MATHEMATICS AND TECHNOLOGIES: BRIDGING DIVERSE LANGUAGES
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One of the most challenging aspects faced by the formal education system in Portugal is the existence of an increasing community of immigrants from the so-called eastern countries and from the PALOP (countries whit Portuguese as their official language). Very little is known about how different aspects of their culture may interfere with formal education in Portugal. In particular, how a deeper knowledge about their characteristic mathematical know-how, in formal and informal contexts may help teachers to increase the quality and efficiency of our educational system. Therefore, access to education is enabled to anyone, allowing the construction of new mathematical and technological competencies. Thus, an adequate mathematical education may be an instrument to reinforce social cohesion*, in preventing discrimination, exclusion, racism and xenophobia, promoting, consequently, tolerance and respect for the human rights.* In this context, the project we intent to develop follows the main objectives: (i) to identify mathematical aspects, formal and informal, involved in the culture of those immigrant citizens in Portugal; (ii) to construct didactic materials, preferably multimedia supported, so that the more striking mathematical aspects are more clearly identified; (iii) to value the impact of the exploration of such materials in mathematical teacher education.

Introduction

The Research Centre 'Didactics and Technology in Teacher Education' (CIDTFF), based at the Department of Didactics and Educational Technology, University of Aveiro, Portugal, is financially supported by the Foundation for Science and Technology (FCT) — Portugal, and has the following main objectives:

• to promote a critical stance towards educational reality in the socio-cultural and historical context of the country;

• to develop research in line with the construction of new theoretical frameworks within teaching and teacher education, in several disciplines and at several levels of teaching;

• to further the design, experimentation and evaluation of innovative teaching methods in curricular didactics as ways towards the interactive construction of knowledge;

• to design, develop and evaluate continuous education programmes, emphasising the value of articulation between research/education/innovation, namely post-graduate courses and action-research projects with school teachers;

• to develop diversified supplementary teaching materials and evaluate their application;

• to disseminate the research work carried out, in particular through suitable publications, within the scientific and educational communities;

• to promote cooperation and exchange with other research units or centres, national and foreign, with the aim of internationalising research and developing cross-disciplinary projects (multi, inter and transdisciplinary);

• to support the development of innovative research projects, in particular those proposed by the young researchers of the Centre;

• to support proposals for intervention in the area of defining educational policies and educational research (http://www.ii.ua.pt).

At CIDTFF, the organisation of research is structured according to three main lines:

Line 1 - Didactic Interaction in Education
Multidisciplinary studies centred on research at the level of the teaching/learning process (basic and secondary education), particularly studies of innovative teaching strategies and methodologies of a given subject; conception, construction and evaluation of didactic resources (support texts, software, video, experimental activities); evaluation of learning.

Line 2 - Dynamics of Teacher Education
The main research focus is on pre-service teacher education, particularly the development, implementation and evaluation of programmes, innovative strategies and methodologies of teacher education, e.g. for future teachers on Baccalaureate and degree courses in education (particularly within the field of curricular didactics).

Line 3 - Dynamics of Continuous/In-Service Teacher Education
Research centred on the development, implementation and evaluation of in-service teacher education methods in various subject areas (primary and secondary), education of educators and professional education.

As we can see in the various Reports presented to FCT, each of these 'lines' is developed through individual programmes based on one or more research projects. The projects are thus 'instruments' which contribute towards the development of such programmes and assure their continuity. This way, the programmes are multi, inter or transdisciplinary. The projects may not be so.

Although the three research 'lines' are distinct fields of research, because of the necessarily integrative view of this research domain (i.e. education), interaction between them is inevitable, namely between 'line 1' (focusing on the problems of learning and teaching of disciplines chiefly at primary and secondary levels) and the others (concerned with the problems of teacher education).

In this context, we developed a project — *ICT and the construction of a (new) mathematics culture* — which is mainly bound by research line 2, although with repercussions on all of the other lines.

ICT and the construction of a (new) mathematics culture project

The project seeks, as a final result, to devise, develop and evaluate innovative strategies and methods for (pre-service) teachers, namely through laboratory approaches (recently) recognised as a way of obtaining significant mathematical learning, facilitators of the construction of a new mathematics and technological culture (Cabrita, 2002).

So, it arises in the confluence of the triptych 'research-education-innovation'. The importance of the interrelationship between research, teacher education and innovation is generally agreed. It is more difficult to diminish that between theory and practice. The construction of a space and time which allow research on teaching and teacher education methods and processes, learning and evaluation in Mathematics will be a means to promote the development of scientific knowledge in the area of the didactics of Mathematics. This place is also justified as a means to improve the teaching/learning process in the mathematics education disciplines, which are part of the courses in some teaching degrees and In-service teacher education. This improvement, reinforced by the attention to the research, results naturally with effect on the initial and/or continuous education of teachers and, consequently, on their practices. On the other hand, knowledge, which forms part of the structures of higher education, of the innovation which they give rise to in educational areas and the results of its evaluation, and the receiving of information which comes from the teachers' didactic activity in the classroom, bring fundamental elements to research in didactics.

Pre-service education of teachers in Mathematics Education should surely follow as one of the principal objectives, contributing towards the construction of a new mathematics culture from the youngest aged. From a perspective of professional mastery it should contribute towards the construction of professional identity sustained by professional competence of a high level, classified as, particularly, intellectual means which allow for analysis and evaluation of the contexts of the teaching of mathematics and the construction of adequate didactic and pedagogic solutions and alternatives; management of motivational diversity for the learning of mathematics; attention to cultural capital, attitudes and differentiated levels of mathematical competence; and understanding and neutralisation of the causes of lack of success in mathematics - increase the desire for the teaching of mathematics and certainly, the predisposition to innovate. This inevitably requires a change of the prevailing conceptions of the teaching of mathematics which, at the moment, continue to maintain teaching as a kind of demonstration, considering the role of mathematical tools as operational instruments of advanced mathematical thinking and of creative imagination, general ability and skill. Significant laboratory approaches, mainly based on exploration/discussion of Information and Communication Technologies, could contribute towards the necessary change, in an innovative perspective.

The project's main functional structure is LEM@tic — Mathematics Education Laboratory — a space that, by strongly supporting itself on ICT, is structured on thematic and transversal 'stations', covering the most diverse mathematics curricular areas, at various educational levels, assuming four main domains: mathematics history; tasks (types, connections, materials), curiosities and bibliography.

Mathematics and Technologies — Bridging diverse languages project

Following the project *ICT and the construction of a (new) mathematical culture* and taking advantage of the main functional structure that supports it — LEM@tic — the project "*Mathematics and Technologies — Bridging Diverse Languages*" was developed.

It meets the goals of the European Council in the *Programme of Detailed Work about the Objectives Pursuing Systems of Education and Formation in Europe* (Conselho da União Europeia, 2002).

Indeed, according to such document, the main strategic goals for the years to come, relating to education and formation are: "increase the quality and effectiveness of education and formation systems (…); easy the access of all to the education and formation systems; open such systems to the outer world" (6). Under this perspective: "Although the education and formation systems have to change, faced with the challenges of the society of Knowledge and globalization, its objectives and responsibilities towards society are far more vast. Such systems play an important role on the reinforcement of social cohesion, the prevention of discrimination, exclusion, racism and xenophobia, therefore promoting tolerance and respect for human rights. (…) (This way) the overall objectives given to education and formation by society are not

restrained to providing citizens with capabilities to succeed in their professional lives. They focus on the personal development of these individuals, to assure they have better lives and play an active part as citizens in democratic societies which respect cultural and linguistic diversity." (id.: 8-9)

In this context, and insisting on the dimension of (self) learning throughout life (namely for the more ill-favored, individuals with special needs, those who abandoned studies precociously and adults), they purport the development of key competences mainly in the areas of numeracy and literacy; mathematics, sciences and technology; foreign languages; and ICT. At the same time, they refer the development of social competences, ability to learn to learn; enterprise spirit and general culture. The term "competence" is set to include not only knowledge but also capacities/aptitudes and attitudes/values whose integrated development allows the use of constructed acquirements in new situations.

Despite the fact that other countries, e.g. the USA, have been dealing with similar problems for a long time (see, for example, May, 1999), constituting, that way, a point of reference (safeguarding the due differences), one of the most challenging aspects faced by the formal education system in Portugal is the existence of an increasing community of immigrants from the so-called eastern countries, from the PALOP and gipsy people[1].

Although recent statistics are not entirely accurate (due to a deficient customs control), it is estimated that there are several thousands of immigrants from those countries in Portugal. In fact, back in 1998, from the 335.000 legal immigrants in Portugal, about 177.800 were stateless; 82.500 were Africans (in particular Cape Verde, Angola and Guinea); 52.000 were European and about 24.700 were South American (mainly from Brazil) (Público and Universidade Autónoma de Lisboa, 2001: 168-169). In 1999 there were already over 2.400 legal Eastern European residents in Portugal. The most represented countries were Russia (434), Bulgaria (341), former USSR (308), Romania (215), former Yugoslavia (152), Ukraine (127) and Hungary (111) (id.:184). In relation to the gipsy ethnic group it is also known that, in 1997, there were about 5.000 students enrolled in the 1st Cycle of Basic Education, 327 in the 2nd and 78 in the 3rd (id.: 187). Systematically provided information, namely by the media, lead us to believe that, nowadays, these values are highly inflated. Just out of curiosity, it is interesting to point out that there is now a 3d new newspaper, "Nasha Gazeta", for Eastern European immigrants, with a weekly run of 20.000 copies (Jornal Expresso online, http://www.expresso.pt, 08.05.02).

Portugal is not the European country with the larger number of immigrant children. It is, however, one of the countries with higher failure and school abandonment rates, even with the efforts of educators in order to "(…) through certain strategies, avoid situations of oppression and disadvantage, covering and overcoming the needs revealed by children" (Pessanha, 2001: 23). We must also acknowledge that the adaptation and (even more) the integration processes aren't easy. Indeed,

"Social and cultural norms, verbal codes, family organizations, costumes, religion and climate are, for them, disturbing. A minority experiments the return to the country remembered and idealized by their parents, facing other adaptation problems. The image they create does not always fit what they find, and they couldn't certainly imagine what would eventually be the adaptation to the school and subjects that, initially, had little or nothing to do with the ones they were used to dealing with. Others live in ill-favored environments, in *sui generis* families, with cultural specifications that force them to undergo, during their development, long periods of mal-adaptation, needs and isolation. Some others also experiment daily situations of abandonment, abuse and family instability." (id., ib.).

We feel uneasy with this situation, being aware of the urgency of its resolution and mainly for not knowing exactly how to handle it, despite all the laudable experiments that have been done and which give us important clues that allow us to advance with some security. Most of these are promoted by over fifty[2] existing organisms, created specifically for the study of this problem.

One thing's for sure: the educational system can no longer impose "its" culture to immigrants, neglecting the advantages of the bi-directional movements it is urgent to establish. It will have, then, to create spaces and forms of knowing, believing and also being able to integrate these new realities in our system. It should be noted that we are no longer interested in maintaining an ethnocentric attitude of "openness" or "tolerance" towards difference but, on the other hand, want to recognize, value, assume and make the most of the enrichment that comes from such diversity for the society in general.

Very little is known, however, about how different aspects of their culture may interfere with formal education in Portugal, and vice-versa. In particular, very little is known about how a deeper knowledge about their characteristic mathematical know-how, in formal and informal contexts (namely mathematical aspects concerning day-to-day life and (traditional) games) may help teachers to increase the quality and efficiency of our educational system. Therefore, access to education is offered to everyone, allowing the construction of new mathematical (and technological) competencies.

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[1] The recent immigration phenomenon with significant indexes in Portugal explains why only in 1999 the Immigrants' Associations Legal Regime was approved, although some of them had already been founded in the 70's (Público e Universidade Autónoma de Lisboa, 2001).

[2] For detailed information about such organisms, consult http://www.deb.min-edu.pt/Nopae/brochura.htm

Thus, an adequate mathematical education may be an instrument to reinforce social cohesion, *in preventing discrimination, exclusion, racism and xenophobia, promoting, consequently, tolerance and respect for the human rights.*

In this context, the project *Mathematics and Technologies — Bridging Diverse Languages,* has the following main aims:

(i) to identify mathematical aspects, formal and informal, involved in the culture of immigrant citizens from East European countries, PALOP and gipsy ethnic groups in Portugal;

(ii) to construct didactic materials, preferably multimedia supported, so that the more striking mathematical aspects are more clearly identified;

(iii) to value the impact of the exploration of such materials in mathematics teacher education programmes (initial, continuous and post graduation).

So, the first step consists of the collecting, analysis and treatment of data, supported by questionnaires, interviews, portfolios, main-list, networks… Cooperation with researchers from eastern countries (already underway) as well as with foreign residents in Portugal, teachers and employers is planned.

This is followed by the production of didactic materials that will be carried out at LEM@tic — Mathematics Educational Laboratory.

Finally, the last step consists of the design, development and evaluation of an innovative teacher education plan exploring the knowledge and the materials from steps 1 and 2. It would be desirable to extend this stage to the aged (an emerging area, in which Portugal is strongly committed to investing)[3] and "*open to the outside world the educational systems of education and formation*" to disseminate the produced documents.

Final considerations

Since its popularisation in the 70s, multicultural education has promised much and delivered little — "in short, multicultural education has had a largely negligible impact to date on the life *chances* of minority students, the racist attitudes of majority students, the inherent monoculturalism of school practice, and the wider processes of power relations and inequality which underpin all these." (May, 1999: 1).

However, we believe that multicultural education can now pursue its main propose – "foster greater cultural interaction, interchange and harmony, both in schools and beyond" (id., ib.)

For that, we believe that a first step towards making teaching an instrument to reinforce social cohesion, *in preventing discrimination, exclusion, racism and xenophobia, promoting, consequently, tolerance and respect for the human rights*, implies the development, in educators, of and attitude of receptivity towards the environment, experiences and cultural differences and a didactic action congruent with such attitude.

Nevertheless, there is another aspect that's to be safeguarded so that the development of this project can contribute to an effective pluri-, multi-, inter- and trans- cultural education:

"There is no doubt that the formation of a multicultural attitude amongst the teachers, enabling them to take advantage of the social and cultural heterogeneity to teach, represents a fundamental step in the construction of a School that defends and promotes individuals' social and cultural rights. The complexity, or perhaps the risk, seems to reside in the way the school takes possession of the "origin culture". That is because when it "returns" such culture, it either testifies its marginality against the so-called "legitimate culture" or ennobles it, reformulating the culture's prestige scale towards the previous existing cultures." (Reis, 1995:53).

It is, therefore, vital the real and effective involvement of the key individuals in this project – the identified minorities, other than just the students – in the validation of the documents that are to be produced and the actions related to them.

Only working in genuine cooperation will it be possible to contribute to the construction of a truly better society.

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[3] One of the most interesting developments has been the University for the Aged.