What are prospective teachers' considerations regarding their intended practice when management interferes with mathematical learning?

Irene Biza, Elena Nardi and Gareth Joel

University of East Anglia, UK

What are prospective teachers' considerations when they make decisions in situations where classroom management interferes with mathematical learning? In this paper we present research that explores prospective teachers' pedagogical and epistemological considerations in intended actions through their written responses to situation-specific tasks. Specifically, we introduce a type of task that addresses both mathematical learning and classroom management issues; and, we discuss the written responses of 21 prospective mathematics teachers to one of these tasks in which a student's unease with Algebra is met with another student's dismissive and offensive response. The analysis we present here observes a lack of balance in the participants' responses in favour of behavioural issues and at the expense of epistemological issues.

Keywords: teacher education, classroom management, task design, situation-specificity

Introduction

The study we report in this paper builds on an on-going research programme initiated by the first two authors and which examines mathematics teachers' considerations when they make decisions in the secondary mathematics classroom. To this aim we use tasks in which we invite teachers to respond to students' mathematical work (Biza, Nardi & Zachariades, 2007; Nardi, Biza & Zachariades, 2012). The use of these tasks so far has revealed a spectrum of teachers' considerations. Furthermore, prior evidence from this research – as well as works such as Jaworski's (1994) *Teaching Triad* (*mathematical challenge*, *sensitivity to students*, *classroom management*) – indicates that classroom management often interferes with working towards commendable learning goals. Starting from this observation we set out to design realistic classroom scenarios that combine seminal mathematics learning and teaching issues with classroom behaviour issues (e.g. classroom management, conflicts between students or between students and teacher); and, to use these scenarios for research as well as in the context of secondary mathematics teacher education. We present outcomes of this endeavour in this paper, especially in relation to the following research questions: (I) What are teachers' considerations when they make decisions in situations where classroom management interferes with mathematical learning? And: (II) Can the type of task design we deploy here – which combines focus on mathematical and classroom behaviour issues – elicit teachers' considerations regarding the teaching and learning of mathematics?

In what follows we present the theoretical perspective of the study, its methodology and one task. Then, we introduce some data and some results obtained through the use of this task with a group of prospective teachers. Finally, we discuss the above research questions in the light of these results.

Theoretical perspectives

The overall aim of the study we draw on here is to refine typologies that describe teachers' knowledge and beliefs – such as Shulman's (1987) constructs of pedagogical content knowledge and Hill and Ball's (2004) mathematical knowledge for teaching – and explore how such knowledge and beliefs transform into pedagogical practice. Explorations of teachers' beliefs and their relation to practice (e.g. Thompson, 1992) acknowledge the overt discrepancy between theoretically and out-of context expressed teacher beliefs about mathematics and pedagogy and actual practice. Therefore teacher knowledge is potentially better explored and developed in situation-specific contexts. For example, Zazkis, Sinclair & Liljedahl (2013) propose *lesson plays* – short stories written in the form of a dialogue between teacher and students – for research and teacher development purposes. These plays draw on specific perceptions of a particular student (or group of students) regarding a mathematical topic and describe a fictional classroom situation in which this topic is discussed. Lesson plays have been used with prospective teachers to support reflection on their future actions and, although the involvement in this activity cannot replace real teaching experiences, it can help teachers develop a larger teaching repertoire.

In a similar spirit, in our studies we invite teachers' comments on classroom scenarios (Biza et al., 2007; Nardi et al., 2012) that they are likely to experience in their lessons. Our tasks based on these classroom scenarios start from a mathematical problem that students are likely to encounter in typical secondary mathematics lessons, followed by fictional student responses to this problem. Participants (teachers, both pre-service and in-service) are invited to: solve the mathematical problem; consider the purposes of its use in the lesson; reflect on the fictional student responses; and, describe the feedback they would provide to the students. Through these tasks we have been exploring pre- and in-service teachers' knowledge of mathematics and mathematical teaching, especially in terms of its gravitation towards certain types of mathematical thinking; certain types of pedagogy; and certain types of didactical practices through the type of feedback they state they would provide to the students. Teacher responses to these scenarios as well as the discussion in follow-up interviews have elicited not only insight into the teachers' mathematical knowledge but also a spectrum of considerations that feature when teachers make their decisions on how to react in a classroom situation. We have described these considerations as pedagogical, curricular, professional and personal (Nardi et al., 2012).

Until recently our scenarios had focused on teaching situations that capture key *mathematical* issues (such as formation of mathematical concepts, use of definitions, visualisation, mathematical argumentation, etc.) – and less on *other* key issues such as classroom management. We now wish to refine our study of aforementioned teacher considerations in a way that addresses the complexity of classroom situations within which the teacher needs to deal concurrently with issues that pertain to mathematical learning as well as to classroom management. To this aim we draw on theoretical perspectives that deal with the classroom social environment such as the social and sociomathematical norms proposed by Cobb and Yackel (1996). Social norms govern the overall interaction in the classroom, including rules regarding students' participation in discussion, group work, and critique of other students or teacher. Sociomathematical norms govern the classroom interactions that are specific to mathematics, such as "what count as a different mathematical solution,

a sophisticated mathematical solution, an efficient mathematical solution and an acceptable mathematical solution" (Cobb & Yackel, 1996, p. 178).

In the part of the study we present here, we propose a new version of the scenarios that expand the aims of the previous one in the following two ways. Firstly, we aim to explore teachers' pedagogical knowledge regarding classroom behaviour management, especially in relation to the teaching of mathematics – such as dealing with a mathematical learning issue while a misbehaviour incident occurs. Secondly, we aim to trigger teachers' reflection on their own considerations on the teaching of mathematics and their role as a teacher. We envisage that prospective teachers' engagement with this type of task, through their written responses first and the discussion afterwards, can support meeting the above aims.

The participants, the data collection and the task

Participants were 21 prospective mathematics teachers (thereafter: trainees) attending a secondary Postgraduate Certificate in Education course (PGCE) in Mathematics in a UK university. This is a full-time, research-led postgraduate course that prepares graduates to teach in secondary schools and combines school and university-based work. Data collection took place in a series of half-day teaching sessions that the first author contributed to the programme. In these sessions trainees were invited to respond to a series of tasks (including the task in Figure 1) designed to trigger engagement with, and reflection on, key issues involving subject knowledge, behaviour management, formative assessment and assessment for learning. We collected the trainees' written responses to each task. Whole-class discussion of the tasks ensued. This study has been approved by the Research Ethics Committee of our institution and agreed upon with the trainees. The data we present here originate in the trainees' written responses to one of these tasks (Figure 1).

The task (see Figure 1) has three parts: a brief description of the context (including Year and attainment level) and the mathematical problem; a dialogue that occurs in a fictional classroom; and, a series of questions in which participants are invited to reflect and respond as the teacher of this class. With regard to the first part, the class has to calculate an algebraic expression for specific values of p and c. Two students, student A and student B, approach the problem differently: student A, substitutes the values from the beginning, whereas student B simplifies the expression first and then substitutes the values. When student A acknowledges her difficulty in simplifying expressions, student B judges student A in an offensive ("you are thick") and dismissive ("what can I expect from you anyway?") way. Both solutions are correct. However student B's approach demonstrates proficiency in important algebraic skills which student A does not seem confident with applying. Student A instead puts herself in the slightly tedious and potentially risky position of working on extensive arithmetic operations. We propose that participants' responses to the task provide evidence for exploring the following questions:

1. Does the response *balance* the mathematical (two different solutions) and the behavioural (verbal mischief that verges on offensive treatment of a peer) issues of the scenario? We see unbalanced responses as: ones that underestimate the value of student B's algebraic solution because of the unacceptable way in which she responds to student A (emphasis on behavioural issues); or, ones that ignore the verbal offense and focus on the mathematical aspects (emphasis on mathematical issues).

2. What *considerations* does the participant bring into play in their response to the task? These considerations can be related to: the establishment of social norms (e.g. sharing and critiquing ideas in a classroom) and/or sociomathematical norms (e.g. existence and acceptance of different types of solutions); epistemology (e.g. appreciation of the simplification-first solution vs the straight-to-substitution solution); pedagogy (e.g. ways of dealing with difficulties with algebraic expressions); and, teacher agency (the role of the teacher in establishing and maintaining classroom norms).

In a Year 10 middle attaining class you have invited the students to solve the following problem:

When p=2.8 and c=1.2, calculate the expression: $3c^2+5p-3c(c-2)-4p$.

After working on the problem for some time you invite the students to share their solution with the class. The dialogue below follows:

YOU: Ok, let's see what we can do with this question. Who wants to share their answer with me?
[Student A and Student B raise their hands at the same time.]
YOU: Student A?
STUDENT A: I found 10.
YOU: How did you find 10?
STUDENT A: I substituted the values 2.8 and 1.2 in the expression. It took me ages.
YOU: Thank you Student A! [to the class] Does everyone agree?
STUDENT B: I have the same answer but I did it so much quicker.
YOU: Go on…
STUDENT B: I worked out the expression before substituting the numbers and I ended up with a much simpler expression: $p+6c$. Then I substituted the values 2.8 and 1.2 and I found 10, *easy*!
STUDENT A: I like the way I did it; I don't like simplifying.
STUDENT B: My solution is brilliant, yours takes ages. You cannot work with letters because you are *thick* [some students are giggling] … what can I expect from you anyway? [some students are laughing].

You heard what Student B said …

Questions:

a. How are you going to respond to Student A, to Student B and to the whole class?
b. What do you think are the issues in this situation?
c. How are you going to deal with these issues in the future?

Figure 1: The task.

Results

In their responses, all participants spotted that both solutions are correct and all of them addressed student B's ill-behaved reaction to student A. However, not all participants addressed student A's difficulties with algebra. We split the scripts in two groups. Group I, 11 out of the 21 responses, include evidence of at least one of the following: the two solutions are not of equal value; student A has difficulties with algebra; the response addresses student A's difficulties in question (a). Group II, the remaining 10 responses, consider the two solutions of equal value and, although three of them mention that student B's solution can be seen as *quicker*, they do not address student A's unease with simplification. They focus mainly on behavioural aspects of the incident. In the following we exemplify from the scripts of both groups.

For example, trainee [3] (group I) writes in question (a):

> [3] on student A: I like that you have acknowledged that your method takes a long while, whilst it gets you the correct answer, which is great; can you see that simplifying may make it easier for you and save you time especially if I gave you a much much longer complicated expression.
>
> [3] on student B: Both solutions to the problem are good solutions they both gave correct answers, student A's solution took a lot longer as they were working with really complicated arithmetic rather than simplifying this doesn't make student A thick so I don't want to hear you use that again, on a positive note I like how you

> have simplified the expression to get a quicker easier method so maybe you could try and help student A with simplifying as it's something student A doesn't like and it will help with your understanding too.

Trainee [14], also from group I, in question (b) mentions that the issues of this situation are: "Student A prefers numbers to algebra. Student B is quite rude" and "[b]oth of these need dealing with". It is evident that trainees [3] and [14] spotted both the mathematical and behavioural aspect of the scenario. Both of them appreciate the algebraic approach as more efficient and, especially for trainee [14], this approach is necessary for the exams: "[f]rom a teacher's point of view student A needs to be taught how to simplify for the purpose of non-calculator papers". Pedagogically, trainee [3] aims to "encourage students to help each other and discuss methods" whereas trainee [14] wants to "ensure that the rude speaking out is unacceptable and not welcome in the class and therefore doesn't happen again" (question (c)).

The *balance* in the consideration of both mathematical and behavioural issues that we saw in the group I scripts was not in much evidence in the group II scripts. For example trainee [6] (group II) writes in question (a):

> I would want to highlight that calling someone else stupid is unacceptable. As this was mentioned in front of the whole class and some people laughed I would make the point of addressing the whole class with this. I would also speak to student B after the lesson regarding their behaviour & lack of respect for their peers.
>
> I would then go on to say that both these methods can be used and both get to the same outcome. However it is up to each individual as to which they use, depending on their preferred method.

In question (b) she mentions that the "[i]ssues are that students believe there is only one way to answer a question" and "[i]ssue of the lack of respect from Student B and other members of the class giggling towards Student A. Need to ensure rules are obeyed". And, in question (c): "Make it clear that respect is extremely important and that there are many ways to solve mathematical problems it is about finding ways <u>you</u> are comfortable with you don't all have to work the same way"[her emphasis]. For this trainee the two solutions are equivalent and it is up to the student to decide which one to use. In this sense they do not address student A's difficulty with Algebra and their *unbalanced* responses lean more on addressing behavioural issues.

Trainees from across groups I and II indicate the norms they wish to establish in their classrooms: a social norm of a respectful classroom and a sociomathematical norm of the acceptance of different solutions for the same problem. Trainee [4] (group I) speaks about classroom "culture" in question (b): "There seems to be a culture of there is only one right way to do questions. Students do not support each other or respect each other methods and contribution" and in question (c): "[I will] create a culture of discussing, sharing and involving each other and make sure no student goes against this culture". In the same spirit trainee [20] (group II) wrote in question (c): "[I will c]reate a classroom atmosphere where students aren't afraid to contribute, be wrong, have opinions. A respectful classroom where everyone listens to each other and supports one another" and later she adds: "To this I'd impose ONE RULE from the start: RESPECT" [her capitals].

Finally, a sense of teacher agency comes across from the scripts: trainees feel responsible for the establishment of the rules in the classroom and students' compliance with these rules – see also "Need to ensure rules are obeyed" from trainee [6] above. In some of the responses this responsibility is stated with a strong sense of ownership: "your comment […] is unhelpful & something I don't want to hear in *my* classroom" [our emphasis], trainee [17] says to student B.

Concluding Remarks

Our analysis of the 21 responses to the task suggests some insight into our two research questions (I and II). Regarding I, our analysis highlights that most trainees discussed social (such as peer respect and value of discussion), and sociomathematical (such as acceptance of different solutions) norms they wish to establish and maintain in their classroom; and, mentioned the degree to which they feel responsible for doing so. Our analysis also highlighted that almost half of the responses focused mainly on behavioural aspects of the incident and either ignored entirely – or made limited reference to – mathematical aspects of the incident (by considering the solutions of students A and B to be of equal value and not addressing student A's stated difficulty with algebra). We posit that this lack of *balance* of consideration for mathematical and behavioural issues (Jaworski, 1994) in a substantial proportion of the responses merits further attention. Our study – in the form of further tasks and analyses of the data generated from these – is currently making progress in this direction. Regarding II, we credit this type of task – which addresses a combination of mathematical and behavioural issues – with allowing this insight into trainees' considerations regarding their intended practice. We are now exploring ways in which the post-task response discussion and scenarios generated by trainees themselves can be utilised towards meeting the aims of the larger study for both research and teacher education purposes.

Acknowledgements

We thank our institution's *Pump Priming Research Fund* for financial support towards this phase of our study. We also thank the participating trainees and doctoral student Athina Thoma for their commitment and support to this study.

References

Biza, I., Nardi, E., & Zachariades, T. (2007). Using tasks to explore teacher knowledge in situation-specific contexts. *Journal of Mathematics Teacher Education, 10*, 301-309.

Cobb, P., & Yackel, E. (1996). Constructivist, emergent, and sociocultural perspectives in the context of developmental research. *Educational Psychologist, 31*(3/4), 175-190.

Hill, H. C., & Ball, D. L. (2004). Learning mathematics for teaching: Results from California's mathematics professional development institutes. *Journal for Research in Mathematics Education, 35*(5), 330-351.

Jaworski, B. (1994). *Investigating Mathematics Teaching: A Constructivist Enquiry*. London: Routledge.

Nardi, E., Biza, I., & Zachariades, T. (2012) 'Warrant' revisited: Integrating mathematics teachers' pedagogical and epistemological considerations into Toulmin's model for argumentation. *Educational Studies in Mathematics, 79*(2), 157–173.

Shulman, L. S. (1987). Knowledge and teaching: Foundations of the New Reform. *Harvard Educational Review, 57*(1), 1-22.

Thompson, A. (1992). Teachers' beliefs and conceptions: A synthesis of the research. In D. A. Grouws (Ed.), *Handbook of research on mathematics teaching and learning* (pp. 122–127). New York: Macmillan.

Zazkis, R., Sinclair, N., & Liljedahl, P. (2013). *Lesson play in mathematics education a tool for research and professional development.* London: Springer.