

# WHAT IT MEANS TO DO MATHEMATICS: THE DISCURSIVE CONSTRUCTION OF IDENTITIES IN THE MATHEMATICS CLASSROOM

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*This paper explores how teachers and students discursively construct mathematical activity as they interact in mathematics classrooms, and the consequences these have on the identities of mathematics teacher and mathematics student. Using a conversation analytic approach we examine how these identities are discursively constituted through the social actions that are performed in the interaction. We offer two contrasting examples that both involve students calculating values using known procedures, but where the identities of mathematics teacher or student are constructed differently.*

## INTRODUCTION

Language is constitutive; our choice of words that we use to describe concepts or tasks and activities creates the meaning that these have for our students. The ways that teachers and students describe the activities of mathematics therefore constitute the nature of the mathematical activity, which in turn influences what it means to be a teacher or a student of mathematics. In this paper we examine how the way that teachers introduce and begin to work on tasks affects the construction of these identities. Whilst there has been a great deal of research into identity in the mathematics classroom (e.g. Lerman, 2011) this has largely focused on researcher's categorisations of identity types. In this paper we take an ethnomethodological approach to examining identity that takes identity as something that is discursively constructed in interaction (similar to the approaches taken by Wood (2013) and Cobb & Hodge (2011)).

## THEORETICAL BACKGROUND

An ethnomethodologically based analysis of identity, such as the conversation analytic (CA) one used in this paper, is based on a turn-by-turn analysis of the identities that the participants in an interaction orient to. It is the identities that the participants themselves draw upon, both directly and indirectly, that is of interest rather than researcher identified identities such as teacher or student (Schegloff, 1997). Having said this, that the participants are orienting to these identities of teacher and student is often apparent through the structure of turn-taking and the actions performed within these turns (Ingram, 2012), as they are in the extracts below. The teacher usually controls who can speak when, generally controls the topic and asks the questions (that

they already know the answer to), whereas students answer these questions (Mehan, 1979).

Ethnomethodological approaches do not enter into the debate about the ontology of identity, or any analysis about the relationship between identity and what participants think or feel. Instead the analysis focuses on how participants display and orient to specific identities and the consequences this has on the interactional activities (Benwell & Stokoe, 2006). This conceptualisation of identity means that identities are indexical to the interaction in which they are oriented to, and are also dynamic and fluid; adapting, altering and developing in interaction.

Using a conversation analytic approach, Zimmerman (1998) distinguishes between three different types of identity that are oriented to in interactions: discourse identities, situated identities and transportable identities. It is the discourse identities that we focus on in this paper, and these are the identities oriented to by participants in a turn-by-turn basis such as speaker, listener, questioner or answerer. These discourse identities are often reflexive and have consequences for the identities of the other participants. For example, by assuming the discourse identity of speaker, the other participants are required to assume the discourse identity of listener (though they may not actually do this). Situated identities relate to the context in which the interaction is occurring, such as teacher and student where the interaction is occurring in a classroom. Transportable identities are carried by participants across different interactions in different contexts, such as female, mother, but are not necessarily oriented to within an interaction.

An analysis using CA focuses on the social actions being performed by turns within the sequential context in which they occur. The design of these turns, including the choice of words, constitutes the nature of mathematical activity that occurs in the interaction. In this paper we examine two transcripts of whole class interactions to show how the participants' identities of mathematics teacher and mathematics student are discursively constituted in the interaction, and how these identities constrain what it means to do mathematics.

## RESEARCH METHOD

This paper uses data from a larger study of interactions in secondary mathematics classrooms (students aged 11-18) in the UK. The extracts are taken from two different lessons, one taught by Tim and the other taught by Todd (all names are pseudonyms). The lessons were video recorded and then all whole-class interactions were transcribed using Jefferson transcription notation (Sidnell, 2010) but there was no intervention or direction given to the teachers about how or what to teach, so the lessons are to some extent *naturally occurring* (Ingram & Elliott, 2019). The transcriptions have been simplified in this paper for ease of reading.

A conversation analytic approach has then been used to develop a detailed description of how the identities of mathematics teacher and mathematics student are constituted in interaction and the nature of these identities in terms of the mathematical activities they involve.

### **THE DISCURSIVE CONSTRUCTION OF THE IDENTITIES OF MATHEMATICS TEACHER AND STUDENT**

In this section we compare and contrast the introduction of the first task of a lesson, showing how each teacher discursively constructs the nature of activity and as the interaction develops how the identities of mathematics teacher and student are reflexively constituted. The first three extracts are from Tim's lesson on limits of sequences, whilst the last three are from Todd's lesson on frequency tables.

- 18 Tim: okay (0.6) your first thing today I've put a problem on the board, I will  
 19 have a problem on the board in about (0.3) 30 seconds, okay I want you to  
 20 look at that (.) first question is quite an easy one, the second question we  
 21 have to need to think about in terms of (.) what it actually means, (1.3) okay  
 22 and I want you to try your best and try and understand (.) how far you can  
 23 get it done, okay. here is your problem. have a go at this (.) I've just inherited  
 24 twelve thousand pounds, (0.4) okay and being the generous man that I am  
 25 I want to donate (.) some of that to charity (.) but because I'm not totally  
 26 generous, (1.2) okay I'm going to donate one quarter of the twelve thousand  
 27 pounds, then the following week I want to donate a quarter of that amount,  
 28 following week a quarter of that amount okay how much will I donate in  
 29 each of the first four weeks, the first few are obviously easy. how much will  
 30 you donate in total okay

Extract 1: Tim introducing the first task.

Tim constructs the activity in his lesson as solving problems that involve 'thinking' (line 21), 'understanding' (line 22) and 'having a go' (line 22). He begins by asking his students to 'look' (line 19) at the problem. The problem is given using words, but Tim has used the word 'look' rather than 'read'. Consequently, Tim is asking his students to go beyond reading the question, and to also think about the problem. Furthermore, Tim describes the second part of the question as something that "we have to need to think about in terms of what it actually means" (lines 20-1). The choice of the pronoun 'we' here aligns Tim with his students in the role of problem solvers, referring to the generic processes that a problem-solver goes through when they encounter a problem; the processes of thinking about the problem, working out what it means as well as what to do as the first stages of solving a problem (Mason et al., 2010). Thus the identity of mathematics teacher includes problem posing, and the identity of mathematics student includes problem solving, thinking, trying, understanding, and having a go.

- 33 Tim: wee:k two:, how much am I donating if I'm donating a quarter of that.  
34 (.) Sam?  
35 Sam: seven point s-, seven (.) point five, no seven hundred and fifty  
36 (1.5)  
37 Tim: ok a quarter of that, seven hundred and fifty points. ok. I want you to try  
38 and work out (0.8) the next (0.5) two weeks, and then I want you to think  
39 about (0.3) how much are you going to end up donating in total.

Extract 2: Tim asking how much is donated in week 2.

In Extract 2, Tim repeats Sam's answer of seven hundred and fifty (line 37), consequently showing that this answer is appropriate and correct. Tim also adds the units 'pounds' to the end of this answer. This revoicing is usually discussed in the literature as a device that teachers use to encourage students to give more complete or mathematical answers, but here it also focuses attention on the specific problem of donating money, rather than a generic calculation of a quarter of three thousand. Here the situational identities of teacher and student are being oriented to by who is asking the question, evaluating the answers, and setting the tasks of what to do next, and who is answering the question.

- 58 Tim: some of you used calculators, some of you didn't. ok that's good. I don't  
59 mind either way. (1.7) I want you thinking about it. ok. the values you got  
60 for the first three weeks were three thousand, (1.0) seven hundred and fifty,  
61 (.) one eighty seven fifty and forty six eighty eight?  
62 [ yep, ] if you round it.  
63 Simon: [forty seven]  
64 Tim: ok (0.7) what I was wanting to think about is what (0.3) is actually  
65 happening. some of us talked about when do you s:top, do you stop.  
66 Steve: nope  
67 Tim: why not. hands up. (1.7) why not. Seb?  
68 Seb: because the number: 9.) keeps getting smaller, cus of ((inaudible))  
69 Tim: so it keeps getting smaller  
70 Seb: yep  
71 Tim: but will there be a point where we actually s:top?  
72 SS: yes  
73 Tim: why

Extract 3: Tim asking do you stop.

In Extract 3, line 58 Tim refers to his students using calculators. By mentioning this he is making it relevant (in a CA sense) to the interaction. In line 59 he then emphasises that he wants the students “thinking about it” before listing the values for the earlier calculations, reinforcing the earlier constitution of mathematics students as thinkers. Tim contrasts the performance of and the answers to the calculations with what he wants his students to do, thinking. There is no discussion of the how the values were calculated and he stated that he did not mind whether students used calculators. The answers to the calculations are listed by Tim without comment and without inviting the students to offer them. Calculations are part of the activity, but attention is on their use in solving the problem rather than the calculations themselves, contrasting ‘working it out’ (line 38) and ‘thinking’ (line 59). Thus both the identities of teacher and student involve the action of calculating, but it is the activity of thinking that is oriented to as something that students should do.

The emphasis so far on thinking about (to use Tim’s words) what is going on leads to Tim’s question in line 65 of ‘do you stop’. The introduction of the question of whether you stop references earlier conversations (“some of us talked about” in line 65). By mentioning these discussions Tim is making them relevant to the current interaction, and indicates that the question is something that is worthwhile discussing; the answer needs to be thought about. Discussing is something teachers and students do together. Consequently, Tim is suggesting that the answer of whether you stop or not is not immediately obvious. This is developed further in line 67 where Tim asks “why not” twice, before re-asking the question in line 71 and asking why in line 73, thus asking his students to offer explanations for each alternate answer. In summary, in the introduction of this problem, Tim has discursively constructed his students as people who think and find meaning, as well as people who participate in mathematical activities such as specialising, discussing, explaining, arguing and justifying.

The next three extracts come from one of Todd’s lessons and illustrate the differences in what it means to be a mathematics student.

- 276 Todd: sometimes in the exam they won’t give you that extra column they’ll just  
 277 give you these two, and they’ll expect you to know (.) that it might be useful  
 278 (.) to put this extra column on, do you know what I mean. And in a minute,  
 279 when you do some practice from the text book it’s the same thing. They  
 280 just give you this bit of the table and they expect you to use your initiative  
 281 (.) to draw in the extra column to do it. ok. well let’s go through these then,  
 282 the mode, the median, the mean and the range. I think we’ll leave the mean  
 283 till last because it’s a bit like the mean one. um Peter and (.) Paul, paying  
 284 attention now specially, right any offers anyone for telling me what, m-why  
 285 of course we always want to know why (.) what the mode, the median the  
 286 mean and the range are. (1.7) ... ((transcript omitted)) Phillip?  
 287 Phillip: er um days absent three is the mode because it’s the most common one

Extract 4: Todd introducing the task of finding mean, mode, median and range.

In Extract 4, Todd's introduction includes references to doing "some practice" (line 279), needing "to know" (line 277) and using "your initiative" (line 280). The question asked in lines 284-286 begins and ends as a what question, but with a request for why sandwiched between. Phillip's answer in line 287 includes the remembering of a definition and procedure for finding the mode and similarly in line 358 in Extract 5 Pierre is remembering a definition and procedure for finding the median. The interaction in lines 313-319 in Extract 5 is all about remembering and applying the procedure for calculating the range. In this introduction Todd constructs his students as people who do practice, use their initiative, pay attention, and tellers and Phillip adds to this remembering definitions, applying them to questions and using them to explain answers.

- 313 Peter: is the range a hundred and seven- seventeen  
314 Todd: range a hundred and seventeen. the range is the biggest number take away.  
315 the smallest number. the biggest number is a hundred and twenty-five, the  
316 smallest number is eight, a hundred and twenty-five take away eight. Paul  
317 Paul: no because the (.) the range is going to be in days absent so it'll be eight  
318 Todd: ah. remember Peter. this table does not have any numbers a hundred and  
319 twenty-five in there.  
(transcript omitted)  
358 Pierre: is the median um ta-add up all the (.) frequencies so [that ] adds up to five  
359 hundred

Extract 5: Calculating the range from a frequency table.

In Extract 5 Peter phrases his answer in line 313 as a question, and later in line 358 Pierre does the same, thus orienting to the teacher's role of evaluating. Yet it is Paul who makes the evaluation in line 317. Todd's response to Peter constructs the teacher also as someone who applies definitions in his calculation of the range. The role of student as someone who remembers continues in line 318 where Todd explicitly asks Peter to remember, but also in Pierre's turn in line 358-9 where he remembers the algorithm for calculating the median.

There is a brief change of focus in line 499 in Extract 6:

- 499 Todd: Peter in the corner. What does that number there represent, this five hundred  
500 Peter: er::m how many (.) times, (0.9) um how many people there was  
501 Todd: good how many people were surveyed. Pip. what does that one thousand  
502 seven hundred and sixty represent.  
503 Pip: um the total um number of days off

- 504 Todd: if you add up everyone's days of absence it will add up to one thousand  
 505 seven hundred and sixty, so as Phillip said, what we're going to do now is  
 506 one thousand seven hundred and sixty, divided by five hundred it's going  
 507 to give you (0.7) what is it Phillip  
 508 Phillip: three point five two?  
 509 Todd: three point five I'm going to call that. Three (.) point five. So the average,  
 the mean average number of days absent (.) is about three and a half...

Extract 6: Calculating the mean from a frequency table.

In lines 499 and lines 501-2 Todd asks the students what these two numbers mean. Todd accepts Peter's and Pip's answers but his acceptance of Pip's answer focuses back on the procedure for calculating the mean and the role of these numbers in the calculation. Again here the students are remembering features of a frequency table. Todd also constructs the identity of teacher as someone who demonstrates procedures, and identifies which calculations to perform, but the students as the ones who perform the calculations. So in this introduction the identity of teacher has been constructed as one that involves posing questions, demonstrating, and evaluating and the identity of student as someone who practices, pays attention, remembers, applies and uses definitions.

## CONCLUSION

In this paper we have shown how the identities of mathematics teacher and mathematics student are discursively constructed in interaction, and how these interactions constitute the nature of these identities. Teachers and students orient to and perform different mathematical activities in interaction, making particular activities relevant to the identities of mathematics teacher and student. In the extract from Tim's lesson mathematics students are discursively constructed as people who think and find meaning, as well as people who participate in mathematical activities such as specialising, discussing, explaining, arguing and justifying. In the extract from Todd's lesson, students are discursively constructed as people who practice, pay attention, remember, apply and use definitions. Whilst all of these activities are part of what it means to do mathematics, in each case students are only asked to do or perform a small set of these actions. We have only shared brief extracts from the lessons for each of these teachers, but for each teacher these same actions are requested of or performed by students consistently across all four lessons that were video recorded. In the study, this consistency is apparent across the majority of teachers who videoed more than one lesson, with only one exception. This suggests that what it means to be a student of mathematics as constructed through classroom interactions is specific to the classroom that these interactions are situated in, and that it is not only the nature of tasks that influence the nature of this identity.

### Transcript conventions (Sidnell, 2010)

Convention Name	Use
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[ text ]	Brackets	Indicates the start and end points of overlapping speech.
(0.5)	Timed silence	Indicates the length, in seconds, of a silence.
(.)	Micropause	A hearable pause, usually less than 0.2 seconds.
.	Period	Indicates falling pitch or intonation.
?	Question Mark	Indicates rising pitch or intonation.
,	Comma	Indicates a temporary rise or fall in intonation.
-	Hyphen	Indicates an abrupt halt or interruption in utterance.
underline	Underlined text	Indicates the speaker is emphasizing or stressing the speech.
:::	Colon(s)	Indicates prolongation of a sound.

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