

## LEARNING TO TEACH STATISTICS THROUGH PROJECT WORK

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*Whatever the debates about the relation between mathematics and statistics as disciplines, the latter is typically offered within school mathematics curricula. This relatively new inclusion has enhanced the opportunity for learners to experience a greater relevance of mathematics curricula to their own lives, and hence also created the imperative to better understand how best to organise teaching and learning toward such goals. Not surprisingly, teacher education has had to take on such challenges and in so doing brought a focus also on what happens within the halls of tertiary institutions. The question this paper addresses is how best do we prepare teachers to connect mathematics and statistics education to learners' own realities. If project work, within a broad social, cultural political approach, is one means for forging such links then there is a need to analyse and better understand the kinds of teacher education pedagogies that may be engaged to build the necessary knowledge, skills, attitudes and values among teachers.*

### INTRODUCTION

For the past few years I have introduced project work to prospective primary school teachers as a means for realising a social cultural political approach to the school mathematics curriculum. Such an approach engages in a very direct way the relation between mathematics (especially including statistics) and society, drawing on several recent developments in mathematics education such as ethnomathematics, critical mathematics education, as well as mathematics curriculum debates of race, class, gender and other dimensions of diversity, and South Africa's own legacy of People's Mathematics from the apartheid era. Given the sharp focus on context, it has invariably and rather naturally opened opportunities for teaching and learning about statistics, but embedded in a particular ideological and value orientation, also supported in the current mathematics curriculum reforms in South Africa, that seek to integrate goals of equity, democracy and social justice. Indeed the topic of data handling, as it is referred to in the curriculum, is most explicitly exemplified with such possibilities in the document (Dept of Education, 2001).

Project work as a means for realising such an approach has been developed in practice and theoretically (Skovsmose, 1994; Vithal, 2000); but what has not been sufficiently explored is the pedagogy by which teacher educators create opportunities for teachers to learn, interpret and give meaning to practices advocated in their courses, and this seems also to apply to statistics education (Shaughnessy, Garfield & Greer, 1996). To this end, as a teacher educator, I analyse my own pedagogy with respect to how student teachers engage project work, and in particular statistics teaching and learning within this context. I distinguish three, though not mutually exclusive approaches, 'a theoretical, imagined practice'; 'an actual teacher-as-learner practice'; and 'an arranged in-school practice', drawing on theoretical methodological tools for researching a critical mathematics education (Skovsmose & Borba, 2000; Vithal, 2000).

### A THEORETICAL, IMAGINED PRACTICE

Typically teacher educators present problems, issues, contexts and examples to prospective teachers who are expected to imagine themselves in their own classrooms working in ways explained by the teacher educator. The situation imagined is a hypothetical one, which may attempt to take account of the diversity present in the education system and likely to be encountered, of learners and school contexts, and the theorising underpinning particular practices advocated

The student teachers, for instance, read and discuss different examples of projects from the literature, usually in groups, and engaged different theoretical ideas in mathematics content and pedagogy, which they present to the class. They discuss about how project work is problem oriented; participant directed; interdisciplinary and based on the exemplarity principle (Olesen & Jensen, 1999). Particular content, including statistical knowledge and skills, teaching approaches,

students' conceptual learning, what the current curriculum documents state, resources available, and possibilities and pitfalls in trying out these new and often imported ideas in different schools and classrooms are debated.

This discussion oriented teacher education pedagogy is taken further to give prospective teachers the opportunity to bring their sociological and pedagogical imagination to bear on constructing practices for implementation. Based on their critique of the projects they had read and analysed, student teachers bring their own intentions, dreams, hopes, backgrounds, experiences and knowledge about mathematics classrooms, curricula, schools and learners and positioning as teachers as well as their interpretation of the approach to develop projects (Vithal, 1997). Such 'theoretical practices' they imagine includes adapted projects, for instance about 'Social and economic relations in the world of a South African child' recontextualised from a similar Danish project (Skovsmose, 1994); but also experimentation with new ideas of their own, for instance, developing a project on usage and wastage of electricity including data about the different forms of provisioning in different areas. These projects create potential spaces for teacher educators to identify and focus on issues of teaching and learning about different aspects of data handling from learners' own life experiences and circumstances, even if mainly in basic descriptive statistics. The teacher education course then takes up these possibilities for extension into other aspects including some inferential statistics beyond an elementary level. In addition students also acquire a statistical literacy from reading related educational research literature. No matter how innovative, this teacher education pedagogy is confined largely to the lecture room.

#### ACTUAL TEACHER-AS-LEARNER PRACTICE

In this approach the teacher educator construes the student teachers as pupils and herself as the teacher so that the prospective teachers can experience the actual pedagogy as learners. It may be described as a serious simulation of the pedagogy intended for student teachers to emulate in their own practices as teachers, by making them directly feel and participate in the practices themselves in coming to know a curriculum approach they may not have experienced as students.

In actually enacting a project work pedagogy, I invite student teachers to consider or suggest "problems" that they might find interesting, important or relevant to their own lives. Such a discussion also includes joint decision-making about choosing different projects as individuals, in groups or as a whole class. In the year that the university closed down due to student protests against student exclusion for non payment of fees the entire class chose a project theme on "the economic relations in the life of a university student" and worked in small groups on units investigating different aspects of the project: e.g. what moneys do students spend during a single year; on what; who pays for their fees, what are fees used for, etc. Similarly the following year group chose a project on "crime on campus" following publicity in local newspapers about the university and its stereotyping as an unsafe historically disadvantaged black university. By collecting and comparing a wide range of data, they showed in their class presentations, the campus to be a relatively safer place, and identified high crime spots on campus. More recently, since HIV/Aids is beginning to show an impact, student teachers undertook a project to investigate their fellow colleagues' knowledge about the disease and sexual practices; including their preparation for dealing with this problem as teachers in school. Yet another group in this class took on a project on levels of waste and recycling in the university.

An important aspect of the projects is acting on findings from analysing data collected. Hence projects include dissemination of information found out on notice boards in the library or cafeteria e.g. about HIV/Aids or crime statistics; and making representation to relevant authorities to effect changes e.g. bins for paper recycling by presenting their reports. As each project theme develops, the activities identified at the beginning form a broad blueprint for the project, which unfold and take shape and evolve as the students knowledge and experience deepens through the project and yields ideas for action.

During the time that the projects run the teacher educator takes different roles as a resource person, facilitator, supervisor and teacher - making suggestions, reviewing data collection instruments such as interview schedules and questionnaires, teaching mathematics, making contacts for other subject matter knowledge, for example in science, as well creating opportunities for using computer software for data analysis and presentation. When the project is

completed, which can extend from a few lecture periods to an entire term or semester, a debriefing in which substantial reflections takes place about the roles of each participant. This is crucial to assist student teachers in their recontextualisation of the project for a school setting - the workings of the group, the ways in which mathematical content and pedagogy were dealt with, and its connection to other subject matter learnt, practical organisation needed for implementation in schools, too much or too little guidance I provided as a teacher or facilitator, assessment opportunities and forms, etc. In this way the project work period opens for extending various aspects of content and methodology further, even if in more traditional formats, because what the teacher-as learner practical experience does, is changes student teachers' reasons for learning how the pedagogy works in quite fundamental ways as mathematics (and statistics) education is seen and enacted as both a tool for critique of context and an object of critique.

#### ARRANGED IN-SCHOOL PRACTICE

This third approach in teacher education refers to deliberately arranging a situation for prospective teachers themselves to implement a particular practice, problems or pedagogy, in a real mathematics teaching-learning situation, with support from the teacher educator and possibly other practitioners such as a teacher in a school. Usually this takes place during that time set aside in most teacher education curricula as 'teaching practice', and follows after the student teachers may have been introduced to the activities to be tried out through one or both of the other two approaches already described. Many factors influence what student teachers eventually come to do in a particular classroom in an attempt to realise to particular approach: from the quality of relationships between the different participants, the school culture for or against change and innovation, strike actions and other pressures faced by teachers or schools, administrative and management support and resources, to the student teacher and teacher educators' own understanding and confidence about particular practices.

While requiring all student teachers to try out innovative practices such as project work when placed for internships in schools, there is much variation. Some student teachers implement only one or two single units related to a particular project theme that they themselves might have worked with. For example students who worked on the project on economic relations in life of a child or university student led whole classes of learners in an activity of identifying and calculating 'pocket money' given or earned by learners and representing this information in different ways for different samples of learners. But other student teachers took advantage of the opportunity to realise what is considered radical by some teachers and schools. For example a project on building a fence for learners' play area ran over a six week period which included measuring and gender debates in the use of different measuring instruments, calculating area, perimeter, percentage tax in costing the fence and fund raising, and making representations to the school principal as well as recording data and information in a letter to the provincial department of education for financial assistance. Further, such practices were presented and written up by student teaches for wider dissemination and discussion (Vithal, Paras, Desai, Zuma, Samsukal, Ramdass & Gcashbe, 1997; Paras, 1998), which may be more readily taken up by teachers and continued later by student teachers because they speak more directly to challenges of practice and context.

This diversity in practice can be seen as enriching for the curriculum approach and results from maintaining a resonance between the teacher education pedagogy and the mathematics classroom pedagogy - an approach that makes central a principal of participant directedness, opens for multiple recontextualisations of ideas. Hence, in yet another interpretation of project work, the student teacher allowed her class to work in groups on several different project problems: how much money is spent on my education challenging the collection and use of fees by the school; how my time is spent after school to reduce the homework given; and a sports survey challenging the school for not meeting their sporting interests (Vithal, 2000). Each of these involved substantial statistical content knowledge teaching and learning which was dealt with in three different ways by the student teacher. First, she gave each group a chapter on data handling from a textbook, which they read and then used to draw tables and graphs. Second she worked with each group discussing the different kinds of data they had collected and pros and cons of different representations for acting on their concerns. Third she included more conventional

whole class lessons on these in which they not only all drew graphs based on their own personal data, but also read and interpreted graphs, similar to a language comprehension activity led by their language specialist class teacher, as they developed a statistical literacy.

## CONCLUSION

In any teacher education programme it is likely that various combinations of these teacher education practices occur, though they may be driven more by one than another in terms of time allocated and how they are valued as indicated by assessment processes. This analytic separation is useful however, for showing up particular advantages and disadvantages of each when it dominates a teacher education curriculum. If an imagined hypothetical practice is predominantly engaged within a teacher education pedagogy, it tends to remain as such, theory, which seldom sees a substantial transformation into practice once they are in the classroom as years of socialisation and the culture of the context take over and mitigate against change. On the other hand an over-emphasis on a teacher education pedagogy as practice in arranged classroom settings can undermine the development of a theoretical understanding of the approach because of the focus on trying to make the innovation work and limited capacity and time to analyse, understand and deal with problems that arise in practice, as indeed any innovation inevitably will throw up. While each of these seem to be more appropriate for developing theory or practice respectively, in the second approach student teachers sometimes struggle to acquire both because they become engrossed in the project work experience itself and the content of the problem. However, having experienced it first hand as a learner they may be more interested and committed to make the additional effort to try it out in a classroom, though they often tend to implement versions and variations of the projects they themselves had participated in as learners in the teacher education programme. Ideally, a teacher education programme should attempt to integrate all three practices especially when introducing innovative practices and theories not well known in the education system as a whole. But what may be desirable is seldom what is possible in the real, unpredictable and untidy world of schools and classrooms, and in the still not yet well-understood programmes and pedagogies of mathematics and statistics teacher education.

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