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► **To cite this version:**

Jenni Ingram. Goals, decisions and responsiveness: Prioritising complexities in interaction. Thirteenth Congress of the European Society for Research in Mathematics Education (CERME13), Alfréd Rényi Institute of Mathematics; Eötvös Loránd University of Budapest, Jul 2023, Budapest, Hungary. hal-04393053

HAL Id: hal-04393053

<https://hal.science/hal-04393053v1>

Submitted on 14 Jan 2024

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Goals, decisions and responsiveness: Prioritising complexities in interaction

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Mathematics teaching is highly complex and this complexity is clearly visible in classroom interactions. These interactions involve multiple goals, including those specific to mathematics learning, but they also involve moment-to-moment decision-making by teachers that are influenced by social and mathematical norms of interaction within the classroom, as well as teachers' knowledge, beliefs and values. As a field we are seeing a shift towards more large-scale studies of mathematics classroom interaction. These studies focus on which interactional practices are supportive of mathematics learning but there is a challenge in considering interactional strategies that are highly valued but are also highly contingent upon the interactional context in which they occur, such as responsiveness to students' thinking. This challenge is illustrated through an extract from an interaction around reflecting shapes where different interactional strategies are in tension.

Keywords: Classroom interaction, responsiveness, patterns and generalisations.

Introduction

In recent years, studies focusing on measuring features of classroom interaction at scale have been increasing (Bell et al., 2020; Ing et al., 2015; Ingram et al., 2020; Neugebauer & Prediger, 2022). These studies have drawn on a range of smaller qualitative studies of mathematics classroom interactions that have identified and illustrated particular features, strategies, or difficulties that influence students' learning within the local context of the interaction itself (e.g., Bishop et al., 2022; Ingram, 2021). However, many of these features of interactions have been found to be rare in everyday classrooms (e.g., Bell et al., 2020; Ingram et al., 2020) though they are often more visible in observations resulting from professional development interventions (e.g., Michaels & O'Connor, 2015; Neugebauer & Prediger, 2022). These larger-scale studies have varied in how they have measured common interactional features such as questioning, as well as the extent to which they have included rarer but highly valued features such as responsiveness to students' mathematical thinking. However, these studies have illustrated the challenge of measuring strategies whose effectiveness and purpose as identified and illustrated in the smaller qualitative studies are locally contingent upon the context and purpose of the interaction itself.

Many of the recent case studies and illustrations of mathematics classroom interactions have also shown that some of the interactional features associated with supporting mathematics learning do not always have this impact depending upon the context and purpose of the interaction. Large-scale studies including a focus on interaction measure the quantity of particular features or strategies during a lesson, or quantitatively analyse the relationships between these features and strategies and particular student outcomes. However, these analyses do not take into account the contingent nature of some of these features or their role in supporting learning. For example, responsiveness to students' mathematical thinking is contingent upon the content and communication of students' thinking in the

moment, as well as what has come before and how it connects to the contributions of their peers and the goal of the lesson.

In this paper, I focus on two such features of interaction that were measured in the recent Global Teaching InSights study of the teaching of quadratic equations across eight country contexts. In this study, there were two domains which focused on the nature of classroom interactions, Classroom Discourse and Assessing and Responding to Student Thinking, alongside two other domains that focused on the mathematical content of the lesson including the Quality of the Subject Matter and Cognitive Engagement. However, my interest in this paper is where aspects of two of these domains coincide within a single interaction in ways that mean that teachers need to make decisions that prioritise one domain over another in ways that are contingent upon the interactional context. Specifically, I focus on using two video components with the study: Patterns and Generalisations; and Eliciting and Responding to Student Thinking.

Background

Responsiveness is widely advocated for within mathematics education research, and there has been a great deal of attention on strategies teachers can use to elicit students' thinking and how teachers can respond to this thinking. This includes work on questioning, handling student errors and equitable opportunities to participate in mathematics classroom interactions. However, as with all teaching practices that have been shown to be effective in supporting students' learning, there are times when responsiveness supports learning but there are also times when responsiveness can hinder learning. This is problematic for research that examines teaching at scale which often relies on measuring the presence or frequency of particular practices in observations. Bishop et al. (2022) go some way in addressing this problem by describing a responsiveness continuum in order to address this binary treatment of responsiveness and illustrate the variation in responsiveness across lessons. Their analysis also reveals the complexity of responsiveness, acknowledging the important interactional work of teacher actions that are often described as not responsive in the literature, as well as highlighting the qualitatively different nature of mathematics within responsive interactions.

Furthermore, larger-scale observations of teaching primarily focus on the actions of teachers (Bell et al., 2020; Munson, 2019), without consideration of the contingent aspects of these actions. All classroom interactions are interactions between different participants and are responsive to these participants (Ingram, 2021). Responsiveness in particular is fundamentally about the interaction between teachers and students, it is co-constructed by both teachers and students (Bishop et al., 2022). In responsive interactions, both the teacher and the students determine the content and direction of the mathematics lesson to some extent. Yet, observation frameworks predominantly measure the actions of different participants separately, occasionally considering the coincidence of particular actions, but they do not (and cannot?) take into account the co-constructed nature of these actions. Few observation frameworks consider students' responsiveness to each other.

In addition, in this paper the focus also relates to the mathematical nature of the interaction and on the use of patterns and generalisations within teaching. In the recent Global Teaching InSights study, patterns and generalisations were rarely used by teachers in any of the countries participating (Bell et al., 2020) but the focus of the study on the relationships between instructional activities and student

cognitive and non-cognitive outcomes meant that the analysis focused on the average frequency of patterns and generalisations across the two lessons from each teacher. This approach masks the role that patterns can have in supporting generalisations in the learning and teaching of mathematics. Using patterns is an important part of teaching, learning and doing mathematics. Extensive research into algebra and the use of visual patterns has illustrated the power of using patterns and supporting learners to generalise from these patterns (Mason, 2017; Wilkie, 2019). Patterns can also be used in terms of the sequencing of examples to enable learners to start from the familiar and build to a more general understanding of a particular concept. Using patterns to support generalisation can also involve sequences of examples or terms that draw students towards noticing the similarities between these examples or terms, which then enables them to move towards the generalising needed in developing an understanding of the concepts involved. This is one of the key principles of variation theory (Marton & Booth, 1997) and related research focused on the role and use of examples in the mathematics classroom. Sequencing is key to learning from patterns within mathematics. However, using patterns to support generalisation is only one aspect of the mathematics under consideration. Consequently, we would not necessarily expect lessons to be dominated by patterns and generalisations from these patterns, and a closer analysis of these contingent mathematical moments is needed to illustrate the role they play in classroom interactions.

Theoretical background

Mathematics teaching is highly complex and this complexity is clearly visible in classroom interactions. These interactions involve multiple goals, including those specific to mathematics learning, but they also involve moment-to-moment decision-making by teachers that are influenced by social and mathematical norms of interaction within the classroom, as well as teachers' knowledge, beliefs and values. Models of teacher learning and teacher decision-making highlight the role of teacher beliefs, knowledge and goals in their teaching practices (Clarke & Hollingsworth, 2002; Schoenfeld, 2011) yet teachers have multiple goals and in their decision-making they have to prioritise some goals over others. Additionally, teachers also build up habits meaning that teachers do not always notice or are not aware of the decisions they are making (Mason, 2002). Research focusing on teacher noticing, and in particular recent work focusing on teacher noticing of student thinking, often seeks to support teachers in noticing when they are acting out of habit in order to open up possibilities for acting differently, and consequently for making decisions differently.

These decisions and habits are often visible in classroom interactions through the established norms of interaction and the deviations from these norms. Interactionist approaches focus on making explicit these norms and deviations through close attention to interactions, and creating detailed descriptions of the patterns and norms that underpin classroom interactions, that often go unnoticed until attention is drawn to them. In addition to the influence of teacher beliefs, knowledge, goals etc. there are also social influences relating to the norms of interaction. These social norms include a preference for the progressivity of interaction (Stivers & Robinson, 2006) i.e., that the goals of an interaction are achieved. While these norms of interaction are often implicit, they have strong influences on classroom interactions. Teachers and students are constantly navigating these different influences on their interactions, responding in ways that support the progress of the interaction, though norms can disguise the complexity of this navigation. When teachers make decisions about whether to or how

to respond to students' thinking, these decisions involve consideration of the mathematics in focus, the goals of the interaction, as well as the students in the interaction. Observations of teaching focus specifically on the decision taken, but in labelling the results of these decisions as being responsive (or not), as involving a pattern or generalisation (or not), or using any other categories within the observation framework(s), the interactional context within which the decision can be obscured.

Methodology

In this paper, I illustrate the complexity of the in-the-moment decisions teachers make with an example of a naturally occurring mathematics classroom interaction that shows the balance between the mathematical and the pedagogical work in classrooms, and the social norms that influence these. The extracts are taken from a lesson revisiting transformations with a class of students aged 11-12 years old in a school serving a very diverse population. The students in the class have encountered transformations in their previous schools but this is the first time the students have met this topic with this teacher in this school. The lesson is focusing on what the students remember about transformations, beginning with reflections. The interaction is around the information that is needed to reflect a shape and after several suggestions from the students, the idea of a mirror line is suggested. In the interaction that follows, the teacher is trying to get the students to state that they need to know *where* a mirror line is before they can reflect a shape. The video of the lesson was captured at the very beginning of a professional development programme lasting 2 years, before the professional development part began.

A conversation analytic approach was taken within the project in the analysis of the whole class interactions around mathematical content (Ingram, 2021). The clips used in the first stage of the analysis were chosen by the teachers themselves as short sections of interactions in their lessons which they wanted to share with the teachers and researchers as something interested or intrigued them at this point in the lesson. These clips were transcribed using Jefferson transcription (Jefferson, 2004). The extracts from these clips shared in this paper are simplified to enable easier reading and to conform to the publication guidelines, and the conventions are included at the end of the paper. The second stage of the analysis involved examining the videos of the whole lessons and the lessons of the other participating teachers in order to identify patterns and similarities across interactions with similar features. The extract shared in this paper illustrates a tension the teacher encountered in using a sequence of examples to support students in understanding that lines of symmetry can 'be anywhere', a difficulty numerous studies have identified as an issue in the teaching and learning of symmetry (Leikin et al., 2000; Ramful et al., 2015), and a desire to involve and engage students more in asking questions, sharing their thinking and explaining their reasoning.

An example of the tensions in teacher actions

The interaction presented here occurs immediately after the students have identified that they need a mirror line in order to reflect a shape and the focus has now shifted to the location of this mirror line.

- 177 Teacher: okay but if I said this, reflect the shape, (.) could I- I could put the mirror
 here, I could put the mirror here [...
178 Student: [which side, you put the mirror side-]
179 Student: [(((inaudible)))]
180 Student: [you put it next to]

- 181 Teacher: [I could put it there], I could put it anywhere, does the mirr- no
 182 Student: [((inaudible))]
 183 Teacher: [it has to be side-]
 184 Student: does it?
 185 Teacher: yeah
 186 Student: really? ...

Extract 1: Locations of mirror lines

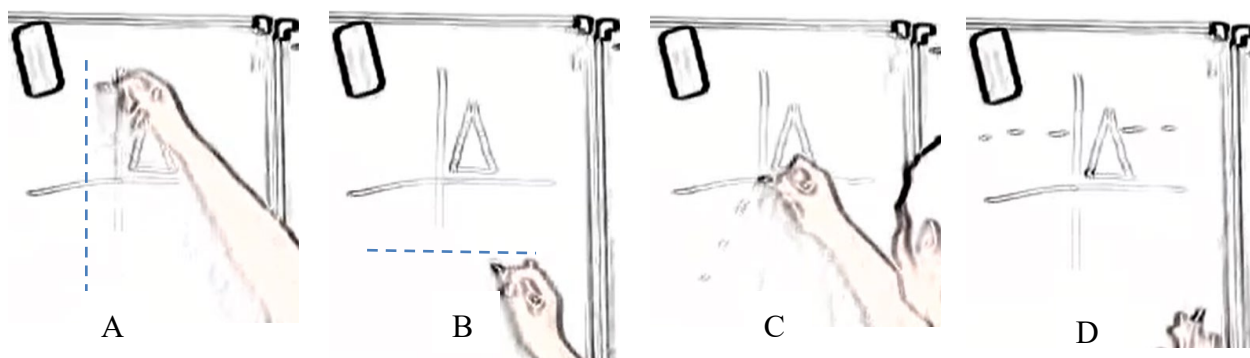


Figure 1: Mirror lines used in the lesson

In turn 177 the teacher gestures two mirror lines, with the first here referring to the annotated line in Figure 1A and the second here referring to the annotated line in Figure 1B and continues in turn 181, firstly gesturing and then drawing in the line of symmetry in Figure 1C. This pattern of mirror lines builds towards the generalisation that a mirror line can be “put ... anywhere”. In this first part of the extract the students call out a range of contributions but the teacher does not appear to respond to the students, but in doing so has constructed a pattern of mirror lines which in the omitted section of the transcript lead to the shared conclusion that in order to reflect a shape, we need to know the location of the mirror line, with the teacher emphasising that a mirror line can “be anywhere”. In this interaction observation frameworks focusing on responsiveness would identify this interaction as having no or low responsiveness. Yet, by not responding to the students in this moment, the teacher has built a pattern leading to the conclusion that mirror lines can be anywhere, one of the goals of this interaction.

In contrast, after the conclusion that the mirror line could be put anywhere in turn 181, the teacher responds to a student’s contribution that the mirror line needs to be sideways – a comment that was made by more than one student in lines 178-180 but not explicitly responded to by the teacher in the first part of this extract. This illustrates the preference for progressivity of interaction alongside the goal of the teacher to reach the conclusion that a mirror line could be anywhere. The teacher prioritises this goal over responding to the students’ suggestions until immediately after the conclusion has been reached.

In Extract 2, turn 203, the pattern of varying the location of a mirror line continues with the teacher erasing the line drawn in Figure 1C and drawing the line in Figure 1D. In addition, the prosody of this “I could have a mirror line there” mimics that used in turns 177 and 181, reinforcing this sense of pattern. The transcription conventions for CERME papers limits the use of transcript notation that illustrate the prosody, but the comma at the end of turn 203 marks that the teacher is about to continue the turn.

- 203 Teacher: it's anywhere. so in this case it's this diagonal here, I could have a mirror line there. right,
204 Student: but how would that work?
205 Teacher: how would that work? That would mean that I would have a shape that would end up looking something like that.
206 Student: oh yeah
207 Teacher: yeah?
208 Student: ((inaudible))
209 Teacher: so it doesn't matter where the mirror line is, I just need to know. if I just gave you a shape in a bag that I said 'reflect this shape' you can't do it unless you know where the mirror line is, right? okay? but the mirror line can go anywhere...

Extract 2: Mirror line that intersects the shape

In turn 204, a student speaks to ask a question. The teacher responds to this question by drawing the shape that would be the reflection of the triangle in this mirror line. In the interaction that follows the discussion briefly returns to the location of the mirror line before moving onto the information needed in order to rotate a shape. Here, in responding to the student's question, the teacher has also illustrated the result of the reflection of the shape in the mirror line drawn. This is not returned to in the lesson which focuses on describing transformations rather than transforming shapes. Here, an observation framework would usually identify that the teacher had responded to the student's question, but while this is more responsive than the teachers' reaction at the beginning of the previous extract, it also disrupts the flow of the examples that support students' generalisations in relation to the mathematical content.

Discussion

At the conclusion of this segment of the lesson, there is a record of the information needed in order to describe transformations fully. In the case of reflections, one of these is "where is the mirror line". In the interaction around mirrors, the teacher has also focused on the fact that mirror lines can be anywhere. This is done by sequencing a series of examples beginning with mirror lines parallel to the axes that the students are most likely to be familiar with, and culminating with a mirror line that intersects with the shape. The word anywhere is mentioned frequently throughout the interaction by both the teacher and some of the students.

The use of sequences of examples to lead to a generalisation is a central pedagogical tool for mathematics teachers, but it can require teachers to ignore or park responding to students' contributions in order to maintain the sequencing. The extracts shared here illustrate this with the teacher establishing a sequence of three examples before addressing the students' arguments about where a mirror line can be. This teacher invites students to share their ideas and their thinking throughout the lesson, as widely advocated in the literature, but in this instance, the sequencing of examples needed to generalise is prioritised over the need to be responsive to students. This raises a challenge in the use of frameworks that categorise classroom interactions or discourse in particular ways. These frameworks reflect both what we know to be effective but also what we value, yet do not and can not reflect the complexity of teaching. Interactions have different purposes within teaching, and these purposes can mean that certain interactional practices, such as responsiveness or maintaining the progressivity of interaction, are more effective in achieving these purposes or goals

than others. Case studies and illustrations of interactions can highlight this relationship between interactional, pedagogical and mathematical but the challenge of recognising these relationships when studying teaching at scale continues. Researchers recognise that particular strategies are not appropriate in all interactions, but reports of larger-scale studies still focus on frequencies and the presence or absence of particular strategies. This masks the underlying value of strategies being used appropriately, and the possibility that particular strategies that we value, such as using patterns to support generalisations, are rare (Bell et al., 2020) but because they are part of a repertoire of strategies, which skilful teachers use when and where they can support students' learning.

Transcription conventions (adapted from Jefferson (2004))

[start of overlapping speech
]	End of overlapping speech
(.)	brief pause, usually less than 0.3 seconds
.	Final falling intonation (.)
,	Slight rising intonation (,)
?	Sharp rising intonation (?)
word-	a cut-off.
(())	Double parentheses contain researcher comments or descriptions

References

- Bell, C. A., Schweig, J., Castellano, K. E., Klieme, E., & Stecher, B. M. (2020). Instruction. In OECD (Ed.) *Global Teaching InSights: A video study of teaching* (pp. 114–25). OECD. <https://doi.org/10.1787/20d6f36b-en>
- Bishop, J. P., Hardison, H. L., & Przybyla-Kuchek, J. (2022). Responsiveness to students' mathematical thinking in middle-grades classrooms. *Journal for Research in Mathematics Education*, 53(1), 10–40. <https://doi.org/10.4135/9781412972024.n1549>
- Clarke, D., & Hollingsworth, H. (2002). Elaborating a model of teacher professional growth. *Teaching and Teacher Education*, 18, 947–967. [https://doi.org/10.1016/s0742-051x\(02\)00053-7](https://doi.org/10.1016/s0742-051x(02)00053-7)
- Jefferson, G. (2004). Glossary of transcript symbols with an introduction. In G. H. Lerner (Ed.), *Conversation analysis: Studies from the first generation*, 13–31. John Benjamins. <https://doi.org/10.1075/pbns.125.02jef>
- Ing, M., Webb, N. M., Franke, M. L., Turrou, A. C., Wong, J., Shin, N., & Fernandez, C. H. (2015). Student participation in elementary mathematics classrooms: The missing link between teacher practices and student achievement? *Educational Studies in Mathematics*, 90(3), 341–356. <https://doi.org/10.1007/s10649-015-9625-z>
- Ingram, J. (2021). *Patterns in mathematics classroom interaction: A conversation analytic approach*. Oxford University Press.

- Ingram, J., Lindorff, A., McCann, E., Riggall, A., & Sani, N. (2020). *TALIS Video Study national report*. DfE. <https://www.gov.uk/government/publications/talis-video-study-teaching-of-mathematics-in-secondary-schools>
- Leikin, R., Berman, A., & Zaslavsky, O. (2000). Learning through teaching: The case of symmetry. *Mathematics Education Research Journal*, *12*(1), 18–36.
- Marton, F., & Booth, S. (1997). *Learning and awareness*. Lawrence Erlbaum Associates.
- Mason, J. (2002). *Researching your own practice: The discipline of noticing*. Routledge.
- Mason, J. (2017). Relationships between proof and examples: Comments arising from the papers in this issue. *The Journal of Mathematical Behavior*, *53*, 339–347. <https://doi.org/10.1016/j.jmathb.2017.07.005>
- Michaels, S., & O'Connor, C. (2015). Conceptualizing talk moves as tools: Professional development approaches for academically productive discussions. In L. Resnick, C. Asterhan, & S. Clarke (Eds.), *Socializing intelligence through academic talk and dialogue* (pp. 347–361). American Educational Research Association.
- Munson, J. (2019). After eliciting: Variation in elementary mathematics teachers' discursive pathways during collaborative problem solving. *The Journal of Mathematical Behavior*, *56*, 100736. <https://doi.org/10.1016/j.jmathb.2019.100736>
- Neugebauer, P., & Prediger, S. (2022). Quality of teaching practices for all students: Multilevel analysis of language-responsive teaching for robust understanding. *International Journal of Science and Mathematics Education*, *21*, 811–834. <https://doi.org/10.1007/s10763-022-10274-6>
- Ramful, A., Ho, S. Y., & Lowrie, T. (2015). Visual and analytical strategies in spatial visualisation: Perspectives from bilateral symmetry and reflection. *Mathematics Education Research Journal*, *27*(4), 443–470. <https://doi.org/10.1007/s13394-015-0144-0>
- Schoenfeld, A. H. (2011). *How we think. A theory of goal-oriented decision making and its educational applications*. Routledge.
- Stivers, T., & Robinson, J. D. (2006). A preference for progressivity in interaction. *Language in Society*, *35*(3), 367–392. <https://doi.org/10.1017/S0047404506060179>
- Wilkie, K. J. (2019). Investigating secondary students' generalization, graphing, and construction of figural patterns for making sense of quadratic functions. *The Journal of Mathematical Behavior*, *54*, 100689. <https://doi.org/10.1016/j.jmathb.2019.01.005>