

TEACHERS' PERCEIVED ROLES OF THE COMPUTER

IN MATHEMATICS EDUCATION

João Ponte
University of Lisbon

The reform movements concerned with innovative pedagogical approaches and the possibilities offered by information technologies rise new problems to inservice programs. These must give careful consideration to their pedagogical and cultural frame and to its inner dynamics. This study focus in the conceptions and attitudes of teachers involved in such a program regarding the educational role of the computer.

Automatic information handling media acquired a prominent role in many fields of our society. They are essential in research, design, control, management, and communication. One finds examples of changes fostered by these technologies in all domains of economical, social, and cultural life. The development of the ability to use critically and efficiently these media is becoming an important educational objective.

The computer is a particularly significant tool in mathematics, allowing to work simultaneously with different representations of data and yielding the automatization of the execution of repetitive tasks. The computer brings with it new concepts and problems, enabling the extension of the range of questions and strategies that the students can deal with.

World wide economic competition pressures school systems for educational reform. Attention is being paid to the development of student "basic competencies" and professionally oriented school programs. But there is also a generalized concern with the present inefficacy of the educational systems to promote in most students higher literacy competencies (see Romberg, 1988). Mathematics is one of the subjects that most contributes to the failure, frustration, and social unadjustment of many students.

Therefore, it is not surprising that, in mathematics education, the major strand of the current reforms concerns not the updating of the content (as was the case in the sixties), but the establishment of new goals and methodological approaches. Problem solving, project work, embedding mathematics in real word contexts, stressing the student's role in the learning process, interest the possibilities offered by the new information

technologies have been orientations behind most recent research and development efforts (APM, 1988; ICM, 1987; NCTM, 1989).

Research on inservice work with teachers aimed at the introduction of these innovative ideas in schools is thus required. But, to be successful, the inservice framework must be consistent with the sort of pedagogy that is advocated for schools. The development of new conceptions, attitudes, and competencies should not be viewed as a mere process of "training" but as a multifaced process of "teacher development".

The inservice program in which this study is based stands on the assumption that thinking on how to use the computer in their classrooms and in other school settings, can be a good starting point for teachers to reflect in a global manner on their own practice. Although the computer may be introduced with little or no change in teachers' conceptions and teaching methods, their interest in making a sensible use of this instrument and their disposition to learn new things, assume new classroom roles, and establish new teacher/student relationships creates a stimulating environment for general educational reflection.

This program is carried as part of the National Project MINERVA, aimed at the introduction of computers in Portuguese schools. Our group is connected to 27 schools, of which 23 at middle and secondary level. In these schools it is constituted an interdisciplinary coordinating team, with 3 to 5 teachers. Depending on the school, mathematics teachers may or may not integrate it. This team is encouraged to organize activities to disseminate the use of new information technologies; to promote the development of disciplinary and interdisciplinary activities and projects, and to support other teachers that intend to use the computer in their classrooms. These activities are proposed to foster a new structure and atmosphere influencing the teachers' professional role (Romberg, 1988).

Different inservice opportunities are offered in this program, targeted to teachers in a variety of situations. For example, there are shorter courses focused in a single powerful piece of software, like LOGO or spreadsheets, intended for "beginners", and longer ones centered in one school topic, like mathematics, or language, intended for teachers having already some experience. There are also more extensive courses for members of the school coordinating teams and the members of the Project group. Most of these courses have flexible organization schemes, alternating formal sessions, sometimes in concentrated periods, with work in the schools. For the teachers, all the activities carried within the Project are considered as part of the inservice program, including the local support directly given to them, the participation in school projects, and the meetings with teachers from other schools.

The inservice program was designed with two essential

elements: (a) its cultural and pedagogical frame, based in the innovative potential of the new information technologies and in the concept of project work (Monteiro & Ponte, 1987), and (b) its dynamics, considered at three levels: personal involvement, group processes, and the role of the program team. This study focuses on the conceptions and attitudes of mathematics teachers, concerning how they view the computer and its role in mathematics education.

Theoretical Background

Reforms aimed at the promotion of new pedagogical approaches or the introduction of new technologies in schools are examples of attempts to educational change. One must be aware that the most critical aspect for the success of any intended process of change in large organizations concerns the role of the people involved (Huberman, 1973; Knupfer, 1989-90).

People can change in various respects. For example, Lewin (1948) distinguished as possible aspects of personal change: (a) change in cognitive structure (like learning new knowledge); (b) change in motivation (such as learning to like or dislike something); (c) change in ideology or in fundamental beliefs; and (d) change in behavior (like control of body muscles).

The cultural and pedagogical frame is an essential aspect of the inservice program. Teachers have their well established systems of ideas and beliefs about themselves, about the subject they teach, about their profession and about their practice (Jones, 1988). An intended process of change necessarily carries with it an underlying rationale. The specification to the teachers of this cultural and pedagogical rationale is essential to introduce new information and conceptual elements that challenge the closed circle of their conceptions and values, their "certainties" (on what works) and their "impossibilities" (in doing anything different). The assumption is that it is much more likely to begin a successful process of questioning these conceptions bringing in new perspectives from the outside, than searching contradictions and weaknesses inside the teachers' conceptual frameworks.

Furthermore, this cultural and pedagogical frame ought to be clearly stated to the teachers if they are to play the role of subjects in the process. Teachers should have the option of adhering or not, the possibility of accepting or not the new views and proposals. The ultimate decision to change is theirs, and they must be provided with all the relevant information to make it conscientiously.

In fact, the personal involvement of the teachers is a fundamental condition of personal change. This involvement should yield them to levels of progressively more autonomy regarding the program team (Canário, 1989).

To foster the involvement of the teachers, the program must take into account their interests, objectives and experience (Rangel, 1979). For them, a very important part of the process of assuming their own process of learning and professional development depends also on becoming confident in defining and solving their own problems (Easen, 1985).

The analysis of needs of the participants has been pointed as the key element in the design of an innovation. However, the identification of needs is a complex task. Teacher training institutions may have more or less defined views about teachers' training needs, but the teachers themselves may consider them irrelevant or unacceptable. Regarding teachers as true professionals is quite contradictory with giving somebody else the role of stating what they need. But the articulation by the teachers themselves of their needs may also be very difficult. They may not be used to this process of self analysis and may not be aware of what possibilities are available and what are their implications. This analysis may only be possible as a result of effective professional development, and not as the beginning point of the process (Easen, 1987). In this program, the analysis of needs is considered as an essential task, but to be carried on an interactive way by participants and trainers (Canário, 1989).

The dynamics of group processes is also a fundamental element of the inservice program. It is quite difficult to surmount all the difficulties surrounding innovations in isolation. To resist to constant criticism, to draw in the experiences of the others, to have reflection partners, teachers find a strong support from their peers involved in the same process. Furthermore, group dynamics, appropriately designed may be an important factor in the change process. As Lewin (1951) as shown, so far as the values of the group remain the same, the individual will resist change, and that so much as he or she will be required to deviate from the norms of the group. If the norm itself will change, the resistance caused by the relationship between the individual and the group is eliminated.

The role of the program team is essential in this process. It has the responsibility of creating the working framework, constructing the necessary materials, make the general proposals, introduce the cultural and pedagogical framework. The team is seen with an affirmative role of creating the appropriate environment to foster the program objectives.

Like all adults, teachers try to protect their self-image as far as possible (Rogers, 1977). Many teachers see programs offered by training institutions as oriented by systems of pedagogical beliefs non-congruent with their own. It is not surprising that they adopt in such cases a defensive attitude. They do not examine the suggestions and proposals that are presented with an open mind, but as instances of a foreign and threatening point of view, that should be distrusted. It is

therefore an important task to establish a climate of confidence and a good relationship with the teachers. This may be achieved by working together in an open way, emphasizing the idea of sharing. The conceptions of the team members are not to be hidden neither to be imposed upon the teachers.

The interest for the new ideas and approaches develops naturally in a stimulating environment with its own challenges. In this respect, the basis for learning is regarded as being the same for children and adults: strong motivation, great amount of activity, reflective looking back and conceptualization.

Results

For this study, data was collected from questionnaires specifically distributed to the teachers involved in different kinds of inservice work. The questionnaires were given at the beginning and at the end of the first set of formal program sessions. The responses were analyzed in the light of the reports and discussions with the team in charge of each course. (Later in the program, teachers will be interviewed--their projects and school activities will then be detailed discussed.)

This study was mostly concerned with the professional profile of the participants, their reasons for registering in the course, their intentions regarding the use of computers in their schools, and their perspectives of the impact of the computer in mathematics education and in education in general.

Participants. The study included 30 mathematics teachers: 11 were on a course in LOGO-GEOMETRY (a program for problem solving in Euclidean geometry), 4 on a course on LOGO (which also included teachers from other subjects and primary school teachers), and 15 were on a course on using computers in mathematics education, in which previous experience was required. The teachers on the two first courses will be called the "beginner's group" and the teachers in the third course the "disciplinary group".

All the teachers in the beginner's group work in secondary schools, with an average teaching experience of 12.7 years. In this group, 11 teachers were female and 2 were male.

In the disciplinary group, 6 teachers come from secondary schools and 8 from middle schools. One was a middle school teacher now teaching at secondary level. She was teaching for 12 years. The years of experience were 12 for the secondary school teachers and 19.9 for the other middle school teachers. All of the teachers in this group were females.

Combining both groups, 80% of the teachers have more than 10 years of experience. This shows that it is not the younger teachers who mostly come to this program.

Reasons for coming to the course. One may get involved in inservice work of this kind because of a general interest on what is being proposed regarding the use of computers in education, or because one wants to have an active role in his/her school, where computers are already being used. Of course one may just want to learn more about the actual use of computers. Teachers could indicate one or more of these reasons or give any other response.

The intention of making actual use of the computers was high in both groups (Table 1), with some teachers indicating the two reasons. However, this intention can refer to its use in the classroom, in club activities, in interdisciplinary projects, in other school activities. The higher rate of responses for the general interest in the different uses of computers from the more experienced teachers may indicate that they do not feel already quite confident in that respect.

Table 1

Reasons for coming into the inservice program		
	Beginners' Group	Disciplinary Group
Immediate intention of using computers	10	8
General interest for the use of computers in education	5	10

In the disciplinary group 7 teachers indicate that would like to know more software and 12 indicate an interest in analyzing other possible uses of the computer. In this group several teachers show a clear concern with the classroom, others refer to the club, others to both, but none speaks in terms of general school activities. It becomes quite obvious that the teachers are essentially concerned with the teaching of their subject.

Intended activity after the course. What sorts of activities these teachers intend to do in their schools? After the first formal part of the program, are they planning immediate use, or are they still reluctant or undecided?

In the disciplinary group, 14 teachers reported intention of immediate use. In the beginners' group, 9 indicated willingness for immediate use and 6 showed some reluctance. From these, some indicated that they would not have enough conditions (meaning lack of physical resources--time, space, equipment), others that they did not had given enough thought to it, and finally others felt that they would need more preparation.

The responses also made clear that many middle school

teachers think in terms of club activities--8 refer to it. That is not the case with secondary school teachers, who mostly are concerned with classroom activities--only 1 refers to the club setting.

Perceived educational roles of the computer. It is important to know what teachers see as the major role of the computer in education. Is it an instrument for individualized support to students? An auxiliary means to create new learning dynamics in the classroom? A resource to the realization of interdisciplinary activities and projects? Will it be essentially used in computer related subjects?

The responses are summarized in Table 2. Again teachers could give more than one response. We may conclude that the dominant concern of the teachers in both groups is the creation of new dynamics in their classrooms.

Table 2

Perceived educational roles of the computer		
	Beginners' Group	Disciplinary Group
Individualized support	1	5
Classroom dynamics	12	15
Resource for projects	6	9
Computer related topics	-	2

A significant number of teachers indicated interdisciplinary activities and projects as an important role, although not as their first choice. This appears to result from the stress of that concept in the inservice program, but should be noted that it is far from being at the center of the teachers' concerns.

Conclusion

Teachers coming to the program have generally a considerable teaching experience, most of them maintaining a stable appointment to their schools. Showing a general interest for the applications of computers in education, they are specially concerned with its role in the teaching of their discipline.

These teachers indicate a major attention to the uses of the computers in classrooms. Although our project emphasizes the possible role of alternative working spaces in the schools, the concept of club as a significant learning environment is only noted in middle school teachers.

Most teachers come to the inservice program motivated to learn how to use the computer in their school. They reveal an intention of immediate use following the first set of formal sessions of the program. Some major ideas presented in the program (such as interdisciplinary projects and school involvement) appear not to be rejected, but are not present in their main concerns.

References

- APM (1988). Renovação do currículo de Matemática. Lisboa: APM.
- Canário, R. (1989). Projecto ECO: Para uma estratégia de formação contínua de professores. Aprender, Nº 7, 26-33.
- Easen, P. (1985). Making school-centered INSET work. Milton Keynes: Open University.
- Huberman, A. M. (1973). Comment s'opèrent les changements en éducation: Contribution à l'étude de l'innovation. Paris: Unesco.
- ICMI (1988). School mathematics in the 1990s. Cambridge: Cambridge University Press.
- Jones, D. (1988). A review of selected research related to the relevance of mathematics teachers' beliefs to teacher education and instructional practice. Unpublished manuscript, University of Georgia.
- Knupfer, N. N. (1989-90). The teacher as a critical component of computer education and school change. Computing in Teacher Education, 5(2), 16-29.
- Lewin, K. (1948). Resolving social conflicts. New York: Harper.
- Lewin, K. (1951). Field theory in social science. New York: Harper.
- Monteiro, C. & Ponte, J. (1987). Project work with teachers involved in a program for the use of computers in education. Proceedings of PME XI, Montreal.
- NCTM (1989). Curriculum and evaluation standards for school mathematics. Reston: NCTM.
- Rogers, J. (1977). Adults learning (2nd ed.). Milton Keynes: Open University Press.
- Romberg, T. A. (1988). Can teachers be professionals? In D. A. Grouws, T. J. Cooney & D. Jones (Eds.), Perspectives on research on effective mathematics teaching. Reston: NCTM.