Noticing language and communication in mathematics lessons

This framework aims to provide a structure to support discussions about language-responsive mathematics teaching through peer observations and conversations. These observations focus on what is noticed in the lessons structured around 4 key dimensions:

- the linguistic demands of the mathematics;
- making connections;
- student reasoning, explanations and argumentation;
- listening and feedback.

It is important that these conversations focus on what was noticed during a lesson or activity. They may only draw on one dimension or a combination of dimensions. The conversations are not about what was missing or what could have happened. Focusing on what is noticed can develop our understanding of the nature of language in our teaching and its role in students' learning while also helping to avoid judgments about the teaching observed.

Linguistic demands of the mathematics

Language and communication in mathematics lessons can consist of words, images, diagrams, notations and other ways of communicating about mathematical objects, ideas, and practices.

For example, naming or labelling features of a diagram can be done using words, labels, notations, colours.... When names are attached to something mathematical, whether that is an object such as a number or angle, a relationship such as parallel or equal, or a process such as conjecturing or generalising, these names can be used to communicate about that object, relationship or process. Naming can also emphasise the importance of a particular action or object; for example, naming auxiliary lines highlights them as something mathematicians may use in a geometric image to work with that image.

The choice of the words we use in teaching can also influence the meaning that is being emphasised. For example, we can describe $\frac{2}{3}$ as two thirds, two out of three, two divided by three, two over three. Each of these conveys a different meaning, which may be more useful in some contexts than others. Two thirds emphasises the fractional structure, two of these things we call thirds, as well as the number it represents. Two out of three may be more useful in probability contexts where it emphasises the number of successful outcomes out of the total number of outcomes. Two divided by three emphasises the process involved, for example when converting to a decimal or when sharing or grouping. Two over three emphasises how we write this fraction.

When focusing on this dimension what is noticed may focus on what the teacher says or write, or what the students say or write, or a combination of these

Student reasoning, explanations and argumentation

Reasoning, explanations and argumentation demand particular structures in mathematics that makes them distinct from explanations and arguments in other subjects. They may involve using definitions, being precise, working deductively, identifying and describing patterns and structures, as well as drawing a conclusion. Even explanations or arguments that draw a false conclusion contain mathematical features such as making a conjecture, making a connection between the problem and a previous problem, using mathematical notation or terms, comparing different solutions or solution strategies ...

Noticing these mathematical features can help students make sense of what a mathematical argument or explanation is, and to identify how they can improve their own explanations or arguments.

It can take time to construct and articulate an explanation or argument.

Listening and feedback

Listening can take different forms and can have different roles in mathematics lessons. Teachers listen to their students, students listen to their teacher, and students listen to each other. There is a difference between listening *for* something in particular (a specific answer to a question) and listening to something. Another distinction can also be made between listening to something in order to evaluate or interpret it (i.e. to understand what students are thinking), and listening to something in order to make connections to other ideas, descriptions and also to develop a teacher's own understanding of the mathematical learning.

It can be very hard to 'see' listening. Listening for something can be seen when mathematically correct responses are given by students but are not used because they do not fit with the particular focus of the task, discussion or lesson. Teachers often notice they are listening for something when they get an answer and are confronted with a thought such as "that was what I was looking for", or "that's not what I was expecting" – it is the sense of expectation that is often associated with listening for something. Listening to something can sometimes be seen through what follows. Are the same words used, are questions asked about what was said whether these questions are for clarification or to develop an idea etc further.

Making connections

Making connections is a key part of teaching and learning mathematics, but there are many different types of connection that could be made (and not all of them are mathematical). Connections that relate to communicating mathematics include between representations, between families of words, between informal ways of describing mathematics and more technical ways, as well as connections between ideas, tasks, methods, or processes. Making connections involves more than experiencing two solution methods, two different representations, two examples alongside each other as it needs the similarities between these to be noticed.

These connections can be made by the teacher and/or the students, and they can also be articulated by the teacher and/ or the students.

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Linguistic Demands of the Mathematics	Student reasoning, explanations and argumentation
The teacher and/or students: draw attention to the language and notation related to the key concepts in the lesson use language that helps build mathematical meaning have the opportunity to speak or write using mathematical language themselves communicate using the language associated with the key concepts *mathematical language here includes notation and representations*	Students have opportunities to give explanations, share their reasoning and/or build arguments Student reasoning focuses on the key mathematical ideas in the lesson The teacher or students draw attention to the mathematical features of an explanation, justification, or argument Students have opportunities to develop and improve the mathematical quality of their explanations
Listening and feedback	**Making connections**
Students are given time to think about their explanations and to articulate them Student ideas and explanations are listened to (including by other students) Feedback on explanations and justifications focuses on the quality of the mathematics. Student ideas, explanations and justifications are built upon or elaborated.	*The teacher and/or students:* make connections between families of words make connections between different representations (symbolic, graphical, diagrammatic, verbal…) make connections between languages (including between more informal and more technical language) make connections between ideas, methods and/or processes

Student Activities (underline or circle those you notice students doing)

Abstracting	Contrasting	Exemplifying	Justifying	Refuting	Thinking
Applying	Convincing	Explaining	Listening	Rehearsing	Transforming
Choosing	Creating	Foregrounding	Naming	Relating	Undoing
Clarifying	Deciding	Generalising	Operating	Reporting	Varying
Classifying	Deducing	Identifying	Proving	Representing	Verifying
Comparing	Defining	Imagining	Reading	Simplifying	Visualising
Conjecturing	Describing	Interpreting	Reasoning	Speaking	Writing
Connecting	Drawing	Inversing	Refining	Specifying	

Lesson notes

Activities		
	Linguistic Demands	
	Listening and feedback	
	Student reasoning	
	Making connections	
	Linguistic Demands	
	Listening and feedback	
	Student reasoning	
	Making connections	
	Linguistic Demands	
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	Linguistic Demands	
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