

Mathematics and Cross-Curricular Activities: Bridges Exist for Crossing them

Some Spanish Experiences and some Personal Thoughts

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Abstract: The paper presents some thoughts on the relations of mathematics teaching and learning and the cross-curricular activities. Some Spanish examples are reviewed and some insights for future actions are given.

Kurzreferat: *Mathematik und fächerübergreifende Aktivitäten: Brücken existieren! Einige spanische Erfahrungen und persönliche Gedanken.* Der Beitrag beschreibt Gedanken zum Verhältnis zwischen dem Lehren und Lernen der Mathematik und fächerübergreifenden Aktivitäten und gibt einen Überblick über einige spanische Beispiele. Implikationen für die Zukunft werden genannt.

ZDM-Classification: M10

1. Introduction

Problem solving, applications, modelling and interdisciplinary tasks are key ideas for transforming mathematics teaching and learning. Too often, these ideas are being reduced to a motivation strategy (“this example shows that we really need to deal with the following concepts ...”) or are being used as illustrative corollaries (“so all this can be applied to various practical cases ...”). We sincerely believe that these items must be the motive force for changing skills, attitudes, and boundaries in the complex educational system. It is clear, for example, that we are forming citizens as persons and we want them to have an integrated view of their world, overcoming the increasing artificial division of teaching jobs. We want to make clear from the very beginning our positive defence of improving mathematics excellence by means of paying more attention to the realistic approach to mathematics.

In this paper we will review a sample of didactical experience made in Spain and we will try to identify some goals for the years to come.

2. A sample of some Spanish experiences

In the last decade we have been observing a positive evolution of teaching attitudes in Spain towards a more open curriculum and a determined adoption of the problem solving tendency. The national reform, the birth of a powerful net of associations and societies of mathematics teachers, the organization of mathematical workshops, congresses, exhibitions, etc. . have brought some fresh air to traditional teaching. While the situation is far from being satisfactory, interesting experience has been made. Let us report here on a small sample:

2.1 Teaching mathematics through newspapers

There has been an extraordinary interest in the use of newspapers and magazines as materials to be used in classrooms for various purposes:

a) newspapers as didactical resources to motivate topics

or to have data or to generate discussions, ...

- b) newspapers as objects to be studied mathematically (diagrams, tables, percentages of publicity, ...)
- c) newspapers as centers of classroom activities (research, information, ...) in order to produce, e.g., a “newspaper” in the school.

From time to time various Spanish newspapers have included supplements devoted to mathematics for distribution or use in primary schools. In Roig (1976), Jiménez/Briaies (1985), Grupo Cero (1984), Baena et al. (1990), Corbalán (1991) and specially in Fernández/Rico (1992) one can find interesting considerations concerning the use of newspapers in relation with teaching activities and the Spanish curricula. Concrete events like the Expo 92 in Seville, Olympic Games in Barcelona 92 and Halley’s comet visit have promoted special publications.

2.2 Geometry and art

The existence in Spain of a rich variety of historical buildings and artistical masterpieces has facilitated some interesting mathematical experience concerning art and historical issues. Rafael Pérez-Gómez has edited a great number of publications, exhibitions and videos in relation with the Alhambra in Granada (see, e.g., Pérez-Gómez, 1987), Miguel de la Fuente made interesting software and descriptions around the Mezquita in Córdoba. The symmetry groups of the plane applied to the Alhambra can be seen using software (Roanes/Roanes, 1993). Several mathematical programs based upon concrete visits (cathedrals, churches, bridges, towers, ...) have been developed and tested in practice (Giménez, 1993). Escher workshops and impossible 3D-figures have generated special interest during the successful itineraries of the French exhibition “Horizons mathématiques” in Spain. Materials combining mathematics and art have been produced recently for the arts-secondary school program (Alsina, 1993).

2.3 Traditional measures

Since Spain had local measures and a complicated measure system before the decimal metric system and since learning to measure is an important part of the basic mathematical curriculum in mathematics and other sciences, the idea of reviewing old measurement methods has become an interesting didactical practise. There have been various exhibitions on traditional measures made by Spanish teachers (Barcelona, Madrid, Seville, ...) and various didactical publications. The first ones were made by Alsina/Marquet (1981) and Alsina (1989) and later by Hernández et al. (1995).

2.4 Recreational mathematics

While the translations into Spanish of Brian Bolt and Martin Gardner’s books have had a powerful and positive influence in introducing mathematical recreations in the classroom, at this moment there are large groups of teachers interested in these topics. Books by Miguel de Guzmán (Guzmán/Colera/Salvador, 1988, Guzmán, 1987, 1991, 1993), the popular books of Fernando Corbalán, Luis Balbuena, David Barba, Luis Segarra and the large audiences of the “Encontros da Matemática Recreativa de A Coruña” (1995, 1996, 1998) organized by A. Pa-

zos show that these “recreational” issues have indeed become a useful tool for training teachers in including non-traditional topics in their activities. While some recreational mathematics are just related to ingenuity in problem solving or sophisticated games, some recreational aspects are based on real-life problems, logical thinking, geometrical intuition, etc., so they become starting points for cross-curricular activities.

2.5 Mathematics and shopping

The idea of using shopping problems as an excuse to practise arithmetical operations or to present applications of mathematics to real-life situations or to generate mathematical models to describe the shopping phenomena, has received attention in recent years. While the old mathematical textbooks included stupid problems with questionable real data (“in a box we have 32614 eggs. Find ...”) in the last decade there has been a growing interest in focusing activities on shopping topics: prices of goods and services, sizes, package presentations, commercial codes, taxing methods, environment implication, planning in advance, rational shopping, etc.

The program “Mathematics for the consumer” developed by C. Alsina and J.M. Fortuny (Alsina/Fortuny, 1993) was initially promoted by the Catalan Institute of Consume and has been translated into Spanish and distributed by several autonomous communities in Spain. Shopping simulation is today a fixed activity in primary schools.

2.6 Mathematics and democracy

Of course our forty-year-dictator Francisco Franco did not like democratic issues at all. After him, when in the late seventies democracy became the basis of politics in Spain, interest was renewed in the mathematical aspects of census, questionnaires, polls, random sampling, election methods, ... These topics, which promote cross-curricular activities, have become traditional in the statistical chapters of textbooks (see e.g. Guzmán/Colera/Salvador, 1988), in classroom activities for secondary schools during elections periods (in both mathematics and social sciences), and a research issue in various university departments, e.g., in the Applied Mathematics Department of the University of Granada.

2.7 Mathematics workshops and popularization programs

Several one-week activities devoted just to mathematics have been organized in recent years, e.g., the so-called Encounters with Science (Alsina et al., 1989, 1990) and the Torrebonica program (Alsina et al., 1996). During all these workshops, real natural measures, constructions, art design, mathematical theatre, astronomical observations, etc., were offered.

The Thales Society in Andalucia has succeeded to generate radio programs on the history of mathematics, exhibitions on photography and mathematics, news on newspapers, etc. with a very positive popularization of different topics.

3. Some conclusions and implications

Analyzing the above mentioned experiences and taking

into account the present trends in the Spanish reform, we would like to derive some conclusions and insights for the near future in order to promote cross-curricular focussing:

3.1 All teachers must be involved

Cross-curricular activities have become a goal for many teachers of mathematics who believe that by means of applications, modelling issues and problem solving there will be more motivation and understanding of the subject. But most of the non-mathematics teachers do not consider this as important as their mathematics colleagues do. Thus there are many examples of mathematics people including references to other subjects but very few examples of materials of other disciplines which include direct bridges towards mathematics.

We also need to consider the problem of having as many teachers as possible doing cross-curricular activities if we want to reach more students than just those following minority experiences.

To prepare and develop cross-curricular issues in the classrooms requires much more effort than to deliver talks and to solve pen and pencil exercises. Therefore easy-to-use and well-prepared materials are needed to facilitate teacher’s preparation.

3.2 Reorganization is needed

Increasing the role of cross-curricular activities opens the need for reorganization of centers, classrooms, visits, schedules, materials, etc. To visit science museums, to discover mathematics in nature and in factories, to make posters with interesting news, to make computations, representations and experiments ... – all these issues may break the usual “four-hours-a-week-text-book-based-delivery-system” in order to have a more flexible organization. Sometimes great initiatives collapse under administrative pressure.

3.3 We demand higher thinking

The repeated and unjustified claim about the decreasing “level” of students must be counter-attacked with strong arguments: when we teach, e.g., applied problem solving or when we use open questions for evaluation, we are demanding more. We are demanding more fresh ideas and ingenuity than when we ask for routine verifications or memoristic practices. We may change contents and skills giving a more general overview of today’s mathematics and, accordingly, make our assessment with higher aims than before.

3.4 New tools open new doors

Today’s technological devices and facilities open up an easier way to change pedagogical strategies. Using Internet, for example, it is possible to find a great deal of useful information and to organize intriguing visits to web sites. This cancels old excuses to avoid the use of real data or the organization of “outside” activities. The virtual paradigm will in the near future bring teaching possibilities which are difficult to imagine today.

4. A concluding remark

The author is convinced that in our reform movement, “how we do it” is much more important than “what we

do". Consequently, interdisciplinary activities, real applications, modelling processes may become not only illustrative examples or motivating points but the key towards another way of teaching and learning mathematics.

Our students, at all levels, from kindergarten to universities, are citizens who combine rational and emotional intelligence. We want them to be deductive, clever, logic, ... but we want them also to be intrigued, full of curiosity, ... We would like to have answers as well as questions. They are not prehistorical human beings but tomorrow's people. Chronology, linearity, sequentiality, ... have played an overvalued role in mathematics education in the past. Perhaps it's time to talk about centers of interest, parallel learning, visual skills, global views, ... It is not our arbitrary caprice. It's their future. And theirs must be ours.

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