher on the choice of student work for discussion and the questions posed. The technology acted as a facilitator in the formative assessment process but the teachers' skills were essential for effective completion.

There were issues however about the delays when answers were sent by students and also a lack of flexibility that meant students were unable to change an answer once it was sent, even if their thinking changed as a result of a continuing discussion with peers and/or self reflection. Students became passive and disengaged when they had sent a response and had

[2] https://www.NearPod.com. NearPod is a simple lesson planning application. Pages are created in an 'editor' by the teacher and all the activities are constructed prior to the lesson. The lesson is started by the teacher and the pupils 'join' the class using a class code.

to wait for others before any class discussion commenced. For other students, class discussion sometimes started before they had completed and submitted their answer. This presents a dilemma and a pedagogical challenge when an application such as *NearPod* is used to send short questions one at a time with delays before discussion. This particular software and use of technology seemed to disadvantage both high and low attaining students to some extent, which needed to be balanced against the benefits identified.

In this lesson, *NearPod* was used as a tool to facilitate a particular teacher-focused formative assessment process. There were clear benefits from the 'send and share' function that increased the speed of communication and the accessibility of data from a teacher perspective but the processing and interpretation of this data was carried out by the teacher. A similar function might be achievable without iPads (e.g. using a visualizer to display written samples of student work) but without the benefits of simultaneous display and speed that this approach provided.

1.4 Aspects of Formative Assessment

The main type of formative assessment planned into the lesson involved the eliciting and discussion of student misconceptions, using the *NearPod* app on the iPads to send questions to students, receive their responses and view their work. This enabled the teachers to view all the students' responses simultaneously, display these for the whole class to see and select examples for whole class discussion.

Through this process the teacher gained an overview of students' thinking and could, theoretically, adapt his/her questioning to stimulate and focus class discussion on those misconceptions. In practice, the teachers found that so many misconceptions were simultaneously presented that this task proved far from straightforward. The range of student responses evidenced in these lessons revealed that students were starting from a less informed position than had been assumed by the teachers in their planning. Although these students' responses could, potentially, be used diagnostically to help establish where they were and identify misconceptions, this was not easy from such a varied range of responses. The teachers had a difficult task selecting suitable student work to discuss and in posing appropriate questions for discussion that could deal with multiple misconceptions and move students' thinking forward.

In addition, only a few students were able to provide coherent or accurate explanations of their work when questioned verbally in the whole class discussion, so opportunities for students to become instructional resources for others were also limited. Although there was an intention to engage students in critical appraisal, of solutions and methods, the mismatch between the lesson content and the prior knowledge of students presented problems with this strategy. As a result, whole class discussions often involved more instruction from the teacher than explanations from students.

A second type of formative assessment process also took place however when samples of student work were displayed. There was evidence from the lesson observations that some students carefully compared their own answers to those displayed from their peers, engaging in a mixed process of peer assessment and self-reflection that led to adjustments in their thinking and understanding. The display of students work enabled students to better understand the criteria for success and how to move forward but through a process involving them in individual reflection rather than discussion.

Nested within the teacher-led formative assessment process of question, answer, display and discussion were opportunities for additional formative assessment by students and their peers. During individual work on the questions, before students submitted their responses, they often worked collaboratively, comparing and discussing how to work out their answers. The amount of discussion varied between the three classes but there was evidence of students acting as assessors and instructors for their peers that sometimes led to changes in thinking and understanding. This strategy also helped students take more ownership of their own learning rather than being dependent on instruction from their teacher.

In the implementation of this lesson plan there were some tensions between the sort of classroom culture in which collaboration and discussion were valued, which the teachers were trying to create, and the prevailing school environment in which quietness and order were seen as important. For the planned formative assessment strategies to be effective there needed to be a culture in which students could express opinions, make mistakes, collaborate and discuss. The school culture therefore presented an obstacle in this case to the formative assessment that the teachers wished to explore.

Within the formative assessment strategies described above, feedback was an intrinsic part of the processes. During the lesson students received feedback on their work from both their teacher and their peers. The whole class discussions were intended to provide a forum for the students to explain and comment on samples of work from their peers. Although some students did receive feedback during this activity, because their work was selected for display and discussion, the quality of the comments from their peers was often not sufficient to move students' thinking forward. The wide range of misconceptions also made it difficult to provide feedback that would be useful to students with diverse difficulties. As a result, the teachers added further comments and frequently acted as instructors in these discussions rather than enabling students to be instructional resources for each other. This general instructional feedback from the teacher became the dominant feature of the whole class discussions although the planned purpose was for students to provide feedback to each other.

Whilst students were working on the questions, however, they did provide some feedback to each other in pairs or small groups. This contributed to processes of peer assessment and self-reflection that resulted in some adjustments to students' thinking and had, therefore a useful function within a formative assessment process.

2. Further Information

The teachers identified the value of the 'send and display' function of the *Nearpod* program in this lesson since this allowed them to see all the students' responses in a single array and display this on the IWB for use in whole class discussion. The difficulty was deciding which responses to select and what questions to pose to facilitate an effective discussion so that the multiple misconceptions could be dealt with and students' thinking could move forward.

The students in this case also identified some clear benefits in using the iPads and *NearPod.* For example, students could see how being able to display answers from all the class simultaneously on the IWB helped them to compare answers and methods. They saw this as a way of learning from their mistakes and identifying where they had gone wrong as well as understanding alternative methods. Students valued this visibility and transparency,

suggesting that this helped them learn from each other in a more collaborative and open learning environment.

The accessibility of student work through visual display on the IWB helped students' opinions and thinking become more central to discussions, thereby changing the nature of the lesson. The focus on student work, with opportunities for self and peer-assessment contributed to what students referred to as a "new way of learning" that clearly contrasted with their normal way of working in class and may take some time to establish for groups used to a more instructional approach.

3. References

Information on Nearpod available at https://www.NearPod.com.

MAP lesson available at http://map.mathshell.org/download.php?fileid=1726

Black, P., & Wiliam, D. (1998). Assessment and classroom learning. *Assessment in education*, 5(1), 7-74.

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Wiliam, D. (1999). Formative assessment in mathematics Part 2: feedback. *Equals: Mathematics and Special Educational Needs*, *5*(3), 8-11.