

IS MATHEMATICS LEARNING A PROCESS OF ENCULTURATION OR A PROCESS OF ACCULTURATION?

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This study aims to identify the degree to which mathematics learning approximates either to a process of enculturation or to a process of acculturation. We examine the practice of a secondary mathematics teacher, in terms of Bishop's notion of 'acculturator-teacher', and the impact of this practice over the students' affect. We conclude by discussing some pedagogical implications resulting from the study.

INTRODUCTION

For a number of researchers (e.g. Bishop, 1988; Clarkson, FitzSimons & Seah, 1999, Knijnik, 2002), most people tend to see mathematics as a culture and value-free discipline. These authors suggest, each one in their way, that failures and difficulties regarding mathematics at school are usually ascribed to the students' cognitive attributes, or to the quality of the teaching to which they are submitted. Thus, social aspects, and especially cultural aspects, have received insufficient consideration in the teaching and learning of mathematics. From the 1980's, however, one can observe a gradual change in the teaching of mathematics, in particular in countries notably marked by a multiethnic population (e.g. Abreu, Bishop & Presmeg, 2002), concerning socio-cultural issues. Keitel, Damerow, Bishop & Gerdes (1989) show how the social dimension has been affecting mathematics education research, and consequently, clarifying the cultural nature of mathematical knowing. According to Bishop (1997), such a dimension stimulates research at five main levels: a) *individual level*, which is concerned with the personal learning both in and out-of-classrooms; b) *pedagogical level*, which is concerned with the social interactions in mathematics classroom; c) *institutional level*, which is concerned with the social norms and interactions within schools, which influence the teaching of mathematics in classrooms; d) *societal level* which is concerned with the relationships between mathematics education and society; e) *cultural level*, which is concerned with the relationships between mathematics education and the historical-cultural context of the society. In relation to the last level, Bishop (2002) argues that situations of cultural conflicts strongly involve emotional and affective reactions by the students. This has led him to an interest in exploring relationships between affect and culture, in terms of teachers' values and students' affect.

Based on the literature of anthropology, Bishop has introduced the concepts of *enculturation* (Bishop, 1988) and *acculturation* (Bishop, 2002) in mathematics education. He argues that both concepts are intensively linked to the teachers' values in relation to mathematics. Further, the author suggests that mathematics education can rely on experiences of enculturation or acculturation, influencing thus the

affective dimension of the students' learning. Enculturation is the induction, by a particular cultural group, of young people into their culture, whereas acculturation refers to the induction into an outside culture by an outside agent. Often one of the contact cultures is dominant, regardless of whether or not such dominance is intended.

From the above premises, we report on a study whose aim is to identify the degree to which school mathematics learning can be thought either as a process of enculturation or as a process of acculturation. In doing so, we examine the practice of a secondary mathematics teacher, in terms of Bishop's notion of *acculturator-teacher*, as well as the impact of this practice over the students' affect. Our basic theoretical assumptions will be firstly presented[2], followed by our methodology and data analysis. We conclude by discussing some pedagogical implications resulting from the study.

CULTURE AND AFFECT IN MATHEMATICS EDUCATION

Much has been discussed about the assumption that mathematics has a cultural history and that different cultural histories can produce different mathematics. In the context of mathematics education this assumption has been treated through distinct approaches and foci. For Bishop (1988), mathematics is a *pan-human* phenomenon in the sense that it consists of six fundamental activities that seem to be employed by a number of cultural groups already studied. These activities are: counting, locating, measuring, designing, playing and explaining. Bishop's ideas about the pan-cultural nature of mathematical activity were developed prior to his later educational analysis using the perspective of enculturation. This perspective presupposes the existence of a cultural consonance/harmony between school mathematics and the culture the student brings from home. However, along the development of his works (e.g. Bishop, 1994) the author re-evaluates his premises aiming at the understanding of cultural conflicts. From these, Bishop turns his research towards the hypothesis that mathematics education may not be a process of enculturation, but instead a process of acculturation.

Within a psychological perspective, the studies developed in Brazil by Terezinha Nunes, Analúcia Schliemann and David Carraher during the years from 1980 to 1995 demonstrate that very poor children from some Brazilian villages can make complex calculations about money, commercial costs and profit, and so on, without being able to solve mathematically isomorphic problems in school (Nunes & colleagues, 1993). According to Nunes (1992), the fact that mathematical knowing can be learnt out-of-school by diverse cultural groups, brings important contributions to the analysis of the process of the teaching and learning of mathematics at schools. From the perspective of ethnomathematics, D'Ambrósio (1997) argues that mathematics education has witnessed significant transformations, most of them due to the fact that it is embedded in cultural diversity, many times not taken into account at schools. Knijnik (2002) discusses the power relationships involved in the school curriculum.

She suggests that mathematical inclusion and exclusion can be understood as results of curriculum choices like what types of mathematical knowledge, what cultural values and principles are considered legitimate to be part of the school. One of the most significant influences of ethnomathematics in education, says Bishop (2006), is related to values and beliefs; it makes us realize that any mathematical activity involves values, beliefs and personal choices. Concerning situated learning perspectives, Lave's (1996) studies with some communities of practice raised fundamental educational questions about the application of school mathematics techniques in out-of-school practices. These studies indicate that the process of learning mathematical strategies and decision-making procedures are part of who is 'becoming' in that practice. People's identities are developed in participating in a socio-cultural practice and, in this sense, learning is seen as developing in practices. According to this approach, such communities and formal schooling are not distinguishable in what concerns the modes of learning. However, learning viewed as changes in participation and formation of identities within communities of practice still represents, in our view, a real educational challenge in regard to school mathematics.

In relation to affect several researchers (e.g. McLeod, 1992; Zan, Brown, Evans & Hannula, 2006) have been emphasizing the fundamental role of the affective dimension in the process of teaching and learning mathematics. McLeod (*ibid*) discusses the existence of three main aspects related to affect, which should be considered in mathematics education: *beliefs*, developed by the students about mathematics; *emotions*, provoking perturbations and blockings, leading to the students to experience positive and negative sentiments concerning their learning; and *attitudes*, developed by the students in regard to the discipline. DeBellis & Goldin (2006 in Zan et al., 2006) add a fourth element in the research of affect in mathematics education: *values*, and propose a tetraedrical model of affective representation, in which each vertice (beliefs, emotions, attitudes and values) interact both with all other vertices and with the individual. As far as we know, it is in Bishop's works that we find the most expressive elaboration of the relationship between culture and affect, in particular, culture and values. For this reason we will take his definition of values as being *beliefs-in-action*: for him, our values are revealed when we make choices; this is when we express elements of our system of beliefs (Bishop, 2002). Bishop's elaboration on culture and affect is based on the notions of enculturation and acculturation in mathematics education, already described in the introduction, as well as the concept of cultural conflicts. Since these notions constitute the core of our study, the next section is dedicated to them and their impact on students' learning in terms of affect.

MATHEMATICS ENCULTURATION AND ACCULTURATION

In developing the concept of mathematics enculturation Bishop (1988) argues that a child does not receive the culture as if it is an abstract entity; cultural learning at

school is not a mere unilateral process that goes from the teacher to the student. According to him, mathematics enculturation in a classroom should have as its target the initiation of the students into the conceptualization, symbolization and values of mathematics culture. And this process is interpersonal; it is interactive among people. In this sense, says Bishop, mathematics enculturation is not different from any other enculturation, and mathematics classrooms should be a propitious environment for mathematics enculturation. In a similar way, Lerman (2006) says that (mathematics) enculturation is a process of getting used to mathematics. Thus, he associates mathematics enculturation to a process of becoming mathematical, and discusses some research that indicates how becoming mathematical can mean different things in different modes of teaching. Later on, Bishop (2002) recognizes that we should not disregard the existence of cultural conflicts generated in classrooms, provoking also the process of mathematics acculturation. He discusses two distinct conceptions of cultural conflicts: a) conflict as a mere aspect of differences and mismatches; b) conflict as an aspect of explicit cultural interactions between the opposite parts. According to him, by adopting the second conception we would have an alternative and reciprocal development of both conflict and consensus, resulting continuously in a 'healthy' alternation between dissonances and consonances. At this stage, the author's studies focus not on the student individually, but in the process of acculturation per se, and in the role of those ones who we could define as being acculturators. In doing so, he observes apprentices (in general) during their experiences of cultural conflicts, and explores, in particular, how the process of acculturation affects the students' actions in multiethnic classrooms. From these observations, Bishop (2002) raises a more radical hypothesis: "...all mathematics education is a process of acculturation...every learner experiences cultural conflict in that process. However, cultural conflict need not be conceptualised exclusively in a negative way..." (p. 192). In what concerns the teacher's role, the author suggests that the teacher is the most important agent of acculturation in mathematics education. He considers two types of acculturator-teacher. The first involves school mathematics and daily-life mathematics: an acculturator-teacher would be the teacher who keeps the exclusivity between these two cultures (school mathematics and daily-life mathematics), who does not make any reference to any mathematical knowledge out-of-school, and who is not able to do anything with this knowledge even knowing that the students may have it. The second type of acculturator-teacher alludes to the institutionalized power of the teacher. In this case, an acculturator-teacher is the teacher who exercises his hierarchical power over the students in a negative way, i. e. by imposing to them what s/he wants through her/his privileged power and position legitimated by the educational institution and system. In both cases, says Bishop, the resulting cultural conflicts, although containing a cognitive component are infused with emotional and affective traces/nuances indicating deeper and more fundamental aspects than can be accounted for from a cognitive perspective. Returning to Lerman's above-mentioned work we could conjecture that the process of

mathematics acculturation, as described by Bishop, might not result in a process of becoming mathematical.

Frade (2007) provides a thoughtful contribution for the issue built over Luciano Meira's (Meira & Lins, 2006) *island metaphor*. In presenting a reconceptualization for the traditional dichotomy between 'the theoretical' and 'the practical', Meira associates the former to a person's life (natives living in an island), whereas the latter is associated with a representation of this person's life (explorers coming to the island and drawing a map). The researcher points out that there is no good reason to think that the natives do not 'theorize' about the explorers' *forms of life* at the moment they are mapping the island. According to Meira's approach cultural conflicts arise inevitably both when the natives begin to live the lives 'imposed' by the map, and when they visit the homeland of the explorers and question the rationale for the map. Based on this, Frade (ibid) has elaborated an interpretation of the island metaphor to mathematics education, in which teachers and students are supposed to belong to two different cultures – with one dominating culture, that of the teachers. She proposes to think that the island corresponds to a mathematics classroom within a *strongly classified curriculum* (using Bernstein's terms) in which 'children-natives' live a great part of their lives. The mathematics 'teacher-explorers' 'impose' on them a map which includes the *vertical discourse* of mathematics – via *recontextualization* – and some established social and mathematical norms, which the children-natives are supposed to share and to follow. The teacher-explorers' homeland would correspond to the 'mathland'. Cultural conflicts arise, for example, when students question the rationale for this map or when they feel themselves to be 'outsiders' in mathland. Frade concludes that whatever the correspondence between Meira's metaphor and mathematics education, it should suggest a kind of 'dominator-dominated' relationship between teachers and students, inviting us to a reflection about the character of mathematics education in terms of humanity.

In an attempt to humanize the imbalanced relationship between the culture of the teachers and the culture of the students Bishop (2002) proposes a reconceptualization for mathematics learning environments based, to a great extent, on Gee's (1996) theoretical construct of *borderland discourse*. This would correspond to the area of intersection between the students' primary and secondary discourses. The primary discourse refers to the discourse learnt and used within the family, at home or surrounding groups. The secondary discourse is related to traditions passed forward by generations through time, aiming at the learning of behaviors in external environments to us. So, this discourse is considered more institutional or formal than the primary one. The potential oppressive character of the process of acculturation leads Bishop to propose that the intentional mathematics acculturation of a young person becomes a *cultural production* in which schools should be the place where the primary discourse of the students' families and communities meet the secondary discourse of mathematics community. In this place the co-construction of meanings, values and cultural practices would occur; it is where Popkewitz's (1999 in Bishop

2002) notion of *productive power* could be developed. According to this notion people are not seen as ‘owners’ of the power, but instead as mediators of the systems of knowledge and rules from which the power derives.

CONTEXT AND METHODOLOGY

The research was carried out in a Brazilian urban secondary school. The subjects involved were 31 students (17 girls and 14 boys) of a Year 6 class (ages approximately 11) and their mathematics teacher Ana. This class was not a multiethnic class, though we can say that it was characterized by a cultural diversity concerning the children’s socio-economical position. Ana was a novice teacher and has taught as a temporary teacher in this school during a period of two years. Data were collected by: a) audio and video recorder of a sequence of mathematics lessons, b) audio recorder of interviews with some students, c) audio and written register of observations in class. The second author of this paper – Diogo – started his observations in the class seven days after starting the recording of the data by audio and video. This ‘entrance’ of Diogo in the class was aimed at developing familiarity with both Ana and the students. By this time, Diogo had registered his observations only in writing. After this period, a sequence of twelve lessons about fractions and geometry were recorded in audio and video. The observations in class were focused on Ana’s practice, especially on the mathematical and affective interactions between her and her students, aiming at identifying processes of mathematics enculturation and/or acculturation. They were also aimed to identify any characteristics of an acculturator-teacher in Ana’s practice, according to Bishop’s parameters. Attempting to search for evidence of cultural conflicts, some students were also asked to participate in interviews in small groups after the observations in class. Throughout his time in the class Diogo interacted with Ana and the students, participating effectively in the classroom activities and clarifying the student’s doubts when requested by them.

ANALYSIS AND DISCUSSION

In relation to the observations of the lessons, we have identified that the secondary discourse, i. e. the academic mathematical discourse was predominant. The discourse of the *borderland discourse* we expected to find as something ‘funding’ the academic mathematics and the students’ daily-life (primary discourse) was not identified during the lessons. On the other hand, we did not find any evidence that the students question this; they seemed completely adapted to and involved in the secondary discourse led by Ana. The potential cultural conflicts resulting from the gap between the secondary and primary discourses were not apparent; they did not have any stimulus to become explicit in the cultural interactions between the opposite parts: the culture of the teacher and the culture of the students. Moreover, the students have shown understanding of and effectively participated within the secondary discourse as it had been the only available or permissible discourse. We conclude that the

students were able to attribute meaning to the mathematics learnt in classroom exclusively through the secondary discourse.

Two illustrations of the preponderance of this discourse in Ana's class are the following: in a certain lesson she was explaining the equivalence of fractions using a text prepared to the students by another mathematics teacher of the school. In relation to adding fractions, the text stimulated the work with equivalent fractions attempting to avoid students' rote learning of rules, but instead getting them used to the concept of equivalence. However, Ana opted to work with this topic in an abstract way; through the practical rule: "... *calculate the lcm* [least common multiple], *divide by the down and multiply by the up*". We are not saying that this method is not useful. What we claim in the terms of teaching in question is that the initiation of adding fractions should dispose of didactical resources and use a discourse closer to the students' primary discourses, likely tangible materials associated with daily-life contexts. An interesting utterance of the teacher addressed to the students drew our attention: "*I think this method* [the practical rule] *is easier. For this reason we are going to use it.*" Despite the friendly tone of Ana's voice, her utterance sounds authoritative; for she does not give any chance to her students to experience other forms of adding fractions and impose to them the method she thinks is better. This attitude of Ana and her preference for a discourse that is exclusively academic reveals some of her values in relation to mathematics. And this can be due to the fact that she was a novice teacher, bringing with her a discourse impregnated from years of undergraduate mathematical studies, which relies mostly on the secondary discourse.

In another lesson, Ana taught geometry to the students, using a sort of game as a didactical resource. On this day a teaching practice student was in her class and helped her in the conduction of this activity. The game consisted of a sheet of paper containing drawings of sixteen plane figures (e.g. triangles, rectangles, and so on). In order to play the game the students were divided in pairs and each pair received one of those sheets of paper in which one figure should be chosen. The game's rule was the following: each pair should discover the figure chosen by another pair. To this end, it was needed that the students had to elaborate questions related to the figures to be discovered, e.g. 'does this figure have right angles?', 'parallel sides?' Such an activity had, in our view, a great potential in exploring bridges between the secondary and primary discourses. We had the expectation to identify elements of a borderland discourse but this was not possible. All the activity with the game as well as Ana's and her students' mathematical systematization, related to both the definitions and the properties of the plane figures, were supported by the secondary discourse.

The two lessons described contain evidence of a process of acculturation, using Bishop's framework. Indeed, Ana can be considered as an acculturator-teacher, since we could identify in her practice two of Bishop's characteristics of an acculturator-teacher. However, this does not imply a negative influence in the students' affective dimension in relation to Ana nor in relation to their learning (at least, the learning

Ana seemed to expect from them!). Either in the lessons or in the interviews, we noted that they nourished a positive affect for Ana. Examples:

Diogo: Every time you need or have any doubt, does the teacher [Ana] help you?

Leonardo: Always!

Diogo: She is a nice teacher, isn't she?

Leonardo: Yes!

Lucas: Yes! She helps, but sometimes I am [still] in doubt. Then, I ask her to explain [again] and she explains.

Our conjecture is that this affect might unfold into a very positive relationship between the students and their learning. All students interviewed by Diogo have expressed more or less explicitly their pleasure to learn mathematics and a satisfaction in completing a task. Examples:

Tainah: It [mathematics] is my favorite discipline, I adore it!

David: Mathematics, for me, is a good discipline. When I grow up I want to be a mathematics teacher. [This surprised us as this student showed much difficulty with mathematics in the lessons observed].

Lucas: When is a thing [in a task] that I don't know I stay there [persisting] and I feel even sweating! But when I see it [the response] is right, then I am delighted!

On the other hand, the two characteristics of an acculturator-teacher identified in Ana's practice do seem to contribute to a development of the students' beliefs that mathematics learning at school and mathematics learning at daily-life are two distinct practices that are insulated from each other. Examples:

Diogo: You said that you use fractions at home. Here, in the school, do you learn and use fractions as you do at home?

Tainah: Here [at school] is the same language! For fractions [at home], we give examples of food. Here [at school] we learn with sticks and at home we add other things.

Diogo: And where do you think is easier to learn mathematics, at home or at school?

Tainah: Are different learning!

Diogo: Could you please explain this better?

Tainah: At home we learn calculating quantity, money, millimeters, and at school we start calculating with natural numbers!

Leonardo: The carpenter is a person who knows mathematics I think, angles.

Diogo: Does he know this mathematics you learn at school?

Leonardo: No!

Lucas: No!

We suggest that this episode captures moments of cultural conflicts lived by the three students. In fact, despite Tainah's statement that the language of fractions is the same at school and at home, she seems to be convinced that learning mathematics in these two contexts is different. She can be revealing another belief concerning an insulation between these two different cultures when she suggests that the learning of fractions at home is related to daily-life and practical uses, whereas at school it passes by an abstraction that moves the practical use of the subject to the mere use of number calculations. Leonardo and Lucas seem to share with Tainah a similar belief of insulation between mathematics in and out-of-school: the carpenter knows mathematics, but a mathematics that definitely has nothing to do with that of school.

FINAL COMMENTS

Considering the specific context of this study we can say that the students have experienced a process of mathematics *acculturation*. However, our research results indicate that such a process may not be necessarily negative, at least in terms of the students' affect in regard to both their teacher and their learning. The affective way – tender and supportive – by which Ana has assisted her students is an evidence of this assumption. On the other hand, the same results suggest that Ana's values concerning the exclusivity of the secondary discourse in class do seem to consolidate a negative belief among the students of a conflicting/insulated dialogue between mathematical practices in- and out-of-school. We conjecture that this might result in an obstacle for the students from experiencing a process of becoming mathematical as we understand it (a question of continuing concern to us for future investigations). We agree with Bishop when he says that teachers should stimulate interactions in classrooms in which cultural conflicts might become explicit, and consequently, objects of negotiation and co-construction of meanings between the opposite parts. In doing so, teachers could make the boundaries between mathematics culture and that of the students more permeable, allowing them not only to cross these boundaries, but also to circulate in and to explore dialogues between these two non-insulated cultures.

At the moment we are observing the practice of a second teacher with the same research purposes and using the same methodological procedures as the study in Ana's class. The preliminary results of this second observation together with those related in this paper suggest to us that, with some revision, Bishop's notion of the processes of mathematical enculturation and acculturation can better account for a relationship between teachers' culture/values and students' affect. We conjecture that teachers' practices are characterized by other relevant aspects, such as the supportive and affective ways in which the teachers assist their students, that go beyond the scope of the notion of acculturator-teachers.

NOTES

1. Supported by FAPEMIG and CNPq.
2. Due to lack of space this paper will not present a wide review of the literature in mathematics education, related to culture and affect; it will be restricted to the presentation of some academic ideas that we believe are sufficient to give a sense to and report on our study.

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