

# Analysing mathematics teacher education from a critical perspective: The case of project work

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## **Abstract**

*While there has been considerable advancement in the last few decades with regards to theories and practices in mathematics education from a critical perspective, very little is known about what it means to prepare teachers for such approaches. In this paper I undertake a retrospective, reflexive analysis of my praxis as a teacher educator over the past decade, particularly when introducing an innovation such as project work to prospective primary mathematics teachers within what may be referred to as a social cultural political approach to a mathematics curriculum that integrates a critical perspective. To do this I draw on theoretical methodological tools developed for researching mathematics education from a critical perspective and reinterpret them for building an analytical framework for mathematics teacher education from a critical perspective. These are imagined hypothetical praxis, actual current praxis and arranged praxis. I then discuss the qualities that connect and transform these praxes and conclude with my reflections about the consequences for student teachers' learning and actions when one of these dominates a teacher educator's curriculum.*

## **Introduction: a social cultural political approach**

Mathematics education from a critical perspective explores and deepens the link between mathematics education in its widest sense and concerns about democracy, equity and social justice. It is not a particular kind of mathematics education but refers rather to a diversity of perspectives that may be brought to bear on mathematics education from social, historical, cultural, economic, political and other dimensions. To this end it draws on a broad landscape of theory and practice within recent developments in mathematics education. I bring this work into teacher education programmes for prospective primary school teachers through what I have termed a social, cultural, political approach to the mathematics curriculum (Vithal, 1997, 2003). Such an approach integrates a critical perspective in that it attempts to go beyond a concern for developing mathematical knowledge, skills, attitudes and values to being able to act in the world towards fairness and justice on the basis of the competences produced. Such an approach engages in a direct way the relation between mathematics education and society drawing on a range of areas such as ethnomathematics, critical mathematics education, as well as issues of race, class, gender and other aspects of diversity, and South Africa's own legacy of people's mathematics from the apartheid era. The current South African mathematics curriculum reforms have increased the imperative to consider mathematics education from a critical perspective since it embeds a particular ideological and value orientation that explicitly implores teachers to respect human rights and other constitutional ideals, in attempting to heal the divisions of an apartheid past. (Dept of Education, 2002).

A social, cultural, political curriculum approach may be realised through a number of different practices such as the "mathematical archaeology" or "unfreezing"



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of texts, artefacts and activities. In this paper I focus on one particular practice that of project work, which has been elaborated with respect to a critical perspective in mathematics education (Mellin-Olsen, 1989; Skovsmose, 1994; Vithal, et al. 1995; Christiansen, 1996; Nielsen et al 1999; Niss, 2001; Vithal, 2004). Inspired especially by project work theories and practices in the Scandinavian countries, 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 that integrates a critical perspective. Within this framework project work is theorised as a research-like activity. It is problem-oriented in that the project ideas to be investigated or explored arise from the interests and concerns of learners and is jointly directed with teachers but where the teacher's role is that of facilitator and supervisor developing mathematical competences, connecting it across disciplinary boundaries with possibilities for acting on the learning gained. Such specific experiences exemplify for learners how mathematics is connected to the real world and its role and function in society.

If teachers are to be inducted into a mathematics education that integrates a critical perspective, the question is, how are its related theory and practices as well as intentions and expectations to be developed and maintained within a mathematics teacher education pedagogy? It may be argued that there should be some resonance between the pedagogy teachers are expected to enact as a consequence of their participation in education and training programmes, and the pedagogy enacted by the teacher educators themselves to induct teachers into the particular perspectives and practices they advocate. This imperative is especially relevant when referring to a critical mathematics pedagogy if teacher educators are not to risk flouting in practice the very values and ideals that they are propagating in theory. (We return to this point later)

### **Mathematics teacher education theory and practice**

Elsewhere I have argued that when taking a critical perspective, a resonance needs to be maintained in the approaches and processes across theory, practice and research. If the argument for the resonance between a critical educational approach and a critical research approach is accepted (Vithal, 2003), then it follows that each provides conceptual tools and frameworks for the other. Therefore it may be possible to appropriate "methodological theoretical tools" used to investigate mathematics education from a critical perspective, to analyse practices associated with the particular theory, be they the practices of teachers or those of teacher educators. That is the argument for resonance between research methodology and mathematics education theory and practice is extended to refer to mathematics teacher education practices. The theoretical methodological tools I draw on and reinterpret for mathematics teacher education are those of "imagined hypothetical situation", "current actual situation" and "arranged situation" developed for researching mathematics education theory and practice from a critical perspective (Vithal, 2003; Skovsmose and Borba, 2004). In this paper it is the widely debated theory-practice relation that is put under the spotlight, on the one hand across the sites of teacher education and school and on the other within teacher education itself in how it negotiates the interaction between theory and practice in the education and development of teachers and teaching.

The framework above was developed and is especially relevant for researching innovations and interventions that are exploratory and not widely available in the educational system. It sought to go beyond advocacy for teachers toward identifying

the theoretical and practical implications of innovations and interventions such as project work for national curricula in which the dominant focus is on an array of teacher and learner changes. However, the impetus for this paper arose from the recognition that teacher and learner change (or lack thereof) must, in part, be explained with reference to teacher education pedagogies and curricula themselves. While teacher education has made enormous strides in understanding mathematics teachers and their work, a number of authors have pointed to the dearth in literature that puts teacher educators and their theories and practices under scrutiny (Adler, 2004; Zaslavsky et al., 2003; Jaworski, 2001) This is even more acute in mathematics teacher education that engages a critical perspective. The question of what theories and practices guide teacher educators as they develop curricular experiences to induct teachers into particular approaches especially those that privilege a social justice, equity, human rights and democracy agenda is being raised in this paper. The interrogation of teacher education practices and theories are especially crucial when expecting to prepare teachers to make large and radical shifts in knowledge, skills, attitudes, values and ways of being in mathematics classrooms. This obligation is sharper when developing a teacher education pedagogy for new and largely non-existent approaches in the education system and when advocating an approach that the teacher educators may not have researched or experienced in the diversity that characterises any education system.

Through a retrospective reflexive account of aspects of my own curricula for preservice primary mathematics teachers, offered over the last decade, I distinguish, drawing on theoretical methodological tools for researching a critical mathematics education (Skovsmose and Borba, 2004; Vithal, 2003) but recontextualised to the domain of initial teacher education: an ‘imagined hypothetical praxis’; an ‘actual current praxis’; and an ‘arranged praxis’. I refer specifically to my experimentation with project work within that component of the programme in which student teachers were introduced to what I have called a social cultural political approach, to develop, illustrate and exemplify my praxis in terms of these three categories which are by no means mutually exclusive but offer an analytic framework for thinking about and understanding our work as teacher educators.

I choose to use the term “praxis”, firstly because it is well developed within critical education and research to refer to “the dialectical tension, the interactive, reciprocal shaping of theory and practice” (Lather, 1986, p. 258). Praxis, for Freire (1997) brings together action and reflection and is appropriate here because I am attempting a retrospective reflexive analysis of my own practices and theories. Praxis allows one to engage both the resonance and the dissonance of the relation between theory and practice. Praxis as action-reflection, is in a sense, “theory in practice” – the doing of theory - and recognises that practice embeds and emanates implicitly or explicitly from theory. Praxis is not a neutral concept, it is associated and used with reference to emancipatory approaches to education that seek to change teaching and learning toward democratic and socially just forms. While the praxis of teachers and schools has come under significant investigation in mathematics education, very little is known or written about how mathematics teacher educators produce a radical transformatory and empowering praxis in their own pedagogy as they work with teachers in ways that embodies the values of equity, diversity, antiracism, antisexism, etc that underpins the theory and practice they advocate. How is mathematics teacher education pedagogy itself to enact democratic, open, fairer and more just ways of teaching and learning within higher education institutions themselves that prepare student teachers for addressing the inequalities and injustices in schools but also provide opportunities to learn to act on them in their own education and training in



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becoming teachers. Freire maintains that “no genuine learning can occur unless students are actively involved, through praxis in controlling their own education” (Aronowitz, 1993, p. 9). Valuing teachers’ vested interests and reasons for learning may be especially relevant in education systems characterised by diversity and large inequalities, making teacher education as praxis especially relevant. Bringing praxis, “understood as political practices informed by reflection” (Aronowitz, 1993, p. 9), into teacher education, allows an analysis of the ideological underpinnings of the theories and practices of teacher education pedagogies and curricular and of the social, political and cultural dimensions of the actions and reflections of teacher educators.

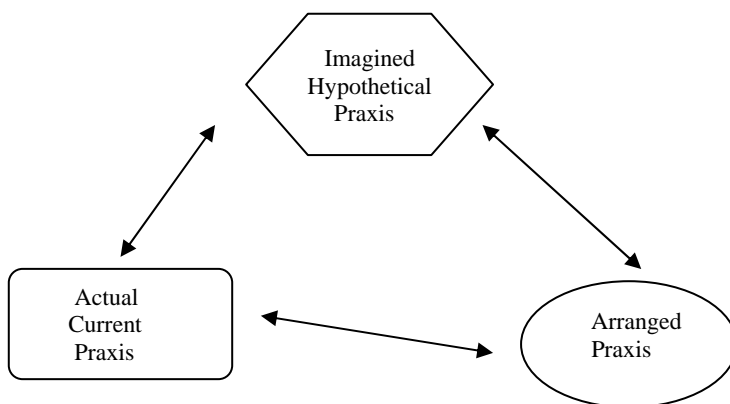
In the rest of this paper the introduction of a praxis of project work into programmes for prospective teachers is analysed as an imagined hypothetical praxis; an actual current praxis; and an arranged praxis. Qualities characterising the connections between these and their transformation are then elaborated, concluding with some reflections on this framework of praxis.



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## Theoretical Landscape



## Practice

### *Imagined hypothetical praxis*

If teacher educators expect teachers to do their work significantly differently from what they have experienced or known, they need to find ways of lighting up teachers’ imagination to think and act differently. In this task, teacher educators also bring their creative imagination to bear when they are introducing innovations or interventions that are not widely available in the system and which they themselves may not have worked with and sustained within the complexity of school settings. Teacher educators themselves interpret national curriculum reforms or theories and practices emerging from research to construct a teaching-learning environment for their student teachers to communicate their thoughts, ideas and dreams. What has to be brought into dialogue are the imagined mathematics classrooms of teacher educators with those of teachers, wherever they may be located in the diversity of the education system. Each

has in mind notions of hypothetical learners and fellow teachers to imagine a different praxis. While an imagined praxis, as various kinds of practice-theory “thought experiments”, may be necessary and crucial to begin any kind of change especially those deemed radical by the people expected to change (such as project work), if that is the only learning opportunity provided by teacher educators, it may not be sufficient to effect the envisaged change.

Typically teacher educators present problems, issues, examples and contexts to prospective teachers who are expected to imagine themselves in their own classrooms working in ways explained and described by the teacher educator. The student teachers read and discussed different examples of project work from the literature (e.g. Skovsmose, 1994; Nielsen and Simoni, 1994; Paras, 1998; Nielsen et al., 1999), usually in groups, and engaged different theoretical ideas both in mathematics content and pedagogy, which they presented to the class. They discussed the theoretical basis for project work, for example about how project work is problem oriented; participant directed; interdisciplinary and based on the exemplarity principle (Vithal, Christiansen and Skovsmose, 1995; Olesen and Jensen, 1999; Vithal, 2004). Particular content knowledge and skills, learners’ conceptual understanding of these, and its representation in current curriculum reforms, as well as possibilities and pitfalls in trying out these often imported ideas in a classroom were debated. For example, even though student teachers could see the mathematics educational potential in implementing project work they expressed concern about time for completing the expected school syllabus; the difficulties of engaging interdisciplinary approaches within the confines of strong timetabling; and parents acceptance of investigating home life conditions (Vithal, 1997) The situation imagined is a hypothetical one, which attempts to take account of the vast diversity and inequalities of learners and school contexts and the theorising underpinning particular practices advocated.

An imagined praxis is in the main a discussion-oriented teacher education pedagogy. It could include observations of the innovative practice but it is a dialogue-driven pedagogy which gives 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 discussed, student teachers brought their own 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 hypothetical projects. Such imagined ‘theoretical practices’ included projects such as ‘Social and economic relations in the world of a South African child’ recontextualised from a similar Danish project (Skovsmose, 1994). But they also created some new ideas of their own such as an electricity project on usage and wastage including data about the different forms of provisioning in different residential areas and investigating late-coming to school (Vithal, 1997). Each of these projects created spaces for developing mathematical ideas and concepts from learners’ own life experiences and circumstances. Many of the project work ideas carried socio-political potential in making visible the injustices and inequalities of not only broader South African society but also quite directly that of schools. Within this imagined praxis the teacher education curriculum followed with possibilities for extension of these ideas together with mathematical ones in more traditional or typical ways such as issues in student learning and difficulties.

The key point here is that issues of both content and pedagogy remain in the realm of the imagined and hypothetical. No matter how innovative, this teacher education praxis is confined largely to the lecture room. The student teacher is engaged in critique of research, theory and practice by studying cases, observing



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learning or teaching, by reading research, or even developing lesson plans or other types of material and activities, but it remains a hypothetical praxis because it draws on and relies on the student teachers' imagination shaped by their own experiences as learners or even as student teachers that may be shaped by the opportunities of having been in other kinds of classrooms such as rural, multilingual, advantaged. Nevertheless the limitations and diversity of settings imagined by teachers and teacher educators are hypothetical because they themselves have not undertaken action and reflection in the pedagogy proposed. The mathematics likely to be developed, the difficulties learners and teachers are likely to experience; the resources needed to make the innovation or intervention work can all be anticipated but it is a "do as I say" teacher education pedagogy derived from and nourished by history, past experience and existing knowledge, skills, attitudes, values and ideology.

### *Actual current praxis*

The 'actual current situation' as a theoretical methodological tool refers to an existing research setting – a classroom, an institution or even a system - before it is acted on to conduct any research. For the purposes of developing this framework, it may be interpreted to refer to a current existing praxis, say in a school or a higher education classroom, before the intervention of an innovation. It forces the teacher educator to recognise how far actual current praxis is from that hoped to be changed and achieved through curriculum reform or innovation and is therefore important for preparing the setting and teachers who are expected to act on any status quo.

However, here I also offer a second interpretation of an actual current praxis to refer not only to existing teacher education theories and practices but one in which the teacher educator deliberately intervenes to construe the student teachers as learners and herself as the teacher so that the prospective teachers can experience the innovation as learners. It is a praxis that may be described as a serious real life enactment of a new pedagogy, intended to provide a different means for critique by both teacher educators and student teachers to consider, in anticipating possibilities and pitfalls when student teachers emulate it in their own practice as teachers. In a sense it may be characterised as a serious simulation of the innovation. The teacher education environment is transformed for the student teacher to be an actual participant as learner in a critical pedagogy, and for the teacher educator to demonstrate and enact a praxis of emancipation and empowerment with reference to student teachers' own lives within the teacher education curriculum. For teacher educators who may not have themselves fully experienced or sustained the innovation they are advocating, it provides an opportunity to put theory into practice to deepen understanding of both through action-reflection. This can also serve to reduce the inherent hierarchy between teacher educators and student teacher as both grapple with what the innovation means in reality.

My experience as teacher educator and researcher at Aalborg University where project work is institutionalised was a powerful influence in subsequent experimentation in my praxis in South Africa (Vithal et al., 1995). To engage an actual current project work praxis, in some years, I set aside several weeks to a term during which I become the "facilitator" or "supervisor" and student teachers become the learners as we jointly engaged the problem-oriented and participant-directed features of this pedagogy. To initiate 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 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” inspired by Skovsmose (1994). Students generated three categories for exploration and then developed these in smaller groups. For example they asked questions about how much students spend as academic expenses – tuition fees, books, etc; living expenses – travelling, food, clothing, accommodation, sport, leisure, etc; and what sources of income do students rely on – university and bank loans, bursaries; parents; work etc. The students then developed questions for surveys and interviews which were reviewed in whole class discussions. Decisions were made about various aspects of the research-like process – whether to sample education students or to include other faculty students; first or final year students; who to interview, when and where to administer questionnaires and interviews, etc. While data production and some initial analysis was begun, to provide students with the appropriate mathematical tools, the link to the school curriculum with respect to statistics education was introduced by giving students a variety of text book chapters from statistics and school mathematics text books. They prepared and delivered lessons to the whole class on different topics – measures of central tendencies and dispersion; histograms and frequency tables, etc which served to develop their knowledge and skills in a new topic that has been included in the new curriculum reforms and served effectively to anticipate some of the mathematics and statistics to be used in the project research. This learning opportunity was also extended to include an introduction to the use of technology in teaching and learning statistics. For example activities involving different computer software such as excel and SPSS that could be used in the project were introduced. The findings from the project were written up as a report and presented to the class.

Similarly in another year the whole 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 from the university security sector, the local police, staff and students and systematic observations on campus, they in fact found the campus to be a relatively safer place, and identified high crime spots on campus. In the year that HIV/Aids became an important issue, student teachers undertook a project to investigate their fellow colleagues’ knowledge about the disease and safe sex practices; including their preparation for dealing with this problem as teachers in school. In some years not all students agreed to participate in the same project and hence smaller groups chose different projects. For example another group in this last class did a project on levels of waste produced by staff and students and recycling in the university. In this a constant interplay in learning about mathematical content and pedagogy occurred. The student teachers were learning the mathematical content on its own terms and learning a content for teaching as they experienced the pedagogy.

An important aspect of the projects is acting on findings from analysing data collected. Hence projects included dissemination of information gathered or analysed 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. The activities identified at the beginning were developed to form a broad blue-print for the project which unfolded and took shape and evolved as the students’ knowledge and experience deepened through the project and yielded ideas for action. Student teachers come to see and experience first hand how the teaching and learning of mathematics can be directly connected to their lives.

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, interpreting mathematics in articles and information collected, making contacts for other teaching in for e.g. science, as well creating opportunities for using technology such as computer software for analysis. Since the point of departure in selecting the project is not learning some specific mathematics but solving a real life problem, opportunities for interdisciplinary engagement within teacher education are created. I was able to often make connection with what teacher educators were doing in science education (for example in the HIV/AIDS or recycling project) or other areas of teacher education (such as action research).

When the project is completed, an evaluation and debriefing in which substantial reflections take place about the learning experience and roles of each participant. For the student teachers these reflections on the actions of the teacher educator provides an opportunity to interrogate the role of the teacher in project work from the perspective of being a learner. For the teacher educator the administrative and educational viability of project work as a sustainable theory-practice whole can be critiqued. A double analysis of praxis as both insider and outsider to the pedagogy is facilitated. In this respect there may be some overlap with a hypothetical imagined praxis at this point because this reflexivity is crucial to assist student teachers in their recontextualisation of the project for a school setting - the process for selecting the project problem; the workings of groups, the ways in which mathematical content and pedagogy are dealt with; and its connection to other subject matter learnt; practical organisation needed for implementation; too much or too little guidance I provided as a teacher or facilitator; assessment opportunities and forms; and the limit of possibilities for learners to act and change something in their lives inside or outside school.

The project work period opens for extending various aspects of project work theory and practice, and mathematical content and pedagogy further later, even if in more traditional formats. For example in projects in which a significant aspect of the mathematics engaged was related to statistics education, other aspects of data handling not dealt with in the project could then follow. Different aspects of a specific pedagogical practice such as how to work with and in groups may be taken up in more details. Also opportunities to develop and engage a research literacy in relation to the topic was often included. In this it is clear that an actual current praxis of project work is not discrete and cut off from other mathematics teacher education practices and theories the student teacher is engaging.

Without doubt, what an actual current praxis does is change students' reasons for learning or investing in an innovative pedagogy such as project work in quite fundamental ways as the relation between mathematics and context is not only made visible but experienced. Mathematics is directly engaged as both a tool for critiquing reality and a tool for critiquing itself as an object with respect to some topic of importance and relevance to student teachers' lives. In this "do as I do" (as opposed to a "do as I say") praxis, depending on the quality of the action and reflection in the project work experience, student teachers will take up or limit the possibilities or potential for its use in the future as teachers in school.

### Arranged praxis

In an arranged praxis within teacher education student teachers enact an intervention or innovation in real time, as real teachers with real learners. It is an arranged praxis because it takes place within a setting which is deliberately created for prospective teachers themselves to implement a particular praxis or pedagogy, in a real mathematics teaching-learning situation for which the student teachers are being educated. Mellin Olsen (1989, 184) describes how he "provokes them (student

teachers) by enforcing them to do a project with their classes, which is based on the students' interests of knowledge, thus supporting their interests". An arranged praxis may be constituted in a number of ways, for instance as a "micro-teaching" environment in a higher education context with learners being brought in, or within the school context during what is typically referred to as "teaching practice" or "internship". The arranged nature of this praxis is also emphasized by the co-operation needed between teacher educators and possibly other practitioners such as a teacher to jointly reflect on the possibilities and pitfalls of a new pedagogy. The uncertainty of the outcomes of an innovative pedagogy that is not widely available in the education system, reduces the inherent hierarchy in the triad of student teacher, teacher educator and teacher as each recognises their different strengths and brings different knowledge, skills, attitudes and values to the teacher learning setting where learners are being inducted into a different way of being in the mathematics classroom. The theories and practice experiences of each participant may complement each other or there may be conflicts but in any event the arranged praxis makes it possible to engage the differences in the real life of a classroom. Action-reflection is ongoing as the practice and its underlying theory come under critique and development.

Typically, the student teachers have been introduced to the activities to be tried out as arranged praxis through one or both of the other two practises already described. Many factors influence what student teachers eventually come to do in a particular classroom in an attempt to realise a particular curriculum approach. This ranges from the quality of relationships between the different participants, an existing school culture for or against change and innovation, strike actions and other pressures faced by teachers or schools, administrative and management support and resources, including the student teacher and teacher educators' own understanding and confidence about a particular theory and its associated practices and willingness to take risks. Examples of projects students generated in collaboration with their learners include: building a school fence for security; redesigning the agricultural science school garden; developing a school vegetable garden to generate school funds; developing a school mathematics newsletter; and creating a dream fantasy school ground (Vithal, 2003; Vithal et al., 1997)

Some student teachers implemented only one or two single units related to a particular project theme that they themselves might have worked with. For example two students who worked on the project on "economic relations in the life of a child" led a whole class of learners in an activity of identifying and calculating "pocket money" given to or earned by learners and represented this information in different ways for different samples of learners. But other student teachers took advantage of the opportunity to try out what was considered radical by some teachers or schools to engage the pedagogy over a much longer time and therefore more intensely. For example a project on building a fence for learners' play area ran over almost the entire six week period set aside for teaching practice, which included measuring, calculating area and perimeter, percentage tax in costing the fence and fund raising, and making representation to the school principal as well as recording data and information in a letter to the department of education for financial assistance (Paras, 1998). Furthermore, such practices were presented and written up by student teachers for wider dissemination and discussion (Vithal et al, 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. In this regard an arranged praxis also provides opportunities for developing a professional praxis. By having done it by themselves and having seen it and heard the learners themselves, the power of an arranged praxis is considerable in leaving lasting impressions on student



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teachers. This may include negative and positive experiences and reflections with different consequences for the survival of the innovation later. An arranged praxis also opens possibilities for the teacher education of the mathematics teacher in whose class the implementation of the innovative pedagogy took place, though from a different relatively safe vantage point of a kind of participant observer, depending on the extent and nature of their involvement in the arranged praxis.

An arranged praxis is unlikely to be the only approach to introducing student teachers into an innovation. This means that the impact of the extent and quality of any imagined hypothetical praxis and actual current praxis must be considered for understanding what happens in an arranged praxis. Depending on how and in what ways a teacher education pedagogy resonates with the mathematics classroom pedagogy for particular student teachers, the arranged praxis opens for multiple interpretations and recontextualisations of the innovation or intervention. Unlike the fence building project that involved the whole class another student teacher allowed her class to work in groups on 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, 2003).

One of the key challenges that emerged for the arranged praxis of project work was in finding and directing mathematics teaching and learning. Questions about where is the mathematics in the project; what mathematics should be engaged and its relation to the curriculum, when is it to be taught, and how is it to be taught, were of much concern. Although each of the projects involved substantial mathematical content and pedagogical knowledge these had to be drawn out in quite explicit ways in post-lesson reflections and planning during the period the project was implemented. For example in the last case above, the student teacher constantly had to direct learners to the appropriate mathematics and dealt with the teaching and learning of mathematics in three different ways. 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 small group in a discussion-oriented teaching, drawing their attention to the different kinds of data they had collected and the pros and cons of different calculations and representations. Third she included whole class exposition-oriented lessons in which they not only all drew graphs based on their own personal data, but also read and interpreted graphs in a language-comprehension type activity as they developed a statistical literacy.

The relation between any arranged praxis and the imagined hypothetical or actual current praxis clearly needs to be considered. How elements of what has been described as hypothetical imagined or actual praxis precede or are offered concurrently with any arranged praxis will shape the learning that student teachers will make and the potential for future engagement with the innovation. The arranged praxis offers opportunities for critical engagement by student teachers with a new theory and practice they may have been asked to imagine or tried as a learner, from the perspective of a teacher. Gaps in the theories and practices become visible when the pedagogy has to be woven into the fabric of regular school life. For example, once in the mathematics classroom, issues of assessment which were not dealt with as imagined or actual praxis, became important for the student teachers and teachers.

In an arranged praxis the limits of the innovation for real classrooms come into sharper relief. From the perspective of student teachers this is a praxis based not in “doing what the teacher educator says or does” but rather “doing it for themselves for real”. Opportunities for learners to engage in the outcomes of project findings, an important aspect of a social cultural political approach to project work, could seldom

be fully realised for a number of reasons such as constraints of time or resources, resistance in the school and lack of agreement or support for the action to be taken. Nevertheless, that student teachers with their learners tried to do something differently meant that they took action and learned about the limits of possibilities for action.



### **Connecting and transforming praxis**

Although a teacher education pedagogy may be analysed with respect to these different praxes, the analytical categories do not exist in the real life of a teacher education curricula as discrete entities and could result in a distortion of reality. That is teacher education programmes cannot be categorised as belonging to one or other category. Typically various combinations of these praxes occur within any teacher education curriculum, though a particular programme may be driven more by one than the other in terms of time devoted and how a particular praxis is valued, for instance as indicated by assessment processes. Each praxis provides different opportunities for learning since each carries different blind spots, strengths and weaknesses. This would mean that some kind of movement from one praxis to another has to be effected. For shifts to take place from one form to another several qualities connecting these praxes may be identified.

First, *pedagogical imagination* is required, which refers to the creative process of continually conceiving alternatives to the dominant ideas and practices to think or do something differently. Pedagogical imagination which Skovsmose and Borba (2004) derive from “sociological imagination” in the work of Mills and Giddens for elaborating the qualities of critical research, is also relevant here because any innovation has to recognise: a historical sensitivity of what has been done and the existing pedagogy; an anthropological sensitivity about what has been done before or in other contexts; and a critical sensitivity that makes it possible to break out of the status quo and not take existing theories and practices as given. In moving from any one praxis to another the teacher educator not only recontextualises theories and their associated practices but brings her hopes, dreams, intentions and aspirations to bear on the construction of the praxis. The teacher educator and student teachers modified practices observed elsewhere but also developed some new ideas of their own. Hence, pedagogical imagination is both an individual, but also a collective engagement which requires co-operation among those involved.

This brings into play a second quality for the movement between praxis – *pedagogical action*. All participants’ active involvement in practical organisation is needed for the innovation to take root. This recognises the constraints and the potential of the educational setting to change. In the playing out of real time project work, practical organisation and action is required to manage all aspects of the context and the pedagogy being tried out. For instance, teacher educators and student teachers had to negotiate different resource and administrative requirements such as modifying timetable arrangements; and to create space to consult and seek the co-operation and participation of a broad range of people both inside and outside institutions to operationalise the project. The extent and quality of pedagogical practical organisation required is shaped by how far the innovation is from the culture and ethos of the institution and its receptiveness to change. The impending new curriculum reforms and the state of transformation of institutions (or at least its requirement) provided an environment in which setting up the conditions for introducing an innovation like project work was more likely to be allowed.

The initiation of an intervention or innovation and its continual analysis and evaluation as it is conceptualised through pedagogical imagination and enacted

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through pedagogical action requires *critical pedagogical reasoning*. Privileging action-reflection, gives pedagogical reasoning and justification an important place in the movement from one praxis to another. For example, although the hypothetical imagined praxis may offer strong preparation for the arranged praxis, many aspects of theory and practice may need to be modified and adapted with clear pedagogical reasoning for the arranged praxis to be realised given the huge diversity of contexts within which a teacher educator must manage the innovation. This quality is important for valuing and legitimating the role and function of critique in the process of innovating given the diverse knowledge and experience domains as well as the unequal relations of power among the different participants in the intervention, as a form of praxis is realised.

The assumption of movement between praxises implies that they are not static. Each of these praxises is *dynamic*, changing and shaping each other as they are realised and as translation occur from one to the other. Also each praxis itself can never be identical to any previous enactment. That is, there are possibilities for transformation and potential for improvement of each; hypothetical imagined praxis, actual current and arranged praxis, in each cycle of innovation as teacher educators gain deeper insights through successive attempts in working with and through a new pedagogy. This is also because different groups of student teachers bring different knowledge, attitudes, values, mathematical life histories and interests to their praxis, whatever category is enacted. The actual direction of movement from one praxis to another as well as how they are combined will also impact the dynamism of any particular praxis.

While each praxis makes visible a certain actuality that is realised in practice, each also carries a large potential of thoughts and ideas that may remain unexpressed but may be carried into the future. *Potentiality*, allows teacher educators to understand what student teachers do and say, not as failure, but as alternate interpretations and refers to what student teachers deem possible in some future teaching and learning setting (Vithal, 2003). These hypothetical imagined, actual and arranged praxises open for different future possibilities for what a student teacher might do as a teacher with respect to the theories and practices advocated in teacher education. Whatever the take up in the actuality of schools or classrooms, at the very least potentiality notifies prospective teachers of the existence of a particular radical or innovative praxis and makes the related ideas available to them.

### Conclusion and reflections

The impetus for this retrospective reflexive analysis arose from a recognition of the advantages and disadvantages for student teacher learning and action when particular praxis dominates teacher education curricula. Over-reliance on any one has particular outcomes for what teachers think and do and how they interpret and recontextualise a particular praxis for their own setting.

It may be posited that all teacher education curricula to some extent would engage an imagined hypothetical praxis, though to different degrees and time periods. This may be as a student learner of mathematics or as a mathematics teacher and dealing with mathematical content and pedagogy issues. However, if an imagined hypothetical praxis is engaged as the main or dominant praxis within a teacher education curriculum, student teachers' learning tends to remain in the realm of theory, which seldom sees a substantial transformation into practice once they are in the classroom. Even though they may have been involved in the particular practice of the intervention it remains still as a kind of "theoretical practice". Not having actually

experienced or tried the innovation, it may seem far out of the range of possibilities and difficult to overcome constraints or obstacles. Hence it requires a strong deliberate negotiation on the part of the teacher educator for it to be brought into an arranged or current actual praxis. Then there might be stronger potential for student teachers to consider implementing the innovation when they become teachers.

An over-emphasis in a teacher education pedagogy as an arranged praxis, with relatively minimal opportunities for imagined hypothetical praxis seems to have a different consequence. The sharp focus on the practice can serve to undermine the development of a theoretical understanding of the pedagogy because of the concern to try 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. Depending on the quality of the experience of the arranged praxis, such as the reaction of learners, the teachers or the school, student teachers may come out with a positive orientation to the innovation with a commitment to implement project work in the future, or with a negative view that may discourage any further experimentation.

While each of these imagined hypothetical and arranged practises seem to be more appropriate for developing theory or practice respectively, a over-reliance on the experience of an actual current praxis leaves student teachers sometimes struggling to acquire both theory and practice from the perspective of a prospective teachers because they become engrossed in the project work experience itself and the content of the project problem. However, having experienced it first hand as a learner they may be more interested to make the additional effort to try it out in a classroom, though they may tend to implement versions and variations of the projects they themselves had participated in as learners in the actual current praxis within the teacher education context.

Ideally, a teacher education programme should attempt to integrate all three practises to give students as varied and holistic an opportunity to learn about and through a particular innovative pedagogy. But what may be desirable is seldom what is possible in the real, unpredictable and untidy world of higher education, schools and classrooms. In my praxis I have experimented with various combinations of the above, with different lengths of time and to different depths, with different project problems and different school conditions. Far more analysis is needed of teacher educators' own curricula and pedagogy and a much deeper critical research of their own theories and practices, especially those that they themselves may have had limited classroom experience with, to develop stronger self reflexivity and to recognise their culpability in what teachers, who come through their programmes, learn, say, do and think.

## Reference

- Adler, J. (2004) *Research on Mathematics teacher education: mirror images of an emerging field*. Plenary panel in the 10<sup>th</sup> International Congress on Mathematical Education, Copenhagen, July 4-11.
- Aronowitz, S. (1993) Paulo Freire's Radical Democratic Humanism, in McLaren, P. and Leonard, P. (Eds.) *Paulo Freire: A Critical Encounter*, 8-24, New York: Routledge.
- Department of Education (2002). *Mathematics: Revised National Curriculum Statement for Grades R-9 (Schools)*. Pretoria.
- Freire, P. (1997) *Pedagogy of the Oppressed: New revised 20<sup>th</sup> – anniversary edition*. New York: The Continuum Publishing Company.
- Jaworski, B. (2001) Developing mathematics teaching: Teachers, Teacher Educators, and researchers as Co-learners. In Lin. L & Cooney, T. J. (Eds.) *Making sense of mathematics teacher education*. Kluwer Academic Publishers.
- Lather, P. (1986) Research as Praxis. *Harvard Educational Review*, 56, 257-277.



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- Mellin-Olsen, S. (1989) Creative uses of mathematics in social contexts. In Keitel, C. (Ed.), *Mathematics, Education, Society, Science and Technology Document Series No 35*, UNESCO, Paris
- Nielsen, L, Patronis, T. & Skovsmose, O. (1999). *Connecting Corners: A Greek-Danish Project in Mathematics Education*. Aarhus: Forlaget Systime.
- Nielsen, L. & Simoni, S. (1994). The Spider's Web: Case Studies of the Relation between Theory and Practice, Masters Thesis, Aalborg University, Denmark.
- Niss, M. (2001) University mathematics based on problem-oriented student projects: 25 years of experience with the Roskilde model, in Holton, D. et al (Eds.) *The teaching and learning of mathematics at university level: An ICMI study*. Dordrecht: Kluwer Academic Publishers.
- Olesen, H. S. & Jensen, J. H. (1999). (Eds.) *Project Studies – a late modern university reform?* Copenhagen: Roskilde University Press.
- Paras, J. (1998). Improving the Playground: A Fence-Building Project in Mathematics.' *Pythagoras*, **46/47**, 57-62.
- Skovsmose, O. (1994). *Towards a philosophy of critical mathematics education*. Dordrecht: Kluwer Academic Publishers.
- Skovsmose, O., & Borba, M. (2004). Research methodology and critical mathematics education. In Valero, P. & Zevenbergen R. (Eds.) *Researching the Socio-political Dimensions of Mathematics Education: Issues of Power in Theory and Methodology* Dordrecht, Kluwer Academic Publishers
- Vithal, R.; Christiansen, I. & Skovsmose, O.: 1995, Project Work in University Mathematics Education, *Educational Studies in Mathematics*, Special Issue on Advanced Mathematical Thinking, **29**(1), 199-223.
- Vithal, R.; Paras, J.; Desai, S.; Zuma, Z.; Samsukal, A.; Ramdass, R.; and Gcashbe; J. (1997). Student teachers doing project work in primary mathematics classrooms'. In Kelsall, P. and de Villiers, M. (Eds.) *Proceedings of the Third National Congress of the Association for Mathematics Educators of South Africa*, 261-276, University of Natal Durban, July 7 - 11.
- Vithal, R. (1997). Exploring student teachers understanding of a theoretical perspective in mathematics teacher education. In M. Sanders (Ed.), *Proceedings of the Fifth Annual Meeting of the Southern African Association of Mathematics and Science Education*, 331-342, Johannesburg: University of Witwatersrand.
- Vithal, R. (2003). *In search of a pedagogy of conflict and dialogue for mathematics education*. Kluwer Academic Publishers.
- Vithal, R. (2004) Devan; mathematics; and project work: A social, cultural, political curriculum approach. *South African Journal of Education*, **24** (3), 225-232
- Zaslavsky, O., Chapman, O. & Leikin, R. (2003) Professional development in mathematics education: Trends and Tasks. In Bishop, A. J.; Clements, K.; Keitel, C.; Kilpatrick, J.; Leung, F. K. S. (Eds.) *Second International Handbook of Mathematics Education*. Dordrecht: Kluwer Academic Publishers.