Chapter 1

Introduction

Learning mathematics is a social and interactional endeavour and is the raison d'être of mathematics classrooms. Learning happens through interaction, not only between students and the mathematics, but necessarily between the teacher and the students, and between students. By looking at interactions we are not just looking for evidence of what students have learnt, but for the process of learning itself.

Learning mathematics is complex. It is not a linear or stable process that is the same for all. Learning happens over time and we are continually building and developing what some would call our 'repertoires of meaning-making resources' (Hall, 2018, p. 34). Some of these repertoires will be enduring across contexts, whether that is across our everyday lives and the mathematics classroom, across the different mathematics classrooms we experience in school, or across the different interactional contexts within a particular mathematics classroom environment. Our interactions, however, are context-specific and vary depending not only on who we are interacting with, but also on the practices and purposes that underlie our interaction. The learning of mathematics is intersubjectively negotiated and happens through the interactional structures and practices examined in this book.

A great deal of educational research focuses on intervening to identify 'what works', yet many of these interventions have been less successful when they have been 'scaled up' into ordinary classrooms. There is a great deal of mathematics learning taking place in classrooms, but teachers, curriculum designers, and school leaders continually seek to find ways in which students can learn more and learn better. Mathematics education research that focuses on classrooms has undergone enormous interdisciplinary growth over recent years. However, classroom interaction whilst structured and patterned, is essentially unpredictable and rarely stable, which poses a challenge to researchers concerned with the process of learning through interaction that are contingent upon the actions of teachers and students. Researchers who are interested in students' learning of mathematics come from a wide range of intellectual traditions and disciplinary roots and the concepts, theories and methodologies informing the research are drawn from fields as diverse as anthropology, cognitive science, linguistics, sociology and psychology to name but a few.

This book takes a Conversation Analytic (CA) approach, with its roots in sociology but also drawing from linguistics and psychology, to focus on mathematics learning as it happens in the mathematics classroom. It also makes use of other perspectives, bringing these perspectives into dialogue with one another, integrating what is already known within mathematics education research about the process of learning mathematics to contribute more than the sum of the perspective-specific findings. CA is data-driven and analytically inductive, and findings using this approach is often descriptive, with claims substantiated through the sharing of transcripts that make visible teachers and students' actions. Learning mathematics can be considered at three interrelated levels of social activity. CA focuses on the micro level of interaction within classrooms but can also reveal the influences of the meso level of the sociocultural contexts of schools and classrooms, and the macro level of ideological structures on the site of learning itself. With CA the analysis is grounded on how teachers and students themselves experience mathematics classroom interactions, particularly their choices and actions within these interactions (Lee, 2010).

The classroom context is dynamic, complex, and is shaped by the teachers and students interacting within it. It is also goal orientated and task oriented in that interactions and activities are planned for and designed to enable students to learn or develop. These goal orientations combine with interactional patterns and structures creating specific interactional contexts (Seedhouse, 2019). This mathematics classroom context can also be examined at different levels. Whilst most research into the learning and teaching of mathematics within the classroom focuses on the context of the classroom itself, there are also sub-varieties of interactional contexts within every classroom. It is these interactional contexts where pedagogy and interaction come together. The pedagogical focus influences the structure and organisation of the interaction, and the structure of the interaction constrains and affords the pedagogical actions. The goal of a mathematics lesson is likely to be to learn some mathematics but there are likely to also be other goals in play, such as developing students' social interaction skills, involving students in their own learning, or managing behaviour. The teacher and the students may or may not share these goals. These goals are achieved through teachers and students interacting with each other. Opportunities to learn mathematics vary between and within classrooms, and researching interactions enables us to better understand this process of learning. From a conversation analytic perspective, the nature of this interaction is key, both in terms of what is said and how it is said. By analysing these interactions in detail, we can see how teachers and students achieve different things through these interactions, and consequently how the learning of mathematics is co-constructed.

Conversation analysis largely focuses on identifying structures and patterns within these interactions. These patterns are often unmarked and considered by many to be common sense, yet by paying attention to these structures and patterns we can see *how* students treat aspects of classroom interaction such as what it means to know, learn, or listen. By explicating these structures or rules as many researchers describe them, we can see how teachers can use them to be more effective. These structures are not prescriptive rules, they are instead interpretive resources which both teachers and students can make use of.

‘Can you sit down please’ is (usually) interpreted by students as a request to sit down, not a question requiring a yes or no response. There are lots of choices that teachers make when choosing both what to say and how to say it, and these choices are made both consciously and unconsciously. Skilful teachers can use these choices to their advantage. Consider the following requests: ‘open your book please’, ‘open your book thank you’ and ‘open your book’. The differences may seem purely semantic, or to relate solely to politeness. but saying ‘thank you’ usually follows the completion of a request and thus implies that the request will be granted. The ‘please’ also changes the imperative to a request. CA is interested in not only *what* is said in interaction but also *how* it is said and consequently what is being done with an interaction.

This book brings together a wide range of findings about mathematics classroom interaction that have resulted from studies using a CA approach. The research is based on three projects all focused on mathematics classroom interaction over a period of 10 years. Building on Mehan’s (1979a) and later Cazden’s (2001) detailed examination of common lesson structures and discourse patterns., I explore the structures and patterns that pervade mathematics classrooms and influence how students treat mathematics, the learning of mathematics and the teaching of mathematics.

Conversation analysis focuses on talk-in-interaction, but this talk is not just considered to be about exchanging information, it is how we collaborate and mutually orient to each other in order to achieve meaningful communication (Hutchby & Wooffitt, 1998). Teachers and students actively construct the mathematics classroom in which they interact. The analytic goal of CA research is to describe and make explicit the norms and procedures we use that help us to make sense of each other when we interact. It is interested in how we achieve intersubjectivity.

At times, the analysis can raise more questions than answers. Some events, situations or cases are very rare, or particular to just one mathematics classroom. Yet illustrating these situations can help us to ask those questions, seek the right data, notice the implicit, which can support our understanding of the interactions between the teaching and learning of mathematics. The same can be true of deviant cases. One of the challenges that arises from using naturally occurring data is that you do not necessarily get sufficient examples to be able to notice a theme or pattern, let alone be able to make any kind of generalisation.

Where the data comes from

The data used in the analysis that has led to this book, and that is used to illustrate the different patterns and structures of mathematics classroom that I have led over the past 10 years. The projects all include data that come from video recordings of mathematics lessons from a wide range of schools and classrooms in England, with students aged somewhere between 11 and 18 years old. This resulted in 42 videos of mathematics lessons or parts of mathematics lessons. In half these videos I was present, sitting in the back of the classroom with a video camera. In the other half the teachers themselves recorded their lessons or asked a colleague to record the lesson. Some teachers recorded just one lesson; others recorded 5-6 lessons. The teachers chose which class to video, which lesson to video and how to teach the lesson, and to this extent the data is naturally occurring. BERA ethical guidelines for educational research (BERA, 2004) were followed, with all teachers and students consenting to the video recordings. At the time of the video recordings I was not working with any of the teachers in my capacity as a teacher educator, though in some cases I had worked with the teachers before or after the video recordings were made.

The way that these videos are shared with you, the reader, is through transcription. CA has a long tradition and specific approach to transcription that I describe in more detail in Chapter 2, but there is a balance between precision and detail, and readability. Transcription is an analytic process (Ingram & Elliott, 2019) and the analysis of the videos involved transcribing and then watching and re-watching the videos alongside these transcripts. Whilst the examination of the patterns and structures I describe in this book resulted from detailed transcripts using the Jefferson transcription system (Hepburn & Bolden, 2013) as illustrated in Extract 1-1, many of the details included in these transcriptions can make them difficult to read.

Extract 1-1: Jefferson transcript of classroom interaction.

```
54   Tyler:     yea:h? (.) but ↑what fractio::n (0.8) what
                >fraction of that< triangle have I shaded (0.8)
                what fraction of that triangle have I actually
                sha::ded (.) Simon,
55   Simon:     um (.) w- ↑half?
56              (0.6)
57   Tyler:     >have I shaded a ↑ha::lf
```

Since one of the main audiences for this book is researchers in mathematics education, perhaps with no experience of reading transcripts from CA research, I have in many places limited the transcription details included in the examples and illustrations to those details that are most relevant to the discussion at the time. So, for example, where pausing and hesitation are features of the analysis in focus, hesitation markers are included and pauses are measured to the nearest 0.1s (using Audacity® version 2.2.2 and 2.3.2 (Audacity team, 2018)). At other times, a simple verbatim transcript has been shared, as in Extract 1-2.

Extract 1-2: Verbatim transcript of interaction from Extract 1-1.

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54   Tyler:     yeah? but what fraction (0.8) what fraction of
                that triangle have I shaded (0.8) what fraction
                of that triangle have I actually shaded (.)
                Simon,
55   Simon:     um (.) half?
56              (0.6)
57   Tyler:     have I shaded a half
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I have also used the convention of all teachers' names begin with T and all student names begin with S. Teacher names are consistent across extracts and uniquely refer to one of the teachers who kindly recorded their lesson(s). Student names are only consistent within an extract and as gender is not a focus of the analysis (that is the teachers and students are not making the gender of students relevant to the interaction) in most cases, the gender of the student pseudonym may not necessarily match the gender of the student in the video. There are two exceptions to this where gender is oriented to by the teacher and the student and in these two situations the gender of the student has been preserved.

Structure of the book

Chapter 2 outlines the origins, principles and tools of Conversation Analysis as well as summarising some of the key structures and patterns on interaction that are the building blocks of any CA analysis. There are several books available that outline CA in more depth for the interested reader and I have been necessarily brief, focusing only on those aspects that are drawn upon in the rest of the book. More thorough recent introductions can be found in Sidnell (2010), or ten Have (2007) and for more detail and examples of CA in a range of disciplines and fields the Handbook of Conversation Analysis (Sidnell & Stivers, 2012) provides a comprehensive overview.

The remainder of the book is split into two main parts. In the first part I focus on structural regularities and patterns, such as turn-taking and repair, that are used by CA researchers to examine interaction in a range of contexts, including classrooms (Gardner, 2019; Macbeth, 2004; McHoul, 1978, 1990). Chapter 3 focuses on turn-taking and Chapter 4 focuses on repair and trouble in interactions. In each of these chapters I begin by examining the patterns of turn-taking and repair within mathematics classroom interaction, highlighting structures that are consistent across interactional contexts as well as exploring variations, and the influence these have on the learning and teaching of mathematics. To begin each of these chapters I have tried to stay faithful to the CA descriptive principles by describing the interactional and learning process as they are oriented to by mathematics teachers and students. Yet description can only take us so far. Towards the end of these chapters I also draw on research within mathematics education to consider how these structures influence learning, while still treating learning as a social accomplishment that takes place over time.

In Chapters 5 and 6, the focus shifts to the processes associated with learning mathematics and draws upon the tools of CA in order to contribute a more nuanced understanding of what it means to learn mathematics. The emphasis continues to be on how teachers and students themselves treat these processes as they interact in the mathematics classroom, but with a focus on the mathematical tasks, activities, and behaviours that students and teachers engage in. However, this in itself deviates from ethnomethodological principles as teachers and students often do not make distinctions between activities or actions being mathematical or not. The distinction between what is a mathematical explanation and an explanation is often not made in classroom interactions. My own experiences as a mathematics teacher, mathematics education researcher and teacher educator are often drawn upon in the analyses in these two chapters.

Throughout I have treated learning mathematics as a way of acting, mathematics is something that you do, not just something you know.