Politics of Ethnomathematics: An Epistemological, Political, and Educational Perspective

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This article discusses the concept of ethnomathematics from three perspectives: the epistemological, the political, and the educational. We use a theoretical toolkit that borrows the concepts of "discourses" and of "disciplining" from Foucault but also the concepts of "language games" and of "family resemblance" from Wittgenstein in order to analyze the pedagogical program of field education in Brazil. A philosophical analysis enables us to investigate the failure of the government's educational policy as well as resistance and social movements among "field populations". Basing ourselves on an anthropological perspective, trying to understand how cognitive acts underlie local activities and how these activities are embedded into a cultural environment, we suggest that this approach might have a positive impact.

Introduction

Throughout the last decades, research carried out in the field of ethnomathematics have aroused lively debates of an epistemological nature, discussing whether or not mathematics are culturally determined, and thus questioning the "possibility of the simultaneous existence of culturally different mathematics" (Barton, 1999). The debate has often amounted to a discussion between essentialist and non-essentialist mathematicians about the universal nature of mathematics (Pais, 2011). Without entering into this debate, we would like to address here some epistemological, political, and educational issues raised by the (potential) use of "traditional" knowledge in local mathematics

curricula. In this paper we use the word 'mathematics' in the plural to emphasize that there are more than one 'mathematics' as shown by the anthropological evidence of diverse mathematical practices on which we will elaborate. Since the 1970s, many educational approaches aiming to teach mathematics to students living in small-scale societies by taking into account the cultural context have been carried out and described by educators. In most cases, these educators have suggested teaching some mathematical concepts in classroom through specific cultural activities involving numbers, logic or spatial configurations that could be used as pedagogical supports (Pinxten & François, 2007, 2011). These teaching practices led governments to implement specific mathematics curricula among different populations, each with their own specific needs and cultural background. In this article we will focus on the epistemological, political, and educational issues raised by such ethnomathematical teaching practices. First, we will focus on some epistemological issues that need to be addressed—in our view—to better understand the nature of (mathematical) knowledge thus taught to students. In the second and third parts of this paper, we will expand on the political, and educational issues, by investigating the case of government policy on field education in Brazil.

Epistemological Reflection

In small-scale societies, mathematics does not generally appear as an autonomous category of indigenous knowledge. However, as it has been confirmed by numerous ethnographies of various societies of oral tradition, a form of rationality occurs within various practices, such as the making of calendars or ornaments, navigation, games, kinship systems, string figure-making, sand-drawings, traditional housing, etc. These activities have generally been used as teaching resources in math classroom through two main different methodological approaches. First, some ethnomathematicians have proposed to use the figures or artifacts produced through such "traditional activities"—but without taking into account the processes involved in the making of these artifacts—as a base to teach usual mathematical concepts. Gerdes (1999) proposes such an approach, using sand-drawings, baskets, etc., as a mean to introduce geometrical concepts (e.g. symmetry) and arithmetic properties (e.g. sum of an

arithmetic sequence), but also as a geometrical support to demonstrate some fundamental theorems such as Pythagoras' Theorem. This pedagogical practice's major disadvantage lies in its disconnection from the actors' viewpoint(s) and from the cognitive acts involved in the creation of such artifacts. The connection between this pedagogical practice and the cultural context is thus highly questionable. The second methodological approach consists in including some specific cultural activities "as such" in the (local) mathematics curriculum (Murphy, 1998; Nkopodi & Mosimege, 2009). The epistemological issue is then to determine whether these activities relate to mathematical practices, and how. Philosophy in general, and the philosophy of mathematics in particular, does not yet offer efficient conceptual tools to tackle this issue, as it often takes for granted all that is mathematical. However, regarding the issue of determining whether or not an activity is related to mathematics, it can be noticed that there is a significant difference between activities that involve numbering and/or measuring, and those dealing with geometrical forms. The counting of yams with a basket as it is practiced in Melanesia—in the Trobriand Islands (Papua New Guinea), for instance—is quite readily recognized by academia as mathematical, as it involves the use of a particular counting method. By contrast, other practices that require "geometrical" abilities (such as basketry or ornamental frieze making) are usually not—or not so readily—regarded and analyzed as mathematical by scholars. This question needs to be further investigated. Although a few ethnomathematical studies have been carried out in that perspective in the last decades (Ascher, 2002; Chemillier, Jacquet, Randrianary, & Zabalin, 2007; Vandendriessche, 2015), there is—to our knowledge—a lack of ethnomathematical in-depth study, aiming to analyze the form of rationality that underlies these "(ethno) geometrical" practices. Progress on that issue would allow us, on the one hand, to better understand the kind of mathematics students could learn while practicing activities such as string figure-making or basket-weaving in math classroom, and, on the other hand, to contribute—in some way—to an epistemological reflection on the nature of mathematics.

Political Power

Methodological approaches that aim to include specific cultural activities in school contexts can be questioned from different perspectives. We will shortly comment on the perspectives of cultural diversity and political hegemony, and finally on the anthropological approach. A first perspective is in line with the above comments made on the methodological approach which consists in incorporating specific culture-related activities into the mathematics curricula without taking into account the connection to the cultural context or to the actor's viewpoint. Within the framework of field education—on which we will elaborate in the next section—government policy on the implementation of standardized pedagogical programs is criticized because of the disconnection from the specific needs and interests of the targeted groups. Moreover a top-down implementation of the pedagogical programs failed to take into account the teachers' viewpoint(s) (i.e. the actors' viewpoint) in setting up and implementing those pedagogical programs. A second perspective on the implementation of pedagogical programs in specific school contexts reflects the philosophical and political notion of hegemony based on Foucault's (1966) concepts of discourses as 'disciplining'. Mathematical curricula and mathematical pedagogical programs can be analyzed as discourses that facilitate the teaching process, but at the same time they regulate and delineate the practices of knowledge. These mathematical discourses can both enable and limit the teaching process, but also the teachers' and pupils' practices and thoughts. Therefore, the mathematical programs that are developed and implemented in specific school contexts turn out to be tools of power (François, Coessens, & Van Bendegem, 2014). Knijnik (2012) analyses ethnomathematical practices from a philosophical perspective that articulates Foucault's theoretical notion of school mathematics as disciplinary. She claims to go beyond the naïve understanding of mathematical diversity as an acknowledgement that there are different ethnomathematics. We have to introduce the notion of power to understand and to analyze the politics of knowledge and how it operates in schooling processes, in the implementation of pedagogical programs and, more particularly, in mathematics curricula. The politics of power has to be understood as the imposition of meaning produced by a *double violence* (Bourdieu, 2003 as referred to in Knijnik, 2012). The first violence consists in

imposing one culture on another. The second one is the power of naturalizing the first violence by accepting the dominant culture as the only possible way of being or, at least, as far more preferable to the former one. In the case of mathematical knowledge, we notice the first move of imposing the Western body of academic abstract mathematics upon all mathematics curricula. The second move is the violence caused by establishing this Western body of academic abstract mathematics as the highest achievement of human culture and as the necessary condition of full citizenship.

The third perspective is the anthropological one, which is central to the discussion of the existence of many ethnomathematics and of their respective values. In line with D'Ambrosio's use of the notion 'ethno' as the 'very different and diversified cultural environments, i.e., in the diverse ethnos' (D'Ambrosio, 1990: 369) we argued that Western mathematics are themselves also considered as having been developed—and as still being developed nowadays—within a particular contextual reality. The research interests of ethnomathematics pertain to the development, analysis and teaching of mathematical knowledge as dynamic processes embedded in their socio-cultural context. The Western body of academic abstract mathematics itself cannot be understood or taught separately from its cultural environment and power mechanisms (François & Van Kerkhove, 2010). Knijnik (2012) refers to the later work of Wittgenstein (1975) to explain the existence of many different ethnomathematics. Wittgenstein abandons the essentialist concept of language and therefore denies the existence of a universal language. Languages—or 'language games' as Wittgenstein calls them—immerse in a form of life, in a cultural or social formation and are embedded in a totality of communal activities. This idea gave rise to the notion of understanding rationality as an invention or as a construct that emerges in specific local contexts. Thanks to the notion of 'family resemblance', one can understand the existence of different kinds of mathematical knowledge and call it ethnomathematics that coexist. Wittgenstein (1975) used the concept 'family resemblance' (*Familienähnlichkeit*) to refute the idea that words have a single and fixed meaning by standing for objects in reality. He also claimed that words acquire meaning from the thoughts of those who are using them. Instead, to Wittgenstein, words are connected by a series of overlapping similarities—as it is the case with family members, among whom no single feature is common to all of them. In

the next section we will discuss both the relevance of epistemological reflection and the notion of political power as related to mathematics teaching. Therefore we will look into the case of field education in Brazil. We will argue that the government's inadequate response to the field populations' demand for an educational approach that respects their cultural identities could be partly explained by (i) denying epistemological constraints and (ii) political hegemony. We will illustrate how new pedagogical programs aim to take into account the cultural context in field education, but at the same time fail to implement it by directing field teaching towards a homogeneous approach. Besides we will illustrate how the governmental education system used pedagogical programs as a "device" (Foucault, 1966) to impose urban curricula to field populations.

Field Education

In Brazil the concept of *field education* is related to the notion of *field population*, which is used to identify specific groups who are involved in certain economical activities that have their own cultural specificities—e.g. family farmers; salaried farmers; vegetal extractive workers; forest people; artisanal fishers; riverbank people; coast inhabitants; settlers and encamped of agrarian reform; slaves of African descent who live in the remaining *quilombo* communities throughout Brazil; and various others who work in rural areas to produce their material conditions of existence (IBGE, 2010). Brazilian social movements and organizations, as well as the governmental education legislation, use the term 'field education' when referring to the teaching and learning processes which are developed to meet the needs of these populations. There is a strong ideological connotation in the term *field*, which was constructed by Brazilian social movements and NGOs during the last decades of the 20th century. The theoretical and ideological debate about the use of the concept *rural education*, as opposed to *field education*, emphasizes the fact that field education cannot be limited to geographical and demographical references. According to Operational Guidelines for Basic Education in Field Schools (Ministério da Educação, 2002), the term 'field' emphasizes the notion of *field of possibilities*. According to the Brazilian statistical report on demography (IBGE, 2010), the total population of Brazil was 190,755,799

inhabitants in 2010 and 29,830,007 people (15.6% of the total population of Brazil) lived in rural areas. The figures for schooling show that 41.8% of the people aged over 15 in this rural population are functionally illiterate, while in urban areas this rate is much lower, at 17.2% (IBGE, 2009). Historically, the organization of schooling brought to field populations in Brazil did not take into account their particularities (Monteiro, Leitão, & Asseker, 2009). Educational policies were not concerned with schooling that considered field reality. In this sense, the curricular content, teaching methodologies and pedagogical proposals of the urban schools were implemented, unchanged, in the rural ones. Therefore, one of the major claims among field populations was an educational approach that would respect their identities. This approach was called 'field education' to underline that it had emerged from the field. The aim was to build a curriculum perspective that would give value to the specific knowledge and needs of field populations (Arroyo, Caldart, & Molina, 2004). In order to meet the claims of social movements, the federal government proposed pedagogical programs even before field education became an official public policy. In 1997, the Ministry of Education proposed the Active School Program (ASP) (Programa Escola Ativa) with the objective to improve the quality of early elementary teaching in the field schools throughout more of the densely populated rural areas of North, Northeast and Midwest regions of Brazil. The ASP prescribed a pedagogical approach designed for multi-grade classes that made a combination of elements such as: teamwork, self-learning, teaching through specific textbooks, community participation, monitoring of students, and continuing education for teachers. Over the years, the ASP was criticized in terms of stereotyping, hegemony and imposition of pedagogical and didactical programs. Monteiro and Alves (2011) conducted an analysis of the ASP math textbooks, and identified that most of their contents were related to numbers and operations. The texts books offered only few discussion and tasks about contents that could be associated with geometry and statistics. Such perspective reinforced the stereotype that mathematics is purely a matter of calculation. Additionally, the textbooks contained examples of a stereotyped field context that was limited to agriculture and animal husbandry. They were illustrated by photographs and drawings of people—supposed to be field folks—that went barefoot, wearing cheap checkered shirts and straw hats, and using carts. When Knijnik

and Wanderer (2013) analyzed the ASP, they based their study on official documents and ASP pedagogical publications, especially those associated with the teaching and learning of mathematics. They also collected data from a questionnaire that was answered individually by 150 teachers, all of whom were responsible for teacher education courses developed in different regional ASP centers in the State of Rio Grande do Sul (southern Brazil). Knijnik and Wanderer (2013) emphasized that the ASP pedagogical guidelines were presented in detail: these guidelines covered not only the contents that were to be taught but also the didactic procedures that are to be followed. This aspect is analyzed as an underlying process of subjection that regulates the teachers' conduct, in order to ensure that their students' learning should be developed within a specific rationality. Although the ASP documents underlined that cultural, political, economic, and social characteristics needed to be considered, the teachers' pedagogical procedures were conducted so as to not include those specificities. Knijnik and Wanderer (2013) argued that an analysis of the teachers' responses suggested they tended to value less the knowledge and experiences of people who lived in field contexts. For example, the teachers' responses showed that they saw field people as people "without culture" or "with little culture" (p. 219, our own translation). Monteiro, Carvalho & François (2014) drew similar conclusions from an analysis of the teachers' opinions about field realities. Teachers tended to describe field students as restricted and inferior compared to students who live in urban areas. The outcomes of their study also suggested that the pedagogical organization of field schools does not yet consider the particularities of field education. Generally speaking, the teaching of mathematics has a peripheral status within their pedagogical planning and less time is spent in class on this subject than on others.

A "New" Governmental Program

Such criticism of the ASP resulted in occasional reformulations. One of the recent changes in the program was the substitution of textbooks. In 2012 the National Program of Textbook organization (Programa Nacional do Livro Didático – PNLD) approved two new collections of textbooks, that were considered as more suitable for

field schools and intended to replace previous ASP textbooks. In 2013 the ASP was itself replaced by the Program School of Land (PSL) (Programa Escola da Terra), in accordance with a ministerial ordinance (Ministério da Educação, 2012). According to the Minister of Education, the PSL aims (i) to promote school access for field students and *quilombolas,* (ii) to maintain them at school, and (iii) to improve their learning in their communities by supporting teacher education. Teacher education should meet operating needs that are specific to rural schools and to those located in *quilombolas* communities by making new resources available: PNLD Field textbooks and a *Pedagogical Kit*. There are no available PSL pedagogical publications that explicitly give guidelines on the processes of teaching in field and *quilombola* schools. Therefore, the only one is the ministerial ordinance signed by the federal government. An analysis of that official document allows us to identify similarities to the ASP. Akin to the ASP, this new PSL program aims to consider the specificities of field school, but its *Pedagogical Kit* directs field teaching towards a homogeneous teaching approach. One year after the signature of the official document, the PSL begun to implement a pilot project in four major regions of Brazil with the support of seven federal universities. It seems that the university staff involved in this implementation has already begun to question the PSL. The universities decided not to accept the Pedagogical Kit, and they now intend to produce specific material for each State in which the PSL will be developed. The Field Education became a public policy when a ministerial ordinance was published (Ministério da Educação, 2012). As a consequence of this policy, all state school networks had to follow the official prescriptions. However, many Secretaries of Education of federated States and municipalities are not familiar with the Field Education principles. Thus, the main criticism about governance and subjection, as described by Knijnik and Wanderer (2013), is still very relevant in many field education contexts, because the people in charge of this public policy are not conscious enough of its actual motivation, which is to give value to field people. Between the end of the ASP (2012) and the implementation of the new Government Program for Field Education (by 2014), the Research Group in Mathematics Education in Field Education Contexts (GPEMCE) of the Federal University of Pernambuco (Souza, 2014) conducted a study. The central research question of this study was how the teaching of mathematics was

developed in field schools at a period when the federal government had no specific pedagogical guidelines (i.e. 2013). The data were collected in the municipality of Igarassu and its educational network of 45 schools, among which 23 were classified as field schools. 104 teachers from those field schools completed a questionnaire with open and closed questions related to (i) professional background, (ii) conceptualization of field education, and (iii) resources used in the teaching of mathematics. The first analysis of the data was a descriptive statistical analysis (using SPSS) of frequencies. The preliminary results show that an overwhelming majority of teachers (90%) responded positively when asked whether they knew what a field school is, and whether they had already heard about field education. However, it was identified that very few teachers (4%) made an explanation that considered the economic and cultural aspects related to the concept of field school. The vast majority of participants (68,4%) based their answer on a demographic notion of the field that was associated with a rural context. Almost all of the teachers did not live in field contexts and, similarly to the findings of Knijnik and Wanderer (2013), and of Monteiro, Carvalho & François (2014), teachers seemed to have a narrow perspective about their students and the field life. From our observations, we could infer that teachers and pedagogical coordinators do not conceive field education as an important approach that could benefit to field people and to their communities. Generally, the educators involved are not conscious of the political and cultural issues associated with field education. Therefore, the actual pedagogical approach seems to contradict both the official documents and the critical perspective proposed by the social movements.

Discussion

On the grounds of a philosophical analysis of the politics of ethnomathematics, we will give meaning to the gap between governmental policy and the organization of schooling and mathematics education in specific social and cultural contexts. Therefore we use the concept of hegemony and Foucault's concepts of discourses as 'disciplining' to investigate the governmental mathematical pedagogical programs. They can be understood as discourses that try to facilitate the teaching process, but at the same time they regulate and delineate the practices

of knowledge. In the case of field education in Brazil, we observe the resistance of social movements that criticize the educational policies of implementing in field schools the urban schools' curricular content, teaching methodologies and pedagogical proposals. Field populations demand an educational approach that respects their cultural identities. This educational approach has to emerge from the field, from local practices and from local knowledge. In tune with Wittgenstein's conception of language games (1975), field populations demand an educational approach in their own language games, starting with their own 'ethnomathematics'. At this point we see that an anthropological approach can play a central role in the field of ethnomathematics. Ethnomathematicians seek to articulate the conceptual approaches of local mathematical practices (mathematical modeling, historical, philosophical, and/or pedagogical perspectives) with an ethnographical approach that would enable them to collect new data about activities that involve mathematical ideas. At the same time, they try to reach a better understanding of the cognitive acts that underlie these activities and how these activities are embedded in the social organization and symbolic systems of the societies within which they are practiced. We suggest that this approach should have a positive impact in the sphere of education. It might incite policy makers and teachers to introduce the mathematical aspects of activities practiced in a particular society, in an attempt to better take the cultural context into account. Further research should be undertaken to analyze how pedagogical programs and educational materials would be accepted and implemented by local educational actors, as well as by populations concerned, if their elaboration was based on the second stage of an in-depth epistemological and anthropological/ethnographic research on local (ethno) mathematical knowledge.

Notes

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