

STUDENT TEACHERS' RESEARCH INTO REALISTIC MATHEMATICS IN THE CONTEXT OF ENGINEERING MATHEMATICS DAYS FOR GIRLS. WHO LEARNED WHAT?

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This paper will report on a project designed to engage some initial teacher education students in research. The students are in their first year of a two year route into mathematics teaching. In the context of a mathematics education module they have drawn on ideas from the Realistic Mathematic education tradition from the Netherlands to develop and run four 'Engineering Mathematics days'. Six schools from a disadvantaged area in Northern England have been funded to send groups of 50 girls to attend the activity days. The student teachers were asked to devise a mini-enquiry focussed on some aspect of the girls' learning.

INTRODUCTION

This paper describes the development of a level 6 mathematics education module taken by students in the first year of two year (BSc/PGCE) routes into teaching. This is a new module and my aims were to raise their awareness of the complexity of issues in mathematics education and to introduce them to relevant literature. The module was linked to a European funded project aimed at raising girls' educational aspirations and attainment.

One of my key concerns as a teacher educator is that I describe classrooms which my students never see. I talk about working in all-attainment groups, working on activities and projects, and working with equipment and resources. When they spend time in school mathematics classrooms they see setted children sitting in straight rows working from text books. I have first to convince the students that there *are* other ways of working and then that there is research evidence to support the effectiveness of alternative approaches. The module was devised to incorporate the students running Engineering Mathematics days for the girls. The students would undertake a min-research project, using the days to collect data, and submit this for their module assessment.

I am interested in the Realistic Mathematics Education project in the Netherlands and how it has been further developed into a pedagogy of realistic teacher education (Korthagan 2002). I wanted to introduce the students to Freudenthal's ideas about mathematics as human activity (Freudenthal 1991). Many of the students talk at interview about wanting to make mathematics more 'real' for pupils in school. RME asks that 'mathematics lessons should give students the 'guided' opportunity to 're-invent' mathematics by doing it (Van den Heuvel-Panhuizen). The students were introduced to and read about the principles behind RME. They worked on a typical RME activity, the van Gogh problem (Treffers, A 1993) and discussed the opportunities for learning it afforded. They then worked together on a whole range of different practical activities drawn from resources published in England. We agreed that it was important that they knew and liked the activities they would be using with

the girls. I hoped that they would select a range so that the girls could look around the room and see that there were more exciting possibilities than could be squeezed into a day. The day was structured around three activity slots each lasting an hour and a quarter and we discussed the need for a balance of different tasks. The days ended with a brief presentation by each group of girls.

Students on teaching practice often move from being observers at the back of the room to standing at the front worrying about 'control'. As observers the students walk around the room and try to establish conversations with pupils and support their learning. It is very difficult for them to learn about children's mathematical development in this role partly because they are unprepared in terms of the mathematics and partly because it is so difficult to establish any meaningful discussion in such encounters. Once they are 'at the front' they become fearful about classroom management and concerned more than anything to 'survive' intact. They are conscious that everyone is looking at them and judging them. They have too much to think about, and make sense of, and the planning of lessons makes huge demands on their time. The activity days provided a very different experience which allowed them to grow more gently into their teacher role. On the first day they hovered around the edges of the beautifully laid out room whilst the girls sat down excitedly and began reading the programme and looking at all the equipment. By the final week many of the students were engaging the girls in conversation immediately and sitting down around the tables with them straight away. The students spent the whole day with their group and it gave them an opportunity to get a very close view of the girls' needs as learners of mathematics and of the girls' interactions with their peers. They also became more aware of their role as teachers in a context where they were not being assessed or judged in any way. The students noticed and commented on the nature and extent of involvement adopted by the teachers who accompanied the girls.

At the start of the unit I had a traditional model in my mind though of the structure of their mini-enquiry

- Read relevant literature
- Frame a focussed question
- Collect data with triangulation in mind
- Analyse the data referring back to the initial reading

I have never found it easy to formulate focussed questions or, if I have the questions, then the project seems to wilfully take off in another direction and not answer them. Two of the students came to see me before the activity days to argue that they could not produce a focussed question in advance because they did not know what would be interesting, or what kinds of questions their data might be able to answer. I agreed with them but felt that I shouldn't and worried that I was not able to teach this properly as already they were falling into the kind of bad practice I was guilty of. I

think I steered them towards an action research model which gave them scope to develop their ideas over the time but still felt legitimate.

When I talked to the students in tutorials after the activity days I found myself unable to resist moving them away from the initial model. I admitted we were not really in the business of answering specific questions and encouraged them to think about key themes which seemed to be significant. I talked about the 'data' not only in terms of the girls' written evaluations but also as their stories from the days. I reminded them of the things people had described in the seminar shortly after the last day and encouraged them to think of their own reflections as data.

When I came to read their assignments I understood in retrospect much more clearly what I wanted them to do. I wanted them to move through the same series of questions whether their focus was on motivation, group interaction, problem solving skills etc.

- What happened on the activity days?
- What do I think this means (in terms of the girls' learning)?
- Why do I ascribe these meanings? Is it because of my own learning experiences or ...?
- What have other writers/researchers found? How have they analysed their findings?
- Do I agree with their analysis? If so why if not why not?

This is much closer to the models discussed by Korthagan (2002 p8) 'In sum realistic teacher education starts from the student teachers' experiences and their gestalts rather than from the objective theories on learning and teaching in the literature.' We held a seminar after the activity days to which each student was asked to bring two questions or issues that they had been thinking about. In our round table discussion two of us were working as tutors with the students to help them develop theory with a small t (Korthagan 2002). It was an opportunity to point them to appropriate reading which in turn might lead them towards theory with a capital T.

WHAT LEARNING HAS TAKEN PLACE?

The girls all filled in an evaluation sheet at the end of the day. In addition many of the students incorporated reflective writing about the activities into their day plans and some encouraged the girls to write down what they were going to say in the final presentation. The key theme to emerge from the girls' responses were their surprise that what they had engaged in was anything to do with mathematics. Some girls also expressed pleasure at having an opportunity to work with each other in a very relaxed in formal setting.

Was there anything that surprised you during the day?

"Yes I though we were going to do maths questions"

“I thought this was going to be sums but it was fun and I didn’t realise I was doing maths”

“No tests”

“The direct non-maths – Although it was implied”

What was the best thing about the day?

“I thought doing the bridge building was the most interesting as we could work in a team with friends”

“The students we worked with were really helpful and I felt comfortable enough to make mistakes”

Some of the students became aware of their preconceptions by having them contradicted in practice.

My experiences of mathematics lessons prior to starting at SHU were working individually in a chalk and talk environment, practising mathematical rules and methods to pass an exam. This being what I am used to became the way that I naturally thought was the best way of teaching mathematics. Working with the Barnsley girls has made me more aware of how my beliefs have changed, during undertaking this Maths Teaching course, on how mathematics should be taught in schools by actually observing how they benefit from group work and thought provoking activities.

Describing the days in their assignments gave the students an opportunity to articulate their developing understanding of the learning process.

The ability to make mistakes often became the girls’ best tools during the course of the days. It was the mistakes that prompted most of the thinking and development of ideas.

It was also a beneficial day in terms of the girls’ learning as they had the opportunity to work in groups and share/discuss what they were doing with the other members in their group and look ah what other groups were doing which was different.

I was particularly interested in the effects on motivation because I feel that motivation is one of the most significant factors in the pedagogy of mathematics. I also feel there is often a lack of motivation on the classroom... I hope that I can employ what I have learned to increase motivation in the classroom I teach in.

Working closely with a small number of girls all day made the students much more aware of their role as a teacher.

There were many activities where success or failure in stimulating mathematical thought depended on how you introduced the activity to the girls.

One student explained in a tutorial that all through the four activity days he had been thinking about how to move the girls’ mathematics on. What should he say as the teacher to give them the confidence to overcome their uncertainty? He felt he had learned a little bit about how to nudge and guide. Now he suddenly realised he was like one of the girls, he was unconfident about this thing called a research project and

scared to start and I was in the role of encourager. 'You are doing to me what I have been doing to the girls.' His excitement at making the link between himself as a learner and himself as a teacher was tangible

Ruddock (1992 p164) argues that it is important for students to be introduced to the 'excitement and power of practitioner research' during their initial teacher education so that they return to research as a strategy for their own professional development. Some of the students did explicitly reflect on the purpose of the project.

This research is not only being carried out because it is a course requirement but it will serve me as a teacher in the future ...after carrying out this research I strongly recommend mathematics teachers to make their mathematics lessons exciting and have practical activities.

On the whole, the engineering maths days have, however, been an extremely beneficial exercise in the setting up, recording and analysing of the data of a real life research project. It is my own and I suspect the majority of my cohorts, first experience of being involved in an educational project in a research capacity.

There are inevitably all kinds of details that I think I will change next year and I want to reassess the teaching I did before we started preparing for the activity days. What I am pleased about is that the students are carrying with them into their professional year all kinds of questions and a personal experience of a model of teaching and learning that they believe was successful. I think many of them will be prepared to try something similar on teaching practice and I shall be encouraging them to do so and facilitating their feedback to each other as they develop their practice in a school setting.

I wanted to take up the challenge of not allowing a gap to develop between theory and practice. Even if student teachers rationally understand the importance of theory as a means to support practice, they soon experience that they are not the only ones struggling so much with everyday problems in the classroom that the whole idea of applying theory becomes an impossible mission.

... The only way out of the feeling of always falling short is to adapt to the common habit of teachers to consider teacher education as too theoretical and useless. (Korhagan 2001 p5)

I don't think I was entirely successful in this aim because many of the students did not make links with the reading they had done before the activity days which was when I introduced RME. They did however make very good use of the reading they did after the activity days and there is evidence in many of their assignments that they have used the literature to help them make sense of their experience.

I have learned something about teaching research. I began by offering the students a model that I don't find easy or indeed really use. In the mathematics classroom I have always been against the idea of telling GCSE pupils that if $b^2 < 4ac$ then the quadratic has no solution and preferred instead to whet their appetite for further study by telling

them that the solutions require us to invent a new kind of number. In the same way I have realised that I don't want to give students a restricted model of research methodology and pretend that it is all much more straightforward than it is but nor do I want to overwhelm them with the equivalent of complex numbers. I think I learned *during* the tutorials how to find the right balance with each individual or pair. There will always be an intuitive and immediate aspect to teaching just as there was for the students with each new group of girls. Our experience does not allow us to codify and formulate our activities rather it gives us confidence that we can act wisely in the situation.

Good practice is not a matter of reproducing pre-programmed response but responding intelligently and wisely to a situation as it unfolds on the basis of discernment, discrimination and insight. Moreover the relationship between understanding and action is an interactive one. One does not first understand and then act. Understanding is developed through acting in the situation and those actions are themselves improved as understanding develops. (Elliott 1993 p8)

REFERENCES

- Elliott, J (Ed) (1993). *Reconstructing Teacher Education: Teacher Development*. London The Falmer Press.
- Freudenthal, H (1991). *Revisiting Mathematics Education. China Lectures*. Dordrecht: Kluwer Academic Publishers.
- Korthagen, F.A.J. (2001). *Linking practice and theory: the Pedagogy of Realistic Teacher Education*. Mahwah Lawrence Erlbaum
- Korthagen, F.A.J. (2002). *Reframing teacher education: the realistic model*. Paper presented at the European conference on educational research, Lisbon September 2002.
- Ruddock, J (1992). *Practitioner research and programmes of initial teacher education*. In Russell, T and Munby, H Eds *Teachers and Teaching. From Classroom to Reflection*. London. The Falmer Press.
- Treffers, A (1993). *Wiskobas and Freudenthal realistic mathematics education*. *Educational Studies in Mathematics* **25** p89-108.
- Van den Heuvel-Panhuizen, M (2000). *Mathematics Education in the Netherlands a guided tour*. Freudenthal Institute Cd-rom for ICME9. Utrecht: Utrecht University.