Exploring primary school teachers' narratives about mathematical ability through a mathTASK activity: the case of Stella

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We report from a study which explored UK primary school teachers' narratives about mathematical ability using semi-structured interviews and engaging participants in situation-specific activities from the MathTASK programme (mathtasks). We analysed the written responses to the mathtasks and interview data through Nardi, Biza & Zachariades' classification of teacher warrants. Here, we first introduce a mathtask (called "Fractions" in which four students grapple with the question "How do I know which fraction is bigger?") designed to elicit teacher talk about mathematical ability and trigger discussion of whether, how and why teachers deploy grouping students by ability. We then draw on one teacher's data to illustrate themes that emerged as characteristic across our analysis: prevalence of personal and professional empirical warrants and limited presence of a priori and epistemological warrants. Ability narratives emerge as strong influences on teacher decision making as do public narratives of mathematical ability as innate.

Keywords: mathematical ability; MathTASK; warrants; primary teachers

Introduction

Teaching mathematics in ability groups is omnipresent in UK classrooms with ability grouping starting as early as 1944 through the Butler Education Act (Marks, 2012). This is despite evidence showing that ability grouping has not raised student achievement standards – in fact, it may contribute to lowering them – and also has a negative effect on students' personal and social development (Towers et al., 2020). The study we present here is part of the MA dissertation research of the first author. The aim of the project was to explore primary school teachers' narratives about mathematical ability. We used semi-structured interviews and engaged participants in situation-specific activities from the MathTASK programme (Biza, et al., 2007), thereafter *mathtasks*. The focus is on participants' utterances about mathematical ability, as well as their intended practice as evidenced in these utterances. We report data and analysis emerging from the use of a specially designed mathtask which aimed to elicit teacher talk about mathematical ability in the context of a specific classroom situation. First, we present briefly key elements from the research literature around mathematical ability that influenced our study. Then, we outline the rationale for using the mathtask instrument, in tandem with semi-structured interviews, for our data collection – and we present the design of the mathtask used in the study. We then introduce our data analysis instrument, the *classification of teacher warrants* (Nardi et al., 2012) which aims to identify the grounds on which teachers make pedagogical decisions. Data and analysis from one participant, Stella, follows. We conclude with an outline of findings from across the study and a brief thought on the implications of our study for policy and practice.

Mathematical ability and ability discourses

Research has shown a prevalence of perceived ability grouping in primary schools as well as its effects on pupils' self-perception and confidence (Towers et al., 2020; Francis et al., 2017). After conducting research in two different schools using ability grouping and limited setting respectively, Marks (2011) observed that almost all pupils believed that one is born with mathematical ability and that teachers did not realise that ability grouping generated narratives about ability as fixed. As Boaler (2016) notes "when students believe that everybody's ability can grow, their achievement improves significantly" (p.150) and also "when teachers believe that everybody's ability can grow, and they give all students opportunities to achieve at high levels, students achieve at high levels" (ibid.).

A prominent discourse of ability is in policy documents and narratives that refer to intelligence and performance in terms of ability (Francis et al., 2017). The focus on getting a correct answer, speedily, and aiming for good grades, rather than gaining understanding, is a consequence of such traditional narratives of mathematics being for a select few (Stipek et al., 2001). As Francis et al. (2017) note with regard to policy discourse,

> "the White Paper 'Excellence in Schools' was focused squarely on raising educational 'standards', setting was notably advocated within the paper as an aspect of this agenda, including the following statement: Setting, particularly in science, maths and languages, is proving effective in many schools" (p.7).

They conclude that the reason setting by ability is still prevalent despite research casting a doubt on its effectiveness and highlighting its potentially detrimental effect is that there are no equally powerful (embedded) discourses. They call for counter-narratives that will reverse the effect of setting by ability narratives and related practise being taken as the only way to properly respond to the learning needs of children. We explore how teachers' own narratives and policy narratives about mathematical ability influence their decisions in practice.

Participants, data collection and data analysis

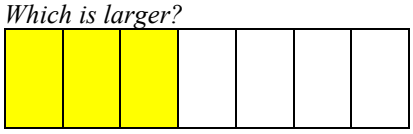
The aim of this qualitative study was to elicit teacher talk about mathematical ability. Participants were five UK primary school teachers with over 4 years' experience teaching mathematics in Key Stage 2, in state and private schools. To start with, we aimed to elicit teacher utterances on mathematical ability in the context of a specific classroom situation, a mathtask designed by the first author (Figure 1). The MathTASK programme engages teachers in reflection on mathematics teaching, through written responses to, and discussions of, fictional but realistic classroom situations that mirror seminal issues on the teaching and learning of mathematics. A situation in a mathtask is triggered by a mathematical problem given to students in class. Responses from students to the problem and a dialogue between students and teacher or/and a reaction from a teacher to these responses follow. A list of questions at the end of the text invites teachers to reflect on issues emerging from the incident (Biza et al., 2007). In designing the mathtask for this study, fractions were chosen as a topic with known challenges for primary pupils (e.g. with fraction equivalence and comparisons). Pupil characters in this mathtask were developed bearing in mind above challenges as well as information sourced from studying policy documents and teacher accounts, e.g. in blogs, about students with perceived low or high ability. Data for this study comprises responses to the mathtask and individual interviews.

How do I know which fraction is bigger?

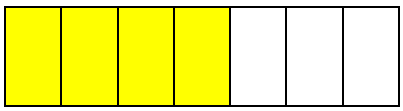
This is a year 3 or 4 mixed ability class busy with fractions. They have recently covered equivalent fractions using circles, bars (blocks), numbers and some manipulatives. The teacher is doing a fraction comparison activity with them that she introduced two days ago. They are sitting in groups of four. The following is the teacher's observation of Group A (Alex, Amy, Jack, Rose).

Activity 1

Which is larger?



$\frac{3}{7}$



$\frac{4}{7}$

Activity 2

Which is larger?

$\frac{3}{4}$ $\frac{1}{4}$

Activity 3

Which is larger?

$\frac{1}{3}$ $\frac{1}{2}$

Activity 4

Which is largest? Which is smallest?

$\frac{3}{8}$ $\frac{3}{5}$ $\frac{1}{8}$

Dialogue per activity

Activity 1

Without talking to each other all students tick the second block as larger.

Activity 2

Alex writes ¼ is less than half so ¾ is larger. "Too easy!"

Rosie: "3 is bigger than 1 so ¾ is larger".

Jack: [surprised] "Nice one Rosie! I didn't think you would get this one". "You answered correctly, remember teacher gave us a rule 'when denominators are the same, the larger the numerator, the fraction is large', so ¾ is larger".

Amy: "I don't like fractions the rules are hard!" she draws two bars and shades 3 and 1 on the other, she hesitantly writes ¾ is smaller because you cut out more pieces.

Activity 3

Rosie: "1/3 is larger than ½ because 3 is larger than 2".

Jack: "I don't think that is correct, ½ is like cutting pizza into 2 pieces only, so ½ is larger". He draws 2 pizzas to illustrate.

Alex: "Drawing wastes time, 1/3 means you cut the pizza into 3 equal parts, so 1/3 is smaller, it's easy".

Rosie [confused] "but in my drawing of blocks, 3 is longer than 2. You two are confusing us?"

Amy is now very quiet, doesn't seem to even follow the discussion. She nervously writes, numerators same, the larger the denominator the larger the fraction**.** 1/3 is larger.

Activity 4

The teacher observes only Alex (excited) writing 3/5 is largest.

Amy is close to tears with a frustrated look on her face. Jack says [annoyed], "Which ones are we supposed to compare first?" "Teacher didn't teach us this". **Teacher decides to intervene at this point.**

Reflections:

1. What are your overall comments on this situation?
2. If you were the teacher how would you intervene, when and what would you say?
3. What particular observations do you make about each one of the students?
4. How would you compare Alex and Jack's mathematical contributions to Amy's?
5. Alex seems to do all the activities with great ease, whilst Amy seems to be overwhelmed, what do you attribute this to?
6. In the last activity Alex correctly identified the largest fraction, do you think he will see the smallest? Elaborate.

Figure 1. The *How do I know which fraction is bigger?* mathtask used in the study.

To analyse teacher talk on mathematical ability, we deployed Nardi et al.'s (2012) classification of teacher warrants:

> ***a priori warrant***: a priori–epistemological (resorting to a mathematical theorem or definition) or a priori –pedagogical (resorting to a pedagogical principle); ***institutional warrant***: institutional–curricular (on the grounds of it being recommended or required in a textbook) or institutional–epistemological (on the grounds that it reflects the standard practices of the mathematics community); ***empirical warrant***: empirical–professional (according to teaching experience, e.g. citing a frequent occurrence in the classroom) or empirical–personal (resorting to personal learning experiences in mathematics); ***evaluative warrant***: justification made on the grounds of a personally held view, value or belief. (pp. 160-1).

To identify teacher claims and warrants, the first author scrutinized the written responses to the mathtask and sifted through the interview transcripts. Claims and warrants for each participant were tabulated. We illustrate this approach in the case of one participant, Stella, in what follows. An excerpt from the table of Stella's claims and warrants is in Figure 2.

Stella's overview of warrants

Stella is a primary school teacher from a state-funded school with 9 years of teaching experience. She has been teaching mathematics to year 4-6 pupils (8-11 year olds). Stella's case was chosen because she gave a very comprehensive written response which made for a rich interview session. Stella mainly relied on empirical warrants to support her claims that mathematical ability is not innate. They were mostly empirical professional warrants but we discerned one empirical personal warrant when she used her own schooling experiences to back up her claim that "mathematical ability is about how you are taught". When talking about the grouping practices in her classroom, she justified her claims with empirical professional warrants with all of them based on what she has observed in her classroom (first and second entries in Figure 2). This was in tandem with several a priori pedagogical warrants (third entry in Figure 2). Her pedagogical warrants were supported by strong institutional warrants (fourth entry in Figure 2).

Stella's assertion that mathematical ability is not innate does not seem to lead her to challenge the institutionally imposed idea of ability grouping. She is a professional and needs to operate within the constraints of the system, even though she is aware of the potentially detrimental effect on children's image of themselves:

> "we started doing that this year, actually, we started to move the children to groups for Maths. The higher, middle and bottom group in different classes and you don't want to label that. But yeah, I think they know. So then, the thing is…Yeah, they always know".

Her narrative may not be strong enough to supersede her professional obligation to align and comply with school policy. As another participant, Emma, pointed out:

> "it depends which school you work, and I've worked in schools where children have to be on ability tables and that's kind of school policy".

Stella's narratives on mathematical ability seem largely based on personal and professional warrants and less on (e.g. research informed) epistemological or pedagogical a priori warrants. We see this as making her vulnerable to institutional impositions and to unquestioned acceptance of setting by ability policies.

Claim	Warrant	Basis	Classification	Quote
Mathematical ability is not innate.	Mathematical ability is about how you are taught.	based on her own experience of being taught	**empirical - personal**	"No, I don't think so. I don't think you're born with it. I think you can learn it. Yeah. I mean, I didn't understand lots of these concepts before, we teach it so different now to how I learnt it when I was in school, so I think it's all about the way you're taught"
A child's ability changes from topic to topic, so ability grouping needs to be flexible.	I have observed that student ability is influenced by what they are good at, which concepts they had good experiences of.	based on observation during lessons	**empirical - professional**	"So it's not just the high ability children are always high ability, in maths we find that it can depend on the concept so it just depends on what they are good at what they've had good experience of"
I do not put high and low ability children working together.	Low ability children need more attention and grouping them separately allows me to give them the attention they need.	based on pedagogical principle	**pedagogical a priori**	"So I probably wouldn't have such a high ability child (Alex) sitting next to somebody that is such a low ability (Amy) because well, I'd rather grab the children that need a bit more input straightaway, so they can move on"
In my class ability groups are determined by results of the activity we do at the beginning of the lesson.	This is what we do in our school.	based on school policy	**institutional warrant - curricular**	"the structure of a math lesson in our class, we would all start on an activity together, and we'll start with resources on the tables. And from that first activity when I would see if the children can grasp it on their own, first of all, and if not, I would assess them at that point, and then start picking out children to put into groups"

Figure 2. An excerpt from Stella's table of claims and warrants (Mashiyane, 2020).

Findings from across the study participants

The research design, data collection and the classification of warrants for the analysis were useful instruments to achieve the aims of this study. Through this particular design of data collection and method of data analysis, we concluded that the teachers in this study did not link their beliefs about mathematical ability with their grouping practices. Whilst they all claimed that they do not see mathematical ability as innate, and all gave different but mostly empirical justifications for their claims, they viewed ability grouping as the standard necessary to engage and support learners' needs. Most of the teachers see ability groups as being flexible and tailored to individual learner needs (even though they differ in how and when groups are determined). Another common thread across all participating teachers is their claim that a teacher does not need to hold overall views on a child's ability: this claim is underpinned by the a priori-pedagogical warrant that a child's needs may differ from situation to situation and grouping by ability needs to be flexible and in response to said needs. That to cater for different learning needs requires ability grouping has been perpetuated by the proponents of ability grouping with limited empirical data (Marks, 2012; Francis et al., 2017). Furthermore, our participants' narratives on ability grouping were grounded on strong institutional warrants with many stating that the decision to group children according to ability within the classroom or in separate classrooms is core school policy. Only one teacher verbalized her preference for mixed ability grouping even though she confirmed that her preference does not matter given school policy that predicates grouping by ability. The ability narratives that result into grouping practices seem to be accepted as given and without seeking evidence of effectiveness. The most frequent warrants that emerged in our analysis were: a priori pedagogical, institutional and empirical, with the third (both personal and professional) being prevalent. The mathematical ability narratives evidenced in the data suggest that these narratives, and ensuing practice, are taken as given and are far from questioned.

Concluding thought

In our warrants-classification supported analysis of the teacher utterances triggered by the mathtask and elaborated in the interviews, ability narratives emerge as strong influences on teacher decision making. So do public narratives of mathematical ability as innate. We found that these influences may perpetuate deeply ingrained teacher classroom discourse and practice. The claims made and warrants given in favour of grouping children by ability shows that there is a strong need for counter narratives (Towers et al., 2020) to challenge the harmful, dominant narratives that frustrate what ought to be at the heart of mathematics education practice and policy: overcoming prejudice about who can do mathematics and making mathematics accessible to all.

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