EDUCATING MATHEMATICS TEACHERS

ADNAN BAKI*

SUMMARY: In our current teacher education programmes, teachers are being prepared in ways that develop "procedural knowledge of mathematics" which assumes that the teacher is the possessor of ready made mathematical knowledge o be conveyed to the student. On the other hand, "conceptual knowledge of mathematics" challenges the assumption that teachers transmit knowledge to students and argues that teacher's conceptualizations can not be given directly to the learner and that conceptual understanding in mathematics must be constructed by the learner. As a result, much of the constructivist educators in the last decade attempted to provide teachers with ways to organize learning environments, manage instruction, and teach conceptually rather than procedurally and investigated the question of what teachers need to know to teach conceptually, where and how teachers can best acquire and develop that knowledge.

This paper addresses each of these questions for Turkish mathematics education and considers some viewpoints which mentioned in the literature. The first section of the paper starts by explaining what is meant by the term "conceptual knowledge of mathematics" which will be used throughout the paper. The second section deals with the current pattern of teacher education and problems in training secondary school mathematics teachers. In the last section, some possible solutions for the shortcomings of the Turkish mathematics education are discussed from a constructive perspective.

Finally, the paper will have implications that the effort of teacher education programmes in mathematics should center on a view that the teacher is to enable students to be actively involved in the process of doing mathematics. In particular, teacher's knowledge of mathematics should be promoted and evaluated in terms of mathematics values and concepts not specific skills and symbol manipulations.

Key Words: Mathematics education, teacher training, curriculum.

BACKGROUND AND RATIONALE

Conceptual knowledge of mathematics

In order to understand what is going on in mathematics education and how students, teachers learn and change, we have to identify the distinction between conceptual and procedural knowledge proposed in various ways by DiSessa (6), Skemp (13), Carter and Yackel (4), and Garofalo and Durant (8). The distinction is problematic because it is not always clear enough to be applied precisely to all situations in mathematics. However, the widespread perception of mathematics as a collection of disparate rules and procedures has been well documented in empirical research on teachers' beliefs (7,14).

*From Department of Mathematics Education, Karadeniz Technical University Fatih Faculty of Education, Trabzon, Türkiye.

Skemp's (13) distinction between *instrumental* knowledge (corresponding to conceptual procedural knowledge) and *relational* knowledge (corresponding to conceptual knowledge) is perhaps the most widely used among constructivist mathematics educators in recent years. Skemp refers to '*relational* knowledge' as the ability to know 'what to do and why', while he defines 'instrumental knowledge' as the ability to use the 'rules without understanding the reasons'. By instrumental knowledge, he refers to the rote performance of a procedure (knowing how to use it, but not necessarily knowing why), whereas, relational knowledge refers to the performance of procedure with understanding.

Carter and Yackel (4) view Skemp's distinction as a useful albeit simplified language for discussing a continuum of mathematical knowledge. For them, 'individuals with procedural knowledge can be thought of as rule and procedure-driven or rule-memoriser. Because mathematics is a series of rules, to learn mathematics means one must learn the rules, usually through memorization. One must also learn the situations to which the rules apply'. This perspective reflects a procedural knowledge of mathematics where there is an authority, such as the teacher or textbook author who knows the rules and procedures and transfers them to the pupil.

In contrast, Carter and Yackel (4) describe lear-ners with conceptual knowledge of mathematics as problem solvers who 'can use their creativity in solving problems and generating mathematical knowledge'. From this description it can be said that the conceptual knowledge of mathematics values learning in terms of understanding and not merely in terms of reproducing the teacher's mathematics or algorithms. It tends to view mathematics as a group of related concepts and ideas, and suggests the need for the provision of opportunities for pupils to construct these concepts and ideas for themselves.

DiSessa (6) describes two main views of learning and teaching which effect students learning experiences in the school system. One prevalent view is a procedural one, that the learning of mathematics and science is simply acquiring new knowledge specifically concerned with the rules, principles and equations of textbooks. These rules, principles and equations are understood essentially on the surface level of knowing the principles by the name and statement, and the equations by letters. DiSessa calls the students who hold this view of learning the 'result men'. Learning, for these students, consists in the matching of problems to equations in order to produce an answer. They must substitute the facts or data given in the problem statement into the proper variables in the appropriate equation. They then perform the indicated algebraic and arithmetic operations to produce a correct answer which is true by virtue of all the presented facts. The answer is often verified in the back of the book. These students rely heavily on authority as a source of mathematical knowledge and tend to solve mathematical problems by employing rules and procedures which have been explicitly taught by the teacher.

The conceptual view, according to DiSessa, describes a rare, but certainly a more powerful way of understanding mathematics and science. Students who hold this view of learning realize that in order to 'get the point', their intuitions must be substantially reorganized; and that they can come to see a mathematical task as a group of related concepts and ideas. They search for the structure of the problem as small pieces that fit together rather than look at the type of the problem in order to identify superficial clues and produce algorithms.

DiSessa (6) argues that the two contrasting views play a crucial role in the classroom. They determine not only what students believe they are learning, but also how they must proceed to learn it. For DiSessa, a student's epistemology shapes the attitude towards, and conception of, both the content and process of learning, and it determines whether the student is a rule memorizer or a conceptualizer. Therefore, the types of teaching that the teacher follows and the concepts s/he hopes to teach will affect their students' epistemologies in ways which will either foster or suppress conceptual understanding.

What is wrong with school mathematics?

In Türkiye, the main characteristic of the traditional way of teaching mathematics is consistent with the procedural knowledge of mathematics set out in the previous section. The teachers' priority is to follow the

textbooks, to spend the majority of their time lecturing to students using the blackboard, to stress algorithms, rules, definitions, axioms, and formulas to be memorized, and to provide sample problems to be used as examples for the solution of nearly identical problems. Students learn 'how to do mathematics' at least; some do, that is, they learn how to follow algorithms and procedures to get correct answers. Teachers and students in this traditional way share a common expectation of mathematics as a discipline of well defined rules and right answers. Students who have been taught in this way learn to be successful 'mathematics students' by memorizing algorithms, rules, and formulas for solving problems and obtaining right answers.

This traditional way frequently leads to students replicating mathematical routines without developing conceptual understanding. Of course, this is consistent with the main goal of their mathematics learning, which is to answer correctly a sufficient number of questions in order to get a high score in the examinations - particularly in the university entrance exam. However, as a consequence of focusing on the development of procedural knowledge, students come to view mathematics as a list of unrelated rules and procedures that must be memorized.

Large number of students therefore, graduate from lycée and enter university programmes with serious deficiencies in their conceptual understanding. It is evident that a significant number of students who were successful at mathematics in lycée failed to study more advanced mathematics at university. Therefore, the traditional method of learning mathematics becomes inadequate when students enroll for undergraduate mathematics courses which required them to think mathematically rather than merely memorize formulas and manipulate mathematical symbols. This reflects the current failures of the traditional approach to the learning and teaching of mathematics in Türkiye.

Today in Türkiye, procedural knowledge of mathematics and the transmission model of learning and teaching are dominant at all levels in the education system. This dominant pattern undoubtedly reinforces prospective teachers' conceptions about learning and teaching primarily that *teaching* is *telling* and *learning* is reproducing what the teacher says. The teacher training programmes do not provide prospective teachers with an opportunity to experience alternative methods and approaches to the learning and teaching of mathematics. Thus, when they become teachers, they are not able to make informed decisions about what and how their students learn, and they are not able to take responsibility for shaping the content and process underlying a task to meet the needs of their students.

If prospective mathematics teachers' conceptions of mathematics and its teaching formed in the traditional system are to be changed, there needs to be a break in the cycle of 'as we were taught, so do we teach'. In other words, to develop more realistic and healthy beliefs about mathematics and learning, we need to change what occurs in the classroom. This can only happen through an interaction between what teachers see in an alternative educational environment and what they bring to this new environment where they are confronted with relevant and meaningful events which require them to reflect on their past experiences, and to modify their previous conceptions of mathematics and its teaching.

PROBLEMS IN TRAINING MATHEMATICS TEACHERS

The current pattern for training mathematics teachers:

The Ministry of Education has been responsible for training, employing and professionally developing its teaching force between 1923 and 1982. In accordance with the law accepted in 1982, the Higher Education Council was established, all the former schools, where mathematics teachers were trained, were placed under the authority of universities. After the integration of teacher education colleges into the universities as Faculties of Education, initial training for secondary school mathematics teachers started at universities with the same pattern throughout the country. Each year, following lycée graduation, approximately 800-1000 students are admitted to the departments of mathematics education at the existing Education Faculties. These students begin a 4 year undergraduate programme providing Bachelor's degree in mathematics education. This 4 year programme is divided into three types of courses: Subject, general pedagogy and subject application courses.

The subject courses are:

1st year	Calculus, linear algebra, number theory, discrete mathematics, physics I,
2nd year	Abstract algebra, analytic geometry, analysis, numerical analysis, probability, physics II,
3rd year	Differential equations, real analysis, differential geometry, statistics, applied and theoretical physics,
4th year	Functional analysis, algebraic topology, projective geometry, complex analysis.

General pedagogy courses for secondary school mathematics teachers consist of 8 three hours per week-semester long courses, and one or two can be taken per semester:

1. Introduction to Education,
2. Sociological Foundations of Education,
3. Psychological Foundation of Education,
4. Curriculum Development,
5. Measurement and Evaluation in Education,
6. Teaching Methods,
7. Field Work,(1)
8. One elective course in computer programming.

These teaching certificate courses are usually taught in the same form for all students at all branches in the faculty of education. The students at the department of mathematics education are not taking a 'teaching methods' course in the sense of teaching methods of secondary school mathematics nor are they taking a 'curriculum development' course regarding curriculum development in mathematics education.

(1) As one term course, this is offered in the last year of the programme and consist of three components: presentation in which students are supposed to prepare and present a topic in front of classmates; visiting schools to observe teachers in an actual classroom; 4 week teaching practice in a cooperative school under the supervision of two cooperative teachers, one of them is a member of the teaching staff in the mathematics education department.

The above mentioned general pedagogical courses are also offered in the faculty and students from different departments take them together taught by the same lecturers or professors in the same classroom. The courses are lecture-based and as 100-200 students from different departments usually crowd into each class, no extensive discussion or personal contact between lecturers and students is possible. Consequently, these courses appear insufficient to provide students with pedagogical content knowledge in relation to the learning and teaching of mathematics.

Subject application courses do not exist as serious entities in the teacher education programmes. Student mathematics teachers are taking this course as a lecture-based course. Throughout my investigation of secondary preservice programmes, I noticed that prospective mathematics teachers not only need to understand the practical and theoretical characteristics of the various teaching methods, but also need instructional models. This has not been fully appreciated by the educators who are in office at the Faculties of Education. However, most of them admit that secondary mathematics teacher preparation programmes are not adequately preparing preservice teachers, but they are also quick to add that many of the reasons for the inadequate programmes are completely out of their hands. There are, in fact, other institutional forces that maintain the status quo in teacher education and these forces may be overwhelming.

Even subject application courses are not under the control of teacher educators but are taught by the subject matter professors who may or may not have any background in teaching methods. These courses are based on a traditional pattern: listening to lectures, with no independent activity on the part of the attendants. Thus, student mathematics teachers through subject application courses are not even aware of viable instructional alternatives. They only see one type of teacher as a model and one type of class as an instructional model, and they tend to rely on teacher-centered task organizations and believe that they will teach best when direct instruction occurs. Thus, student-centered instructional approaches remain unknown and seem risky and untenable in prospective mathematics teachers' eyes.

The other primary problem with the current pattern

of teacher preparation programmes is the limited amount of field experiences. The gap between theory and practice is too wide. The general objectives of teaching practice were described by Cepni (5) as:

* to make student teachers confident enough to believe that they will be able to accomplish their future tasks properly;

* to enable them to develop and to gain the practical skills needed in their future role as teachers; and

* to make them active and familiar with forthcoming professional responsibilities.

These objectives appear admirable yet nothing could be further from the truth. The period of teaching practice is officially fixed at four weeks in the current teaching training programmes and prospective mathematics teachers are expected to develop enough confidence about their future tasks and necessary skills as an effective teacher during the four week period of teaching practice. This situation clearly shows the current approach in the Turkish teacher education to be 'learn first and practice later'.

In essence, the Faculties of Education with this current pattern, train and prepare mathematicians not mathematics teachers. It is evident in the initial training programme that the mathematics component is strong but not relevant for secondary school mathematics, and the pedagogical content knowledge component is virtually non-existing. Of course it is true that mathematics teachers should know sufficient mathematics beyond the level that they are supposed to teach. But the mathematics they need is at the same time different in content as well as significance from that needed by the mathematicians.

On the other hand, mathematics teachers need special training in developing a sound understanding of certain mathematical content which is particularly important for teaching at secondary schools. The current teacher education programme does not provide prospective mathematics teachers with an opportunity to study and learn some mathematical topics which they will teach in secondary schools. For example, basic concepts in Euclidean geometry, trigonometry, arithmetic sequences, geometric progressions, systems of linear equations, and modular arithmetic are not taught in the current teacher training programme, while they are critically important for secondary mathematics teachers. In this regard, there is a need to rethink and reevaluate the content of the subject courses run in the existing mathematics education departments in the country in order to decide what mathematical content is necessary and appropriate for the prospective mathematics teacher. The unfortunate part of this situation is that so little effort is really being made to help Turkish prospective secondary school mathematics teachers.

The possibility of alternative learning and teaching methods:

A conference was held on 'Mathematics and Science Teaching in Secondary Schools' on 12-13 June, 1984 in Ankara. In this conference, Nasuhoglu (11) claimed that the outcome of science and mathematics education at secondary levels was not satisfactory because schools were not able to develop students' scientific thinking skills, positive attitudes towards science and mathematics nor to develop students' problem-solving skills. The majority of the students memorized the facts, rules or principles without grasping their real meaning. Ural later (15) supported Nasuhoglu's claim that students in Turkish secondary schools do not have many opportunities to develop critical problem solving skills or to learn by doing, since most classroom activity is based around the book and the lecture. Under these circumstances it is hard to motivate students to different needs and wider goals. In addition, he declares that all courses in secondary schools are taught according to the examination-oriented nature of the curriculum by using exposition teaching methods.

It is evident in the literature that the years spent in mathematics classes, watching teachers and being students contributes to the continuity of a traditional cycle of 'as we were taught-so we teach' (3) in mathematics education. Thus, the time spent in mathematics classrooms at the department of mathematics education as students gives prospective mathematics teachers a specialized apprenticeship of observation. By watching teachers through school days and paying attention to their own experiences and teaching tactics and strategies, prospective mathematics teachers develop ideas about

the teacher's role, form beliefs about what works in mathematics learning and teaching, and acquire a repertoire of strategies for teaching specific content. This leads to a vicious circle which is reproduced continuously; rule-memorizer university teacher, rule-memorizer secondary school teacher, rule-memorizer prospective teacher, rule-memorizer student and so on (Figure 1).

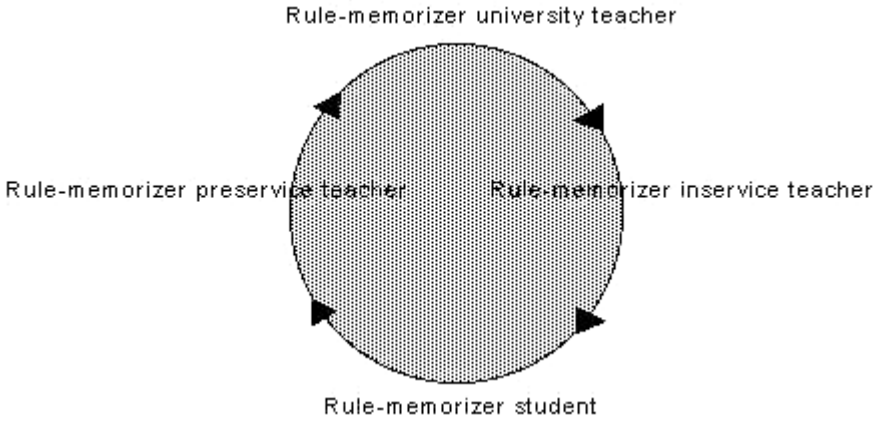

Figure 1: A vicious circle in mathematics education.

Consequently, prospective mathematics teachers' experiences within the current teacher training programmes influence and shape their conceptions and views about what they do with their students in the classroom. The vicious circle is not easily broken through in service activities because inservice teachers are never involved in any different experience during their professional lives. So, they carry their procedural knowledge of mathematics throughout their professional career and even though they may encounter different teaching activities they always approach them with great skepticism. For instance, Baki (2) reported that teachers commonly share the idea that when they state a series of procedures, theorems, and proofs correctly and clearly, and solve problems with plenty of symbols, they must necessarily be understood. Furthermore, if these teachers were succesful in mathematics at secondary school and in their teacher education programme, they are likely to approve of the patterns they saw in the past and perhaps they may not be interested in alternative ways of teaching. Even if they are critical of their own past teachers for teaching uncreatively, they may lack alternative models.

The other obstacle for the constructivits teaching is the structure and physical arrangements of Turkish classrooms. Students sit at desks arranged in rows and facing the teacher, so they can pay attention to the teacher and the blackboard. This arrangement is suitable for exposition-based or lecture-based methods of teaching rather than other teaching methods. On the whole the classrooms are bare, and discussion, unless closely monitored by the teacher, is largely absent. Because of the physical arrangement of the desk, it is too difficult for students to share their ideas with each other and it is difficult for the teacher to initiate group-work activities. Only the teacher is able to move in the classroom during the lesson. These conditions in the classrooms do not provide enough scope for teachers to use investigative methods in their teaching even if they attempt to do so.

The other factor that may cause a reluctance to attempt to try different models, is the students' numbers in the classrooms. There are approximately 50 students in each classroom. In fact, it is a common phenomenon for Turkish secondary school mathematics teachers to believe that the lecture method is most suited to the classroom where the students' numbers are very high. The classrooms at the Faculties of Education have almost the same conditions. Whatever the activities or methods the teachers try to apply, there must be compatibility between the physical arrange-

ment of the classroom and the activities of either the teachers or students involved. Even if teacher educators attempt to use different models beside the lecture, they will face problems in organizing their classroom environment and lessons in such a way that facilitates active involvement of students.

However, well-known teacher educators in Türkiye support the idea that if there are more than fifty students in a classroom, the lecture method of teaching should be used (5). These teacher educators use Ausubel (1) as a reference for their views about the lecture method. It is clear that Ausubel does not agree with the argument that the weaknesses come from the lecture method itself. He believes that teachers mostly abuse the lecture method. For him, the method can be interesting and meaningful to the students, if the teacher who uses it knows how to use various techniques such as exploring previous knowledge and then trying to build new knowledge on what has already been learnt.

On the other hand, there has been some criticism from national reports, media, and teacher educators; for examples, Baki (2) criticized the lecture method for making students passive and resulting in students who do not understand concepts. He argued that an effective teacher in the Turkish context would be described as a teacher who asks questions during his/her teaching, since discussion and interaction between teachers and students in the Turkish context mostly start with questions initiated by the teacher. If this is true, the questioning strategy in the Turkish classroom becomes most crucial in order to initiate interaction and discussion between students and the teacher. This view seems compatible with a constructivist view of teaching which suggest the use of questioning strategies to access students' thoughts and assess their previous knowledge.

Instructional use of the computer in mathematics education

Türkiye is the only country in the Middle East which tends strictly to follow the West in every field without regarding its own cultural background. This path requires the prioritisation of Western values over traditional Turkish values. This inclination has sometimes caused a superficial understanding of Western trends and created problems in getting at the philosophies behind them. This is particularly so in education; in fact controversies, misunderstandings and misconceptions are endemic to the Turkish educational system. For instance, the incorporation of computers into the educational system in developed countries created a rapidly developing trend in Türkiye without teachers or educators fully comprehending their potential. It has been said everywhere that computers can improve education; most of the time it is understood that the presence of computers in schools will guarantee this improvement. It seems likely that at least part of the failure of this innovation in Turkish educational system rests on teachers' lack of appreciation of its underlying philosophy or rationale, and of the complexities involved in "introducing" the computer into the educational system.

Although the computer was first introduced in schools in the early 1980s, it is a new educational medium in Türkiye. "Introducing" computers into schools was widely agreed to be urgent in Türkiye. By contrast, educational thinking about computers is, and remains today, relatively underdeveloped. There is no extensive research carried out in this field to provide enough information about how schools are employing computers. This make it difficult to provide sufficient information about the present situation of school use of computers and teachers' attitudes towards compu-ters. Government documents and newspapers are the only source of information. As far as I was able to determine from newspapers, and the Ministry of Education's Research Unit's publications, only a few lycée and army colleges were using computers in their curricula. However, there are many computer-equipped primary schools and private schools particularly in larger cities using computers for introducing informatics into these schools.

According to the Ministry of Education's Research Unit, in 1985 approximately 3000 personal computers were supplied to 200 pilot schools including primary and secondary schools (most of them technical and vocational lycée), officially resulting in the beginning of computer education in schools. Although, the government recommended that computers should be used in

the primary, middle, and lycée schools, there is no any effort to create compatibility with the electronics network in the country and to substantially develop the contents of education in the Ministry of Education.

Many journalists between 1986 and 1994 worried about computer education in schools and wrote about serious problems related to the integration of computers into education. The main problems they indicated were: the university entrance examination that no ready software developed for the purpose of preparing students for; the unpreparedness of supplementary machinery and tools; an absolute lack of qualified teachers; goverment's non-systematic promotion of the project; and the complicated procedures involved in purchasing computers for schools.

These criticisms also reflect the other fact that the integration of the computers into the schools has been under the control of politicians, administrators, and businessmen rather than educators, teacher educators and the Faculties of Education so far. It is difficult to find inservice mathematics teachers knowing how to use computers in teaching practice. Furthermore throughout my investigation of the current teacher training programmes at the Faculties of Education, I can conclude that these programmes do not provide prospective mathematics teachers with an appropriate training to enable them to teach mathematics with computers in secondary schools when they become teachers. No education faculty where secondary mathematics teachers were training has a computer course for this purpose, and no education faculty is planning to offer this kind of course (2).

Although the current teacher training programmes offer an elective course to prospective mathematics teachers, these courses generally introduce computer programming, usually BASIC, are taught by technology specialists and usually do not focus on the instructional use of computers in mathematics. Therefore, it is important for current teacher education programmes to take the initiative in revising current programmes to prepare new teachers in the use of computers in schools in the way compatible with learning and teaching theories and approaches of the kind that are so much in evidence in the recent literature on mathematics education.

In this section, while describing the current structure followed in the preparation of mathematics teachers in Türkiye, I have tried to indicate its serious shortcomings in terms of the improvement of educational situations in mathematics in relation to the three main issues mentioned at the beginning of this section. The following section is devoted to the discussion of social and political factors which have affected the improvement of teacher education in Türkiye, and some possible suggestions for appropriate action to improve the current situation in mathematics education.

SUMMARY AND CONCLUDING REMARKS

There are two major points which arise from this review:

1. The feasibility of breaking with tradition in mathematics education:

This review illustrates that the existing pattern in teacher education has proved its inadequacy for providing alternative approaches to mathematics teaching. Trainee teachers are never involved in any different experience during their training, and they carry their procedural knowledge throughout their professional lives. This contributes to the reproduction of rule-memorizer teachers and students in mathematics education. The other obstacle for conceptual teaching and learning is the University of Entrance Examination which measures only procedural knowledge, and does not provide enough scope for students to learn mathematics through exploration.

The feasibility of 'breaking with tradition' seems dependent upon an achievement in changing what occurs in the classroom. From the point of view of the present work, this proposed change in mathematics education started from the vantage points of teacher training. The present work adresses the shortcomings of the current pattern followed in the preparation of mathematics teachers, and offers an alternative approach to the learning and teaching of mathematics. This approach aims to provide a foundation which addresses these educational shortcomings. It priori-

(2) The author of this paper as the first researcher and educator developed and implemented this kind of course at the Department of Mathematics Education of one of the Faculties of Education in Türkiye in Autumn term 1992.

tizes student-centered methods over teacher centered methods; student task-based lessons over lecture-based lessons.

2. Computers are isolated from the mathematics curriculum:

It is relatively easy to teach computing as a subject in Turkish universities; for example, there is already a well established curriculum for the purpose of computer programming and software engineering. Yet, because of the traditional view of learning and teaching in Turkish schools, and because of the absence of teachers' previous experience of teaching with computers, it is extremely difficult to teach school mathematics with the computer through new approaches to teaching which are relatively widespread in the developed countries' educational systems. Learning to teach is a developmental process which should include opportunities for the development of knowledge structures that support teachers' professional development. Simply teaching teachers how to use the computer does not automatically prepare them to be 'better' teachers in facilitating the learning of their students. In order to overcome this problem, the computer should be seen as a vehicle for new ways of teaching mathematics, and it should serve as a window through which prospective teachers could view alternative approaches to mathematics learning and teaching.

This review also illustrates that the integration of the computer into schools has so far been under the control of politicians and businessmen rather than educators and the Faculties of Education. Apart from this, the existing teacher training programmes only introduce computer programming, usually BASIC and PASCAL. Courses are taught by technology specialists and do not focus on the instructional use of computers in school mathematics. From the point of view of the present study, the computer is seen as a vehicle for new ways of learning and teaching mathematics. Introducing the computer into mathematics education from this perspective might provide solutions for the shortcomings of mathematics education. For example, if we introduce computers into the classroom in a way that provides opportunities to explore mathematical concepts, students might then bridge the gap between skills and concepts, and they may begin viewing mathematics as a group of related concepts and ideas.

The other shortcoming to be discussed is that the traditional way of teaching mathematics in Türkiye is mainly based on lectures. The teacher 'performs' like a traditional lecturer as the students sit listening and taking notes. In this teacher-centered model, the primary requirement for a student, as indicated, is to remember what the teacher said. In addition to this, the teacher in secondary schools has to follow standard textbooks which are edited by the Government. Because of the uniformity of these textbooks, it is hard to motivate students to different needs. Under these conditions, creativity is seldom necessary for students to succeed, and most of them lack creativity and critical thinking abilities. In this regard, using computers in an exploratory way may radically change the teaching practice from teacher-centered to student-centered, and may change conceptions and views about mathematics and its teaching in Türkiye from being broadly procedural to a more conceptual approach.

Implications for teacher education

Prospective mathematics teachers do not come to the faculty of education as empty vessels; they have conceptions and views about mathematics and its teaching which have been constructed throughout their schools years. As this is the mathematics they will teach, what they have learnt about the subject matter in lycée and faculty classes turns out to be a significant component of their preparation for teaching in lycée. They have learned that mathematics is a fixed body of rules and procedures, an uninteresting subject best taught through memorization and repetition.

This paper addresses the need for a new preservice curriculum in helping prospective mathematics teachers:

* to develop a critical perspective on mathematics learning and teaching; and

* to move beyond traditional views of mathematics learning and teaching and to offer a route for learning to teach mathematics compatible with a conceptual view of learning and teaching mathematics.

The necessity to involve teachers in the type of learning experiences and environments that they are

expected to implement in their teaching, has been advocated by various researchers (9,12). They propose that teachers should have practical experiences with approaches, materials and activities that they are expected to employ when they will eventually be teaching. For example, Simon and Schifter (12) 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.

With this in mind, new courses should be designed and implemented as an alternative to traditional types of teacher education courses in some significant ways. Distinctive aspects of the courses should include student task-based lessons, exploration and investigation together with groupwork and discussion.

The new preservice curriculum as an intervention to break the cycle in a secondary teacher preparation programme at a Turkish education faculty, should be designed to lead trainee teachers to reinterpret their past experiences with mathematics and construct new understandings and conceptions about mathematics and its teaching. In this way we would respect the continuity of their learning both as students and as teachers of mathematics.

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Correspondence:
Adnan Baki
Karadeniz Technical University
Fatih Education Faculty,
Dept. of Mathematics Education
61335 Sögütlü, Akçaabat
Trabzon, TÜRKIYE.