

## **CURRICULUM MANAGEMENT IN THE CONTEXT OF A MATHEMATICS SUBJECT GROUP**

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*This paper analyses how Simon, a mathematics teacher, manages the curriculum, uses the textbook to plan his practice and conducts students' assessment. It also seeks to understand the relationship between such curriculum management and the collaborative work undertaken by the mathematics teachers' subject group. This is a qualitative and interpretative case study, with data collection through participant observation, interviews and documents. The results show that the teacher manages the curriculum adjusting the expectations of different educational players (colleagues, students and parents) and his own expectations. They also show that curriculum management supported by the collaborative context generates tensions when a teacher makes decisions that diverge from those assumed collectively.*

**Key-words:** Curriculum management, mathematics, mathematics subject group.

A key aspect of professional practice is the way the teacher manages the official curriculum in order to meet the stated objectives, taking into account the students' characteristics and the conditions and resources of the school. In Portugal, curriculum management is particularly complex, giving the social tensions concerning mathematics teaching, largely fuelled by the performance of the students in mathematics in national (GAVE, 2002) and international assessments (OCDE, 2004). Innovative teaching practices are increasingly challenged in many forums, particularly in the public media. This paper aims to describe and analyze how a teacher manages the official curriculum, including the strategies and resources that he uses and how he assesses his students' learning.

### **CURRICULUM MANAGEMENT IN MATHEMATICS**

Different levels of the curriculum may be distinguished. There is the prescribed (or formal) curriculum of official documents, the available curriculum mediated by school textbooks, the planned (or shaped) curriculum by the teacher, the curriculum in action put in place by the teacher in the classroom, the curriculum learned by the students, and the curriculum evaluated, for example, through national examinations (Gimeno, 1989; Stein, Remillard & Smith, 2007).

Curriculum management refers to the actions of the teacher that contribute to the construction of the curriculum in the classroom (Gimeno, 1989; Ponte, 2005). The focus of the management process is students' learning, and it is according to such learning (at least in theory) that decisions are taken. Curriculum management has to do, essentially, with the way the teacher interprets and shapes the curriculum, on two levels: a *macro* level, concerning the overall planning of teaching for an extended period, and

a *micro* level, corresponding to the teaching process in the classroom. The teacher makes decisions selecting tasks, strategies, and materials appropriate to the objectives and purposes of mathematics teaching, taking into account his/her students and working conditions. The teacher adjusts the curriculum as he/she evaluates and periodically reflects on his/her professional practices.

As a curriculum manager, the teacher faces new challenges. The cultural diversity of the student population requires the implementation and management of a dynamic curriculum that seeks to meet the demands of modern society. At the same time, the role of the teacher is changing from a “deliverer” of knowledge, to that of a facilitator of learning (Brooks & Suydam, 1993; Ponte, 2005). When planning his/her teaching, the teacher selects the tasks to propose to the students. These may be all similar (usually, exercises) or diversified (including, for example, problems, investigations, projects, and modelling tasks, as well as exercises) (Ponte, 2005). Tasks may be framed in mathematical contexts or refer to other contexts. According to current curriculum documents (ME-DGIDC, 2007; NCTM, 2000), the tasks should help the student to develop a comprehensive view of the mathematics activity, increase their understanding of mathematical processes, and help them to develop their mathematical reasoning.

School textbooks are important resources for curriculum management. Their use changes according to different perspectives on their role in different contexts (Ponte, 2005). In Portugal, the *Relatório Matemática 2001* (APM, 1998) indicates that textbooks are the teaching material most used by teachers from grades 5 to 12 (82% of the teachers use them always or in most classes). Textbooks have a large tradition in the field of education and occupy a central role in the classroom, influencing the work of teachers, and helping in delimitating the knowledge students are supposed to learn (APM, 1998). In general, teachers use textbooks to organize their classroom activity and to select tasks to propose to students to do in the classroom or at home. In this way, textbooks are key mediators between the different dimensions of the curriculum, particularly the curriculum taught and prescribed by the central government and the curriculum learned by students (Pires, 2005; Ponte, 2005).

Students’ assessment is closely linked to curriculum management, playing a regulatory role in the teaching and learning process. Santos (2002), for example, suggests that assessment should be diversified and occur in formal and informal situations, with the active participation of students, contributing to their development and to the success of learning. The negotiation and establishment of an appropriate contract for assessment are important issues that can determine the success of students’ learning (Nunes, 2004).

These challenges require teachers to work collaboratively, in order to frame and solve the many problems that arise in developing and adjusting the curriculum. It also requires the ability to reflect on teaching practice and students’ learning, creating dynamics that promote their professional development and the school culture (Hargreaves, 1998; Nunes & Ponte, 2008). For schools to make a significant development

in curriculum management and teaching practices, teachers' active involvement in innovative projects, carried out collaboratively, is an essential condition (GTI, 2008).

## METHODOLOGY

This study follows a qualitative approach (Erickson, 1986), with a case study design (Stake, 1994; Yin, 1989). The study involves a group of 14 mathematics teachers of a secondary school with 12-18 years old students. The mathematics subject group has an extensive experience of working collaboratively and in recent years has developed various projects at the school. Most of these projects emerged from the need felt by the teachers to improve their practice and to help students to overcome their difficulties. During the school year 2007/08 the subject group developed the project "Investigations, proof and problem solving tasks in textbooks and in curriculum management", involving all classes from grades 7 to 12. This project aims to diversify tasks in the mathematics classroom, to encourage the students' in learning mathematics.

This study focuses on the group of teachers of the project and within that group, on three teachers: Ana, the coordinator of the subject group, Matilde, a new arrival to school and to the group, and Simon a teacher at the school for 28 years. These cases provide several contrasts that may enable understanding to the relationships between professional knowledge and curriculum management, as well as with collaboration and leadership at the school. In this article, we present the case of Simon and give special attention to his curriculum management, because of his professional experience and role in the group.

Collection of data was done during the school year 2007/08 and includes participant observation (Jorgensen, 1989) of the group working sessions and two classes, with record of field notes in a research journal, two interviews with each of the three teachers selected for case studies, and collection of documents (Adler & Adler, 1994; Patton, 2002; Yin, 1989). According to the research plan, data analysis began simultaneously with data collection, to identify the need for further collection of data. The second level of data analysis involves the development of categories focused on professional knowledge, curriculum management, collaboration and leadership that may provide an interpretation of the data. The third level of analysis seeks to explain the meaning of the data, to provide contributions to the understanding of the phenomenon under study (Merriam, 1988).

## SIMON: MANAGING THE CURRICULUM

Simon is a teacher with 28 years of experience teaching mathematics classes from grades 7 to 12. Throughout his career he played several roles in his school such as deputy head teacher, in-service teacher education coordinator, department coordinator, and project coordinator (of mathematics projects and of other school projects). He is an in-service teacher educator in professional development courses and belongs to several working groups in and outside his school. Because of his professional experience and the initiatives he promotes in the group, Simon is recognized by his colleagues as the leader of the group. This academic year he has only grade 12 classes.

*Planning.* At the beginning of the school year, Simon makes the annual plan together with his colleagues who are teaching the same grades. This planning begins with the group of teachers browsing the school textbook and, together, making changes in the annual planning of the previous year. When questions arise, particularly about the number of lessons to assign to each unit, the group uses the mathematics curriculum and its “roadmap” with the methodological guidelines for planning. Once the overall plan is made, he and his colleagues direct their attention for the planning of the first unit [Group Working Session (GWS), 11/Sept/07]. At this stage, from inside his textbook, Simon hands several sheets, handwritten in pencil. In a table with just two columns he registered an analysis of all the tasks of the textbook, in a uniform way:

This is my “curriculum management.” These sheets are worth gold! I have done this for all the textbooks that I use. (...) The first approach is always the textbook. I solve all exercises (...) This symbol [a ring], here around the number indicates that the task is very important and I note those tasks that are more difficult [marked with an arrow] and those that do not interest, because they are poorly structured or have errors [marked with a cross]. They [the teachers from the group] always ask me for my sheets. [GWS, 11/Sept/07]

They [the students] know that everything I have decided to do I have solved before. I also see other textbooks, especially when I am introducing new units. [Interview, 16/Oct/07]

Simon seeks to be well prepared for his teaching. Therefore, he knows well the textbook that he uses, reading the sections on the subject that he is going to teach and solving all the exercises. His individual working plan is based on his vision for teaching mathematics. For him, the most important thing is that his students enjoy what they are doing and develop capacities that allow them to be autonomous and mathematically competent:

To learn, students have to like what they are doing, then what I like most is that they solve their own problems. First, I would like them to be able to read a problem and not turn their arms down, not discouraging, therefore grasp the problem. (...) Achieving that with my classes is to get weapons to grasp and solve the problems which arise. [Interview, 16/Oct/07]

To achieve these goals, Simon diversifies both the tasks that he proposes to his students and the strategies he uses to solve them. However, he begins by assuming that it is not always possible to manage the mathematics curriculum diversifying the situations proposed to students. The major obstacles are time, or lack of it, coupled with the need to meet the official curriculum, taking into account the external evaluation of students at the end of grade 12:

What I have more in mind, but I do not do always, is diversity, both of tasks and resources. I think it makes the lessons more attractive. Difficult things, easy things, open [tasks], closed [tasks], some [done] in groups, other individual (...) [I use] several resources: calculators, computers, manipulatives... I think some-

times I have to do more! Until grade 12 I do. In grade 12 I do too little, just the calculator with great strength. [Interview, 16/Oct/08]

*Tasks.* In addition to the tasks suggested in the textbook, Simon selects other tasks to offer his students a variety of experiences to foster the different aspects of their mathematical competency. However, in grade 12, this is not always the case. It is perceptible that, at this grade level, he assigns an important role to problems that require using the calculator and to tasks that promote the development of written communication in mathematics. In such work, he highly values the textbook:

First the textbook, then the other things. (...) We have a grade 12 textbook that has so many proposals that we have difficulty in selecting things. (...) We have to give everything and then we have no time for anything else! (...) Unfortunately, the textbook doesn't have much open tasks, but (...) problem solving, it has a lot. And it also suggests the use of technology, a little bit the computer, the calculator a lot. (...) The worksheets we have done [Law of Laplace, Slope, Lighthouse] were things related to communication, a bit following last year's project [project communication in mathematics]. [Interview, 8/Apr/2008]

Simon believes that the selection of tasks is not an easy job, and through the discussion that he develops with his colleagues who teach grade 12, he attempts to address their difficulties: "The collaborative work between colleagues can be a great help to feel more secure and confident on what we do and we developed in our classes and the materials we propose to our students" [Final reflection, 14/Jul/08].

*Curriculum materials.* The textbook is the curriculum material most often used by Simon when he is planning the work and assigns it a central role in the classroom. Therefore, he considers vital to choose a good textbook, highlighting as key elements in a textbook the nature and the diversity of the tasks. For other curriculum materials, he likes to diversify its use, but he acknowledges that in grade 12, because of the national examination, he just uses the calculator. However, he states that this is not always so: "I do not use the computer in grade 12 and I always use it in other grades" [Interview, 8/Apr/08].

*Classroom work and assessment.* Simon argues that the classroom work must be focused on the student. So, he seeks to promote since early the students' autonomy:

Another thing I do is also autonomy, and as the years go they [the students] are increasingly autonomous. (...) I guide them! I say: "Look, I think that you should do this or that!" After, each one follows his/her path! There are some that do everything, others who do very little and I am not concerned to control it. The other day in a classroom, (...) they had questions in some exercises but they were all in different exercises and it could not be a lesson for all at the same time, so they made a request: "Look, do this and this and this," and I did it! [Interview, 8/Apr/08]

When performing tasks constructed by the mathematics group, Simon uses different strategies in the classroom, according to its purpose. Usually, he demands that stu-



dents work in the tasks in pairs or in small groups. In assessment tasks, students work individually and in two phases.

Decisions about assessment provide an interesting episode concerning the relationship of Simon and the group. In fact, the other grade 12 teachers felt that the students should do assessment tasks just in one phase. That is what Ana and Diogo indicate:

*Ana* – I think that if the task is to assess the students' learning then it has to be done individually. (...) I do not agree to give a second chance, because there are students with private tutoring and already know the task and many of them can provide ready-made answers.

*Simon* - I think that they perform much better in a second stage. And I do not agree with you [Ana] that the reason is that they have external help and they already know the task.

*Diogo* - I agree with Ana. In addition, if it counts for assessment, we have to do all in the same way, so that some [students] benefit and others do not. [GWS, 20/Nov/07]

However, Simon decided to use a different strategy. He chose to give a second chance to his students to improve their first response to the task, once corrected and commented. He did so because he strongly believes that this helps students to improve their learning. As he mentions, “students learn from the mistakes they do and a second chance allows them to improve their performance” [Interview, 8/Apr/08].

That decision was discussed in the following working session, as Simon announced his decision and suggested the group to analyze and reflect on the performance of his students in both phases. There were some negative reactions, especially from Ana and Diogo who have disagreed with Simons' decision [GWS, 4/Dec/08]. The issue was taken up later at meetings in which the group built tasks and discussed how to implement them in the classroom [GWS, 15/Jan/08; 19/Feb/08; 8/Apr/08, 6/May/08]. As a result, some other members of the group began to use Simon's strategy. In particular, at the end of the study Diogo admitted that this strategy can help students improve their learning, as he has verified with his own classes [GWS and Final reflection, 14/Jul/08].

The assessment of the students is one of the tasks that Simon acknowledges be the toughest for him. A major problem is the classification of the open tasks and its visibility in the students' final grade. With the collaboration of the subject group, he tried to overcome the difficulties, investing more in the construction and assessment of diversified tasks and testing different criteria for classification, starting from the criteria used in the national examination. Also the review of the assessment criteria established by the department of mathematics and the construction of a self-assessment grid helps to minimize this issue:

I add under the formula, the four tests we had done so far, the three compositions [from open tasks], participation in the classroom in the first and second

school period... In terms of knowledge and attitudes, and I gave a number. [Interview 2, 8/Apr/08]

Simon believes that to make decisions concerning curriculum management and to adjust his practices, the information concerning the work that he develops with his students in class is more useful than the one he collects from the tests:

The assessment that I do all the classes is much more useful. Because everyone thinks they know [what I'm talking about], but when I come to the conclusion that they do not know I have to come back to do it in a different way. [Interview 2, 8/Apr/08]

However, the external assessment has a crucial role in the teaching strategies of Simon. That is visible in how the students do independent work in the classroom, in the tasks that he proposes, the curriculum materials and assessment instruments he most often uses (textbook, calculator, and tests). He is very concerned with the quality of his students' learning and their success, particularly in the mathematics' national exam and access to higher education. He also notes that,

We [the math teachers] are always together, to speak of what happened [in class], and what we are going to do. (...) The assessment instruments are always made [together] and they are always the same. There are no complaints from our group, from anyone: the school community and parents. (...) The school realizes that we [subject group] work very, very in group. [Interview, 16/Oct/07]

Simon's words suggest that he seeks to take into account the expectations of students and parents. In this sense he also builds with his colleagues the assessment tools that he uses in order to harmonize them with the views of the other teachers and to support the decisions about his students' assessment.

*Work with the mathematics group.* Simon says that the discussions that the group has done in the project working sessions have been very "interesting" for him. In particular, he stresses the construction of open tasks, the definition of criteria to assess and to reflect on the results of students:

The construction of tasks with a group of proofs, problems and explorations and investigations and their implementation in the classroom, the discussions we had in the sessions, has always been very enriching, and the exchange of ideas and clarification of points were a highlight of this project. (...) Discussions on the grading of the students' work on their achievements and to give them feedback were undoubtedly very important aspects for my learning. The contributions of all colleagues made me to reflect on my practice in these aspects, questioning what we did and discovering ideas and suggestions perfectly workable in practice in the future. [Final reflection, 14/Jul/08]

The collaborative work developed in the group played an important role in the individual work of Simon. His activity has also a major influence in the way the mathematics group works, with a culture of collaboration that has been strengthened over

the years with the development of various school projects. This culture of collaboration seems to have been fostered by the way almost all teachers of the group have been involved in the project by joining and participating with enthusiasm. They appear to think that these initiatives are essential to their growth as teachers. These initiatives seem to be the key to the way they work as a group and have contributed to their working culture, where exchange of ideas, experiences and materials are welcome.

## **DISCUSSION AND CONCLUSION**

The curriculum management carried out by Simon at the macro level contains a collective and an individual side. The collective side involves the annual planning and the construction of units and tasks. In this process, we can see that he is an important element, particularly in its preparation, solving all the tasks of the textbook and feeding in this way the discussions of the group. Simon's curriculum management at micro level is markedly individual. He seeks to promote his students autonomy in mathematics learning, encourages them to take responsibility in their own actions and to be independent thinkers. This is much in line with the innovative teaching described by Boaler (1998). That is, mathematics education carried out in line with current curriculum orientations is possible at school level, both in Portugal and England.

His decisions have as a starting point, first, the school textbook. He seeks to understand the proposals presented and selects tasks in order to diversify the learning situations (planned curriculum). In addition to the tasks of the textbook, he offers other tasks to his students constructed together with his colleagues, and uses them for assessment. The information that he gets from his daily practice with his students helps him to regulate the teaching-learning process. The test is the instrument that he uses most. However, the formal assessment of students at the end of each term takes into account the information from students' work in the open tasks and involves the students' active participation. Simon manages the curriculum on the context of the mathematics teachers' group, but there is an individual mark that differs from the group. For example, the classroom strategies that he uses to perform the tasks in two phases differ from those initially supported by his colleagues. Also, we see that he tries to conduct the curriculum management dealing with the tension between different expectations in teaching and assessment of pupils, parents and colleagues and his own personal views. On the one hand, he proposes tasks from the textbook and, on the other hand, he gives his students more open and contextualized tasks which require the use of technology. Simon manages the curriculum taking into account its various dimensions. His practice (curriculum in action) goes beyond teaching from the textbook (mediated curriculum), exploring open tasks that involves students in significant mathematics activity (Boaler, 1998).

Second, his formal assessment practices essentially use the results of the students in tests and open tasks. However, to regulate his teaching practices he uses the information that it collects from his daily work with students (Nunes, 2004; Santos, 2002). Simon accepts the challenge of keeping diversifying his assessing practices, despite



considering this to be one of the most difficult tasks of his work as a teacher. The experience of Simon, the various projects in which he participates and the collaborative work that he develops within the mathematics group of his school are key elements to help him to manage the curriculum in order to promote his students' learning (Hargreaves, 1998). Equally essential, seems to be his ability to address and solve issues of professional practice, reflecting in action, and about action (Schön, 1983).

Finally, the various initiatives of the group, in particular, its projects, are a key to the sustainability of the culture of collaborative work (Nunes & Ponte, 2008). This dynamic and working context seem to motivate the involvement of the teachers in teaching and learning. In particular, such dynamic appears to support the professional development of Simon and his capacity to accept new challenges. There are situations that generate conflicts in the group, especially when most participants favour some decision and some individual practices diverges from that. One important conclusion that we draw from this analysis is that Simon, the natural leader of the group, nurtures his relationship with his colleagues using curriculum management as a focal activity. The professional practice of these teachers, supported by this working environment, shows that current curriculum orientations may be implemented not just at an individual or small group level, but by a whole school mathematics subject group. From this study new issues emerge for future research, namely: How teacher's practices and curriculum management influence students' learning of mathematics? What conditions are necessary at schools, and more widely in the social context, so that this kind of collective curriculum management takes place, very much in line with current curriculum orientations?

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