13th International Congress on Mathematical Education
Hamburg, 24-31 July 2016

UNDERSTANDING PROFESSORS' DECISIONS TO ASSESS STUDENTS' LEARNING OF PROBABILITY

Isaias Miranda-Viramontes
Instituto Politécnico Nacional, Mexico

Beatriz Adriana Rodríguez-González
Universidad Politécnica de Zacatecas, Mexico

This paper analyses how two probability professors decided to evaluate students' understanding of the concept of probability. The analysis is based on Wenger's concepts of practice, participation and reification. We show that the community of practice in which those professors participated contributed to aspects of decision-making that were not always related to assessing the learning of probability.

INTRODUCTION

Some researchers in mathematics education have analysed the relationship between teachers' practices and beliefs related to what mathematics really is (e.g. Beswick, 2012; Ernest, 1989); while others have developed theoretical frameworks that seek to establish a relationship between teachers' practices and teachers' learning (e.g. Jaworski, 2006; Goos, 2013). In the context of the practices of statistics teachers, scholars have focused on exploring the relationship between what teachers plan to teach, what they actually do in their classroom, and what students learn from that planning (e.g. Eichler, 2011). In this paper, we use Wenger's (1998) social theory of Communities of Practice (CoP) to explore the relationship between the practices of probability professors and how they decide to evaluate students' learning. Although there is no consensus among mathematics educators in relation to what the term practice means, as Da Ponte (2011) has emphasised, we consider Wenger's (1998) social theory of CoP a useful theoretical framework for studying that relationship (CoP has been recommended to study teacher's practices; see Gómez-Blancarte & Viramontes, 2014; Goos & Bennison, 2008). Specifically, drawing on Wenger's concepts of practice, reification and participation, we examine how two probability professors decided to evaluate students' understanding of the concept of probability. Thus, the objective of this paper is to show how a social theory (see Lerman 2001) may shed light on our understanding of the practices of probability teachers. The following section explains, briefly, the concept of practice and those of participation and reification as they apply to this study.

PRACTICE IN THE THEORY OF COMMUNITIES OF PRACTICE

The concepts of community and practice play an essential role in CoP, though they cannot be defined independently; that is, they intertwine such that the concept of community of practice must be understood as the essential element in CoP. In this sense, Wenger (1998) claims that practice always occurs in a community; "practice is the source of coherence of a community" (p. 72), and describes three dimensions in which practice and community are interrelated; namely, mutual engagement, joint enterprise, and a shared repertoire.

Mutual engagement exists when people (e.g. professors) are involved in actions (e.g. teaching) that require establishing meanings (e.g. what to learn, and how to enhance learning) that must be

negotiated. Since practice does not exist in isolation, or without reference to specific actions, mutual engagement gives coherence to a community. A joint enterprise is defined as people's negotiated response to specific circumstances. According to Wenger (1998): "[d]efining a joint enterprise is a process, not a static agreement" (p. 82). For example, when probability professors discuss what teaching strategies are appropriate for improving students' learning during a faculty meeting, they are engaged in the joint enterprise of making learning accessible to students. A shared repertoire, meanwhile, consists of "routines, words, tools, ways of doing things, stories, gestures, symbols, genres, actions, or concepts that the community [of practice] has produced or adopted in the course of its existence, and which have become part of its practice" (Wenger, 1998, p. 83). In the context of this study, an example of a shared repertoire is the concept of how to assess students' learning.

Participation and reification: the duality of meaning

The concepts of participation and reification are also interrelated. The former "refers to a process of taking part and also to the relations with others that reflect this process" (Wenger, 1998, p. 55), while the latter refers "to the process of giving form to our experience by producing objects that congeal this experience into 'thingness'" (p. 58). We may say that, on the one hand, reification makes participation palpable; on the other, participation makes reification interpretable. The interplay between these two processes is what Wenger calls *the duality of meaning*. An example of this duality can be seen when probability professors implement (participation) the teaching strategy they previously agreed upon at the faculty meeting (reification). Hence, in order for the professors to make their teaching practice meaningful, they must reify their agreements.

STUDY PARTICIPANTS AND DATA COLLECTION

Two probability professors participated in this study: P1 and the second author of this paper, P2. Both have taught for 10 years. At the time of the study they were teaching a Probability and Statistics course to undergraduate business students (20-21 years old). P2 had taught this course three years earlier (at that time her colleague was another professor: P3). P1, on the contrary, had not taught it before. In order to create a community of practice, P2 encouraged P1 to attend regular faculty meetings where they could discuss all matters related to their teaching.

Data for the study were gathered at those faculty meetings. P1 did not permit the meetings to be recorded, but did allow P2 to share all information regarding what was discussed, including documents, personal notes and verbal agreements. The key documents analysed in this study were two assessment worksheets elaborated in the context of the organization of two festivals. Let us briefly explain P1 and P2's agreement during their first faculty meeting, the main characteristics of the two documents, and the contexts in which they were elaborated.

First faculty meeting: P2's previous experience

At the first faculty meeting, P2 proposed organizing a Probability Festival to assess students' understanding of the concept of probability and to encourage them to apply probability to real problems. She told P1 that three years earlier, when she taught the same course, she and P3 had organized such a Festival (PF-1) to evaluate the same concept. PF-1 was organized by P2 and P3 as follows: they divided their classes into groups of 4 to 5 students. Each group had to invent a game of chance involving risk and present it during PF-1. The festival was open to the entire school community. P2 and P3 elaborated an assessment worksheet that a specialized committee used to

evaluate the performance of the groups. After P2 explained the characteristics of PF-1 to P1, they agreed to organize a second Probability Festival (PF-2). P1 asked P2 to give him the PF-1 assessment worksheet so that he could become familiar with the assessment criteria.

Characteristics of the PFs' assessment worksheets

The PF-1 assessment worksheet consisted of three segments: 1) personal information; 2) the setting of the game (maximum value: 80 points); and, 3) the Presentation (maximum value: 20 points). The PF-2 worksheet had the same segments but assigned different maximum values to segments 2 and 3 (70 and 30 points, respectively). For purposes of this paper, we show only the Presentation segment of each worksheet (Table 1). The main difference between them is that the latter includes a description of the "Maximum profit in the game" (*i.e.*, the *money item*).

PF-1		PF-2	
Value (points)	Description		Value (points)
10	Group organization: dress, punctuality and organization of the presentation		15
10	The explanation [of the game] is clear	The explanation [of the game] is clear and a lunch was offered to the specialized committee	10
		Maximum profit [obtained] in the game	5

Table 1: Description of the Presentation segment of the PF-1 and PF-2 assessment worksheets.

DATA ANALYSIS

P1 and P2's processes of participation and reification during their first faculty meeting can be explained in terms of their mutual engagement and the repertoire they created. On the one hand, by sharing her previous experience P2 created a mutual engagement: she showed P1 what her participation in PF-1 had been and what she knew about that event. Then she had to negotiate the meaning of organizing another PF. With regard to P1's participation, he needed to construct the meaning of a PF in the context of his first experience in teaching the Probability and Statistics course. On the other hand, by accepting P2's proposal P1 created a joint enterprise that consisted in making the PF-2 possible and visible to students.

The duality of meaning is observable in the way that P1 and P2 modified the PF-1 assessment worksheet to create the version used at PF-2. The modifications P1 proposed to P2 –*i.e.*, incorporating the need to evaluate whether the groups brought lunch for the committee, and the money item– were based on his way of representing students' learning. Although thinking about offering lunch may not be related to the understanding of the concepts of probability, P1 might have perceived an opportunity to evaluate something distinct from learning; namely, that *business students should be courteous*. Regarding inclusion of the money item, P1 believed that in the context of games of chance involving risk, the more money students make, the better their understanding of the concept of probability. In summary, P1's participation in the new PF design

captured his experience of conceiving the use of the concept of probability in real life. This experience was reified in the two descriptions incorporated in the Presentation segment of the PF-2 assessment worksheet.

CONCLUSION AND FINAL REMARKS

In this study, we examined how two probability professors decided to assess students' understanding of the concept of probability by taking into account their own experience. Using CoP, we showed how this decision was rooted in the process through which P1 and P2 experienced teaching the same course. They found a commonality in discussing similar topics to determine the best way to evaluate the concept of probability. Since the PF-2 was part of P1 and P2's strategic evaluation of the concept of probability, we can assert that P1 and P2's practice played an important role in developing that strategy. In a sense, the professors "congealed" their experience into the PF-2 assessment worksheet. We believe that this analysis: 1) may help understand how professors' decisions may affect the teaching and learning of the concepts of probability (for example, before the PF-2 took place, both professors focused on the importance of teaching combinatorial analysis as a tool for calculating probabilities in the context of games involving risk); 2) allows us to perceive the existence of decisions that are not always relevant to the learning of probability (e.g. the decision to provide a lunch). We assume that further analysis is needed to understand how (and what) probability professors learn from their participation in faculty meetings.

References

Beswick, K. (2012). Teachers' beliefs about school mathematics and mathematicians' mathematics and their relationship to practice. *Educational Studies in Mathematics, 79*, 127-147.

Da Ponte, J. P. (2011). Teachers' knowledge, practice, and identity: essential aspects of teachers' learning. *Journal of Mathematics Teacher Education, 14*, 413-417.

Eichler, A. (2011). Statistics teachers and classroom practices. In C. Batanero, G. Burril, & C. Reading (Eds.). *Teaching statistics in school mathematics: Challenges for teaching and teacher education* (pp. 175-186). New York: Springer.

Ernest, P. (1989). The impact of beliefs on the teaching of Mathematics. In Paul Ernest (Ed.), *Mathematics teaching: The state of the art* (pp. 249-254). London, England: Falmer Press.

Gómez-Blancarte, A. L. & Viramontes, I. (2014). Communities of practice: A theoretical framework to design for teachers' statistical learning. In K. Makar, B. de Sousa & R. Gould (Eds.), *Sustainability in statistics education. Proceedings of the Ninth International Conference on Teaching Statistics*, Flagstaff, Arizona, USA. Retrieved from: http://icots.info/icots/9/proceedings/home.html

Goos, M. (2013). Sociocultural perspectives in research on and with mathematics teachers: a zone theory approach. *ZDM Mathematics Education*, *45*, 521-533.

Goos, M. & Bennison, A. (2008). Developing a communal identity as beginning teachers of mathematics: Emergence of an online community of practice. *Journal of Mathematics Teacher Education, 8*(1), 41-60.

Jaworski, B. (2006). Theory and practice in mathematics teaching development: critical inquiry as a mode of learning in teaching. *Journal of Mathematics Teacher Education, 9*(1), 187-211.

Lerman, S. (2001). A review of research perspectives on mathematics teacher education. In Lin F. & Cooney T. J. (Eds.), *Making sense of mathematics teacher education* (pp. 33–52). Dordrecht: Kluwer.

Wenger, E. (1998). *Communities of Practice: Learning, meaning, and identity*. USA: Cambridge University Press.