The contribution of ethnomathematics to adults learning mathematics

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This paper focuses on bricklayers' professional knowledge and use of mathematics. It gathers and describes episodes observed in bricklayers' professional practices that illustrate how mathematical knowledge is embedded in their professional activities. Independent of schooling, bricklayers apply mathematics daily and implicitly. It is this practical knowledge of mathematics that, after being uncovered, is most relevant to the adult-learning mathematics contexts for us educators, as it not only connects school content and curricula to labor-market necessities, but also makes use of adult learning experiences to support new mathematical learning.

Introduction

Nowadays, professional knowledge is considered a source of wisdom and inspiration in designing curricular activities in adult education. From the viewpoint of mathematics education, professional knowledge as well as cultural mathematics are seen as important components of the pedagogy and didactics of the field. In addition, mathematics education can really determine a student's success in professional careers and job opportunities.

The research presented in this paper addresses the issue of bricklayers' professional practices that involve mathematical knowledge. Their professional activities include the building of walls, stairs, the foundations of houses, etc. Thus, the research collects and describes situations found in bricklayers' work which illustrate the use of implicit as well as explicit mathematics. In particular, it addresses the following questions:

- In what ways do bricklayers use mathematics in their professional activity?
- What kind of relationship exists between this professional use and formal mathematics instruction?

For us, the relevance of studying bricklayers' professional knowledge is to put it to good curricular use in the context of adult mathematics education. By investigating what bricklayers know in practice, we intend to explore their mathematical reasoning and calculations to enlarge, strengthen, and develop their mathematical competencies. Simultaneously, with this study we hope to highlight, on the one hand, the value of bricklayers' work, with its professional specificities, practices, social prestige, and role in society, and on the other, the universal component of work, its role and place in society, and its intrinsic meaning for most social groups.

Theoretical framework

The theoretical framework that guides our research derives from ethnomathematics and the concept of 'communities of practice' and its relationship to learning.

Ethnomathematics is considered by D'Ambrósio (2002, p.9) as:

> …that mathematics which is performed by cultural groups such as urban and rural communities, groups of workers, professional groups, children within a certain age, indigenous societies, and many other groups that identify themselves by common goals and traditions.

Furthermore, D'Ambrósio (1996, p.7) also notes that ethnomathematics should be understood as

> …a strategy developed throughout history by the human species, within a certain natural and cultural context, to explain, comprehend, control, and live together with empirical and perceptible reality as well as with imagery.

Knijnik (2000, p. 54) argues that the social group's way of life, its practices and knowledge constitute the context within which the ethnomathematical study should be developed. Thus, Knijnik presents the *Ethnomathematical Approach* as

> The researching of traditions, practices and conceptions of mathematics of a subordinated social group and the pedagogical work which is developed in order to allow the social group to interpret and decodify its knowledge.

Thus, the concept of ethnomathematics provides a valuable framework not only for researching mathematical activity from all over the world, but also for discussing and reflecting upon its findings and relating them to educational practices and aims. In fact, since the 1970s, research findings from the field of ethnomathematics have demonstrated i) that different cultural groups possess particular ways of approaching mathematics, ii) the social, cultural and political nature of the variables and processes involved in mathematics education, and iii) the complexity of the articulation between mathematical knowledge based in primary culture and that promoted by schools, highlighting the dissociation of formal mathematics education from daily life. (Moreira, 2007). The findings of ethnomathematics contribute to the socio-cultural contextualization of the teaching of mathematics and simultaneously promote a critical attitude toward it.

The notion of "community of practices" put forward by Lave and Wenger (1991) points out that "learning is an integral and inseparable aspect of social practice" (p. 31). Moreover learning, as a component of a social practice, involves the whole person and the activity that she/he is working on – tasks, functions and comprehension do not exist separately. As the same authors point out (1991, p.53):

> Learning thus implies becoming a different person with respect to the possibilities enabled by these systems of relations. To ignore this aspect of learning is to overlook the fact that learning involves the construction of identities.

Wenger (1998) emphasizes what he terms the three dimensions of a community of practice. They are: a *mutual engagement,* a *joint enterprise* and a *shared repertoire*.

Practices unfold in a social world where interest, powers and status are present. As Wenger (1998, p. 77) states:

> A community of practice is neither a haven of togetherness nor an island of intimacy insulated from political and social relations. Disagreement, challenges, and competition can be forms of participation.

Being shared, a social practice ends by connecting people in diverse and complex forms that constitute themselves as participants in the community of practice. In order to achieve community coherence, Wenger proposes, the people in question engage in the “negotiation of a joint enterprise” (1998, p. 77).

Methodology

We decided to use an ethnographic perspective to understand bricklayers’ daily routines and to better comprehend how mathematics emerged in their professional practices. The ethnographic research demanded our continuing attention as researchers playing the role of the participant observer, with daily proximity and direct involvement in the bricklayers’ social setting. Therefore we visited the construction site weekly, and the observations were done in the professional context. Semi-structured interviews were also conducted to learn about the bricklayers’ school experience and professional trajectories, as well as their personal thoughts about mathematics. All the interviews were done in the professional setting according to the bricklayers’ availability and in accord with their job routines.

Data was collected from September 2006 to July 2007 in a civil construction setting located in the Lisbon area (Sintra). Usually we visited the setting two times a week. Since we were acquainted with the owner of the building company, it was easy to get permission to carry out participant observation and to interact with the bricklayers during working hours. There were eight full-time bricklayers at the job site.

The key participants in the project were selected mainly for their predisposition to collaborate, as well as their ability to communicate with the researchers. Another important criterion was to have at least five years’ experience in the trade, to ensure that they knew their profession in detail. Finally four male bricklayers between forty and sixty years old were chosen. Although their levels of formal education were different, all of them dropped out of school during basic education either because their family's economic status did not allow them to continue their formal education, or because they wanted to be independent from their family.

The construction of the “squadron”

Throughout the field work, several episodes were observed that involved the use of mathematics. Distinct mathematical content easily emerges in bricklayers’ professional contexts, clearly showing possibilities of working out mathematics in connection to bricklayers’ real work needs, especially in the areas of Geometry and Arithmetic. One of these episodes is the construction of a tool called a 'squadron', used to verify that walls are perpendicular to each other.

In fact, one of the bricklayers’ daily routines is to measure angles, especially right angles. In order to do this, bricklayers often use a tile because they know that a tile contains four right angles rigorously measured. However, to build up perpendicular walls, as in rectangular rooms, and be sure that the walls will keep the right angle between them, bricklayers need a more appropriate tool than tiles. For this purpose they construct what they name 'o squadron' (the 'squadron').

To construct the 'squadron' bricklayers use long, thin wood strips that they nail together following precise procedures. The following dialogue, recorded while Mr. Antonio, (one of our key participant in the project) was making a 'squadron', describes the process of making and confirming the accuracy of the 'squadron'.

> **R**(esearcher): Mr António, I see that you already divided the inside of the house into smaller rooms. How do you know that this wall (internal wall) is perpendicular to the exterior wall?
>
> **Antonio**: Well. I know because I made my measurements.
>
> **R:** How did you take these measurements?
>
> **A:** I used the 'squadron' to be sure that the wall was in 'squadrian' (perpendicular).
>
> **R:** How do you make a 'squadron'? Do you mind showing me?
>
> **A:** Yes. Come here so I can show you.
>
> Antonio placed two long, thin wood strips on the floor and joined two of the ends with nails, making an angle between them of roughly 90º.

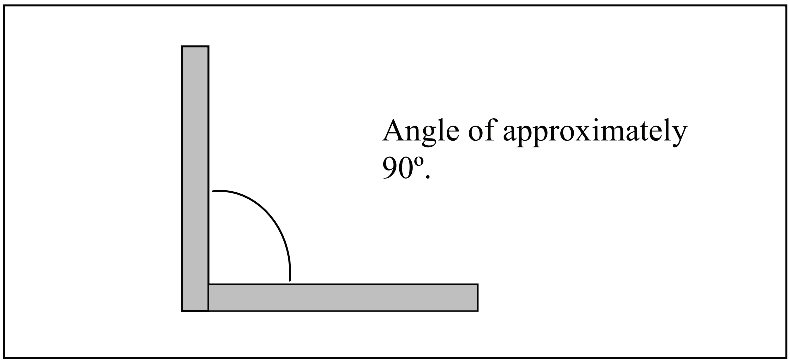

Fig. 1 First step in the construction of the "squadron"

> **R:** You told me that the angle between the strips is 90º more or less. However, the 'squadron' needs to be a precise instrument. You need to have an angle with a rigorous measure…
>
> **A**: Yes! Of course! I need to be sure that between the two strips there is a right angle. We will get there.
>
> **R**: So, what is the size of the angle?
>
> **A**: We know that is 90º. Now to be sure that the 'squadron' has a right angle, we measure 30cm along one strip and 40cm on the other; or, another possibility is to measure 60cm on one strip and 80cm on the other. (Fig.2)

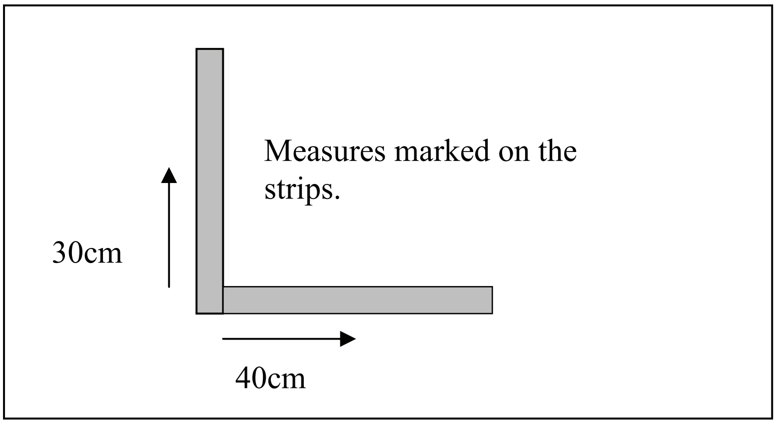

Fig. 2 Second step in the construction of the 'squadron'

R: Is it finished?

A: No. Now comes the most important step.

R: Why?

A: Because now I need to measure 50cm between the first pair of marks or 1m between the second. (Fig. 3)

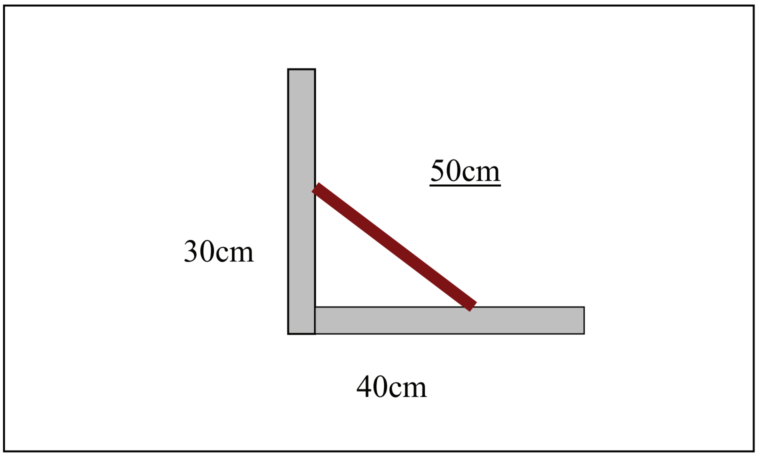

Fig. 3 Final step in the construction of the "squadron"

R: Why are you using the measures of 30cm and 40 cm, or 60cm and 80 cm?

A: Because this is my 'scale' and I'm sure that with these measures, the other side of the 'squadron' will measure 0.5m or 1m, and thus I know that my 'squadron' has 90º.

R: Do you always use all these measures?

A: No! I use the measures 30cm and 40cm or the measures 60cm and 80cm, depending on what I'm doing.

R: So the 'squadron' is for measuring right angles. Can you prove that the angle in the 'squadron' is a right angle?

A: Of course I can prove it. With my calculations I have no doubts, but even so I can put a tile on the 'squadron' to prove that the angle has 90º.

Thus, the construction of the "squadron" shows an empirical use of the Pythagorean Theorem as a way to obtain right angles. We asked Antonio where he acquired this knowledge. Antonio said that he learned it a long time ago, with experience and with the help of elder masons.

Discussion

The Theorem of Pythagoras is taught in school. However, what emerges from the above dialogue is that bricklayers have been familiar with the application of this theorem for a long time. António does not know the formal name of the Theorem of Pythagoras, but he knows how to apply it in his professional context in the particular case of two Pythagorean triplets – 30, 40, 50 and 60, 80, 100.

Fernandes (2004) relates a similar finding in a study about mathematical knowledge in a locksmiths' workshop. The apprentice locksmith also uses the Theorem of Pythagoras to verify if the cover of a chair is in 'esquadria'—that is, if it has a rectangular shape—and they use the Pythagorean triplet 6, 8, 10 (p. 249).

Research conducted by Duarte (2003) in Brazil also pointed out that bricklayers use proportions to solve mathematics problems in the course of their work. In fact, several professional practices used by Brazilian bricklayers are similar to the ones observed in our study.

When we spoke with Antonio about the construction of the 'squadron' he was not impressed by our explanations of the Theorem of Pythagoras. From Antonio's professional point of view the Theorem of Pythagoras does not hold much interest, mainly because the professional context does not require it.

In fact, during field work, we witnessed several situations where bricklayers did not recognize that they were using mathematical knowledge, in spite of its connection to the formal mathematics content they encountered in school. That is, frequently bricklayers apply mathematical knowledge in a practical and intuitive way, using specific strategies to solve problems, without being aware that mathematical ideas are involved.

Therefore, to study bricklayers' practices and describe them, highlighting their mathematical process and contents, allows us to make use of their practical examples for situations in lifelong education. In this way it is possible both to construct curricula aimed at adults learning mathematics and to develop curricula suitable for labor markets.

Moreover, bricklayers' knowledge of mathematics, collected by means of fieldwork throughout several real episodes, might constitute a set of significant materials that could provide more examples to use in educational contexts, for either adult or regular education.

Thus we argue that these practical applications of mathematical concepts may constitute, for us mathematics educators, material to work with in order to certify mathematical competencies in an official process. We aim to highlight that educational researchers should understand, explain and propose courses where the dynamics of the relationship between mathematics and the workplace are considered as resources for cultural improvement and further mathematical competences. Thus, our next task to develop this work further is to design a course and create curricular materials based on these findings.

Finally, it is important to say that this research does not claim to exhaust the understanding of the phenomenon studied. As in any work that attempts to mine reality, data is infinite. The humility to appreciate that fact is always necessary.

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