Breaking with tradition in mathematics education: experiences of Turkish student teachers within a Logo-mathematics environment

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ABSTRACT

This paper describes the development of views and attitudes of a group of Turkish student teachers during a model course aimed at introducing a Logo-mathematical culture based on the constructivist leaning and teaching paradigm. The model course provided the participants with a micro-environment of practice for experiencing new ways of approaching mathematics as both a learner and teacher. A study was done which highlights the complexities and at the same time illustrates the educational dilemma of promoting a constructivist philosophy within an educational system based on direct instructional methods.

Main conference themes: teacher education

Educational areas:

Study topics: mathematics

Secondary keywords: culture, innovation, Logo

INTRODUCTION

In developed countries researchers continue to be interested in the impact of computers on the teaching and learning of mathematics. As plans for reforming schools call for increased use of technology mathematics educators and researchers see the promise of enhancing and changing mathematics instruction with computers. However in Turkey preservice courses in mathematics tend to be dominated by traditional teacher centred methods in which lessons are mainly in the form of lectures.

This current pattern does not provide Turkish trainee teachers with an opportunity to exploit new approaches to the learning and teaching of mathematics and experience themselves the role of the mathematics learner in the computer integrated environment in which they are expected to teach. From an acute sense of urgency to provide such experience a model course was designed. The main research question is of the associated study was: *What is the feasibility of a model course for breaking with tradition in mathematics education in the Turkish context?*

First we need to clarify the term ‘micropractice’ which will be used throughout this paper. It designates a process of practising new ways of learning and teaching mathematics by playing the role of both a secondary school learner learning mathematics in a Logo based environment and a secondary school teacher developing, presenting and evaluating Logo based lessons. This provides an experience close to observing *and* practising alternative lessons in a real classroom. These alternative lessons were analyzed with classmates and researcher with respect to point of view about mathematics and mathematics teaching. This formed the basis of the study.

WHY TEACHER EDUCATION?

“American students’ performance will not improve much if the quality of teaching is not much improved. And teaching will not improve much without dramatic improvements in the field of teacher education”. [1]

If this statement is true for the US, it is even more applicable to Turkey. In any society improvement in education needs a similar improvement in teacher education. It is evident in the recent literature (see for example [2]) that many innovations have failed because the central role of teachers in the educational development process was not taken into account. When a teacher is not convinced that innovations will benefit the students and classroom practice, it is doubtful that any effort will succeed [3]. To develop more realistic and healthy beliefs about mathematics and learning we therefore need to change what

happens in the classroom through relevant and meaningful events which require teachers to reflect on past experiences and to modify conceptions of mathematics and its teaching.

THE LOGO-MATHEMATICS COURSE

In this study, the term Logo-mathematics is used to refer to the particular form of mathematical expression mediated by Logo programming.

Design principles for a Logo-mathematics environment

The central focus of the study has been on a model course which has a different approach to teaching and learning of mathematics in a computer integrated environment. It should help preservice teachers to learn to teach mathematics for conceptual understanding by doing and by experimenting with something different and better than what they experienced as pupils in mathematics classes.

Teacher involvement in learning experiences and environments which they are expected to implement in their teaching, has been advocated by various researchers. For example Simon and Schifter suggest that “teachers need to experience the role of mathematics learner, consistent with the constructivist view, before they are ready to facilitate such learning among their students” [4]. The model course was based on a similar assumption and differed significantly from traditional teacher education courses. It was hoped that this one-term noncredit course entitled *Teaching and Learning Mathematics within Logo-mathematics Environment*, designed by the researcher and implemented at the Department of Mathematics of the Faculty of Education in Karadeniz Technical University in Turkey, allow a group of student mathematics teachers to begin to question their current conceptions, expectations and views about mathematics, mathematics teaching and the role of computers in mathematics education.

Components of the course

Introduction, Exploration and Project Development and Presentation were the components of the course. The introduction of Logo at the technical level took two weeks, exploration of the link between Logo and mathematics and reflection on Logo activities took three weeks, and project development and presentation took four weeks.

The first component (introduction) was designed as 4 class sessions (approximately 8 hours) for getting to know each other, for getting familiar with the basic Logo commands and syntax and for becoming confident in Logo use.

The second component (exploration) was designed as 5 class sessions (approximately 10 hours) to show the participants that a computer based environment for learning and teaching mathematics can be established through Logo. The activities of the course were chosen from several textbook series in mathematics and structured around situations to investigate (rather than content to be learned), both on and off the computer (for a more detailed description of the activities of the course, see [5]).

After this the participants were ready to assume responsibility for applying their experiences to the design of own projects on mathematical concepts and to present these as real teachers in a secondary school mathematics classroom. They were given 4 weeks to complete this task. Their presentations were to be model lessons in which each participant presented a project to a group of actual student teachers in the course who were pretending to play the role of secondary school students.

METHODOLOGICAL CONSIDERATIONS

Data do not exist in a vacuum waiting to be obtained in pure form, instead data are a product of interaction between the researcher (teacher) and the participants (student teachers) in classroom and other social situations.

I have observed 12 student teachers during their micropractice of learning and teaching mathematics to see whether this micropractice led to reconstruction of prior experiences and development of new visions of mathematics learning and teaching which were more consistent with the constructivist view of mathematics. The course was an organic link between theory and practice: for the participants to see alternative ways for learning and teaching in action, and for the researcher to see himself teaching and intervening as a constructivist teacher and observing the participants during their groupwork and projects.

Data were gathered through interviews (at the beginning, midterm and end of the course), through course reflections (written after each class session in the form of keeping a journal), through recorded observation by the researcher (including the researcher's own classroom observations and course reflections).

The methodology for the data analysis involved three levels: case studies, vignettes (portraying participants) and cross sectional analysis. During the construction of the case studies, I attempted to identify some recurrent themes in the transcriptions of the interviews, the participants' writings and the researcher's field notes. The vignettes written for each of the participants were mainly based on case studies. These provided synthesis of views, attitudes and

practices over a cluster of case studies. The third level of analysis was a cross-sectional analysis which used case studies and vignettes as sources, and attempted to go back to the specific themes evident in these sources and examine these in terms of what conceptions the participants brought into the course and also to what extent these conceptions and views were operationalized within a computer integrated setting (for a detail description of both data collection and analysis, see [5]).

INITIAL CONCEPTIONS OF PARTICIPANTS

It is widely accepted that mathematics teachers make decisions about mathematics and any innovation in the mathematics curriculum according to the conceptions which they hold [6]. These conceptions have been shaped by cultural, system and environmental factors such as an institutionalized curriculum, traditional notions of teacher and student roles in the mathematics classroom, teacher status in society and in the educational system. These factors create implicit notions of teaching and learning of mathematics in the minds of prospective mathematics teachers.

Three themes emerged from an analysis of initial views on mathematics and its teaching. Firstly, tension was evident between how mathematics teaching 'ought to be' and how it has to be in the traditional sense. In spite of a common feeling of dissatisfaction with the current pattern of mathematics education, based mainly on memorization and rote learning, many of the participants seemed to lack knowledge about alternative learning and teaching methods, and leaned towards accepting the *status quo* because of institutional and societal constraints.

Secondly, the initial views of participants on the use of computers in mathematics education reflected traditional norms and values in Turkish society. The initial data illustrated that viewing the computer as a catalyst for educational change is connected with ideas of modernism, of not following Europe in servile imitation and of undermining traditional conceptual skills of pupils.

Thirdly, all participants had a social agenda in their own teaching and valued a good relation and social interaction as important factors in helping the pupils to develop positive attitudes towards mathematics. This agenda appears to be built on a dormant tension associated with past experiences with their own teachers. Amongst all the participants there was a common feeling of dissatisfaction with their own schooling which led to universal support for a greater degree of interaction between teachers and pupils. We may note that at this initial stage none of the participants saw the computer as a way of

increasing this interaction and some of them saw the computer as potentially damaging it.

Finally, the participants brought with them many ideas compatible with procedural views of mathematics and mathematics teaching which the course was to challenge. However, they also brought many appropriate ideas which appear to serve as a catalyst for 'breaking with tradition' and which did not need to be challenged or changed during the programme.

INTERPRETATION OF EXPERIENCES

Several recurring themes came up in connection with the 'micropractice' within the Logo-integrated mathematical environment.

The place of the teacher in a class with computers

Seven of the participants leaned towards use of computers as a supplementary tool for their lectures in a limited and controlled way. They wanted to see the mathematics classroom as it currently is in schools in Turkey and believed that computers for every class would be difficult, the country cannot afford it, but a computer lab for every secondary school was seen as reasonable. With pupils going to the computer lab for at least two hours a week after class Logo activities would reinforce for pupils what the teacher has shown in the classroom.

Five of the participants believed that the computer would not benefit mathematics learning and teaching if used in lecture mode. These participants valued informal activities in mathematics learning and suggested that teachers should relinquish their classical role and learn to prepare Logo activities for pupils to explore mathematical meanings. A view commonly shared by these participants was that pupils would have the chance to review topics and explore mathematical concepts, and would be able to learn things by themselves through direct analysis of computer feedback.

How to explain these two different views? It seems that participants in the first category felt obliged to meet the current daily demands in mathematics teaching and finding teaching mathematics through open ended exploratory activities too extreme they attempted to narrow the gap through computer based activities supplementary to their lectures. Participants in the second category appeared to receive the message conveyed by the course.

Seeing mathematics through Logo

At the outset of the course most of the participants viewed the computer as nothing more than an object to learn about in itself. After micropractice within

a Logo-integrated setting participants expressed the following five views about Logo:

- Logo does not have much connection with school mathematics;
- Logo activities could enrich the teacher's lecture;
- The teacher could also sustain pupil interest in mathematics by using predesigned Logo activities after the actual classwork;
- Using Logo activities the teacher could encourage pupils to consolidate understanding of what they had previously only vaguely and abstractly known;
- Logo can raise pupil interest in mathematics through exploratory activities.

These five views can be put into three categories. At one extreme we have such satisfaction with the experiences during the programme that by projecting these experiences on pupils Logo-based exploratory activities are seen to deepen prior mathematical knowledge and to offer new insights. Another extreme is not seeing any particular potential for using Logo in mathematics class. Here mathematics is teaching, teaching is lecturing and lecturing has nothing to do with computers. The third category falls between these two extremes. Here there is acceptance of Logo activities as part of the mathematical work, but it is felt that it would be inappropriate in the classroom itself (for example, it should be in a computer lab after the normal classroom period).

REFLECTIONS

The information from the model course provides new insights into Turkish mathematics teacher education and offers some important conclusions about the complexity of changing conceptions. Initial views about computers among prospective teachers ranged from regarding them as merely a western fashion to epitomising all that is good in terms of modernism. The present research has shown that both of these positions can be built upon provided that the computer is used as a means for learning and teaching specific subject material, rather than as a technological object to learn about its own right.

Some preliminary conclusions

Traditional versus constructivist is an oversimplified dichotomy

At the outset of this study I saw traditional and constructivist as two opposed tendencies. This is a too simplistic viewpoint. For example beliefs in modernism and discontent about memorization can be used as a catalyst for different kinds of views.

Logo-Mathematics provided a means to build on existing tensions

Through micropractice participants had a chance to think things over 'for themselves' while working on Logo as learners, on how they might effectively integrate computers into their future mathematics teaching. The tension between constructivist and traditionalist approaches was critical in opening up ways of breaking with tradition. A primary mechanism for this was the construction of Logo programs and exploration of Logo activities. The dynamic and interactive nature of Logo-mathematical activities acted as a catalyst for developing links between Logo and mathematics.

Limitations of the study

The length of the course was almost trivial compared to the continuity of traditional experience of participants. During the course the micropractice appeared at best to stimulate the appetite of the students. The findings merit further research over a longer period of time; the investigative method is offered as a model.

Another, related limitation of the study is the difficulty of effectively matching the Logo based materials and the existing curriculum resources. Current textbooks do not feature much material suited for Logo use and there certainly is none which actually uses Logo or the computer in general. However, it may be sometimes easier to affect change in attitude by a radically new alternative, than by trying to assimilate innovations into the existing curriculum.

Implications for further research

This study offers a possible way to make effective changes. One question arising from the current study is: what kind of support could be given to first year teachers for instituting practices which are likely to be questioned in traditional school settings? This question deserves continued study and investigation in Turkey. In particular, it would be interesting to explore, perhaps with a greater number and over a longer time, elements of traditionalist orthodoxy which could be used as starting points for change.

The current study did not follow the prospective teachers into classrooms. There is a need for a longitudinal study which would offer teachers longer time for a model course and which would continue at least into their first year of teaching in the school. This would allow investigation of the relationship between what teachers say and do on the course and how they operationalize these ideas in a real classroom.

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