

## COMMUNITIES OF PRACTICE: A THEORETICAL FRAMEWORK TO DESIGN FOR TEACHERS' STATISTICAL LEARNING

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*Drawing from Communities of Practice theory (Wenger, 1998), in this paper we propose a design for statistical learning for teachers enrolled in professional development programs. This design has to do with activities based on participation and reification: two processes that define learning as a negotiation of meaning. According to this theory, design for learning is to establish conditions to create experiences of meaning. In teachers training, such experiences involve interconnections between training practices and teaching practices (e. g., planning, teaching and analyzing classroom lessons). Taking into account the necessity to improve statistics teaching this article gives some elements to support teachers' statistical learning.*

### INTRODUCTION

In some countries there is a consensus on the statistics curriculum in regard to the current recommendations of developing statistical reasoning and thinking and not just statistical knowledge in students (Batanero, Burrill & Reading, 2011). In order for statistics teachers to understand and convey those recommendations teachers' training is inevitable. Due to "[m]any practicing teachers, for different reasons, have not learned some of the content they are now required to teach, or they have not learned it in ways that enable them to teach what is now required" (Adler, Ball, Krainer, Lin & Novotna, 2005, p. 361), in-service statistics teachers need continuing professional development in order to adjust their methods to suit the needs of statistics curriculum.

Even though professional development programs are different from each other in regard with their context, methodology, pedagogical approaches and the content knowledge, what they have in common is to enhance teachers' learning. Thus, we consider that a social theory of learning can be used as a criterion for the design of teacher professional development. As Wenger (1998) claims, in design for learning "it is our *conception* of learning that needs urgent attention" (p. 9). A social conception of learning is assumed because teaching is strongly influenced by different social phenomenon such as the interaction between educators and teachers. On the one hand, educators define the competence necessary for teachers to teach a certain topics; on the other hand, teachers' participation is necessary to produce and adopt those topics.

Based on the social theory of learning developed by Wenger (1998), we propose a design for teachers' statistical learning. In this theory learning is a process of social participation in *communities of practices*; it is the result of a process of *negotiation of meanings*. Negotiation of meanings refers to both an open process and recovery process, "with the constant potential for continuing, rediscovering, or reproducing the old in the new" (Wenger, 1998, p. 96). Thus, according to Wenger's theory, learning is a matter of negotiation of meanings that involves the interaction of two constituent processes: *participation and reification*. In a design for teachers' learning these processes deal with two relevant aspects: 1) what teachers will learn; 2) how they will learn it. The first aspect consists of the institutional designs around which learning is organized (reification); the second one is to make teachers engage in practices related to what they will learn (participation). In this paper we describe the ways in which participation and reification create opportunities for teachers to negotiate meanings about statistics in the context of professional development programs.

### DIMENSIONS OF DESIGN FOR LEARNING: PARTICIPATION AND REIFICATION

#### *Participation*

Participation "refers to a process of taking part and also to the relations with others that reflect this process. It suggests both action and connection" (Wenger, 1998, p. 55). It is both

individual and social. In the context of a professional development program teachers and educators embody the process of participation. Both teachers and educators constitute a community of practice defined by their relations of mutual engagement, which “draws on what we do and what we know, as well as on [...] the contributions and knowledge of others” (Wenger, 1998, p. 76).

To enhance teachers’ participation we have to engage teachers in activities related with their teaching practice in order to make decisions that influence their teaching community. Therefore, we need to establish connections between both communities (the program community and teaching community) to maximize the impact of teachers’ education on teaching practice. We use Lessons Study Group (LSG) as scenery to make these connections. LSG is a promising method for teachers to use their teaching practice and improve their professional knowledge. Lessons study refers to the process of instructional improvement of which the research lesson is the core piece (Lewis, 2000). This method is gaining increasing interest in statistics education research (Garfield & Ben-Zvi, 2008; Sánchez & Blancarte, 2010; Leavy, 2010). LSG is a popular place to see new subjects or approaches in action, and the involvement of teachers in LSG impels them to participate in actions, discussions and reflections to build common meanings about new approaches for teaching statistics.

The LSG involves four types of practice in which the teachers have specific forms of participation: 1) planning the lesson, 2) teaching the lesson, 3) analyzing the teaching and 4) revising the ongoing lesson. We describe each of them and also propose a set of four analytic skills suggested by Hiebert et al., (2007) that will serve as a reference point around which to organize each practice: a) *specifying learning goals*, b) *conduct empirical observations of teaching and learning*, c) *construct hypotheses about the effects of teaching on students’ learning*, and d) *use analysis to propose improvements in teaching*. The central construct of these analytic skills is for teachers to learn how to analyze teaching in terms of students’ learning.

1. *Planning the lesson*. In the context of the professional program teachers and educators jointly plan a lesson on a statistics topic (e. g. graphs), a fundamental statistical idea (e. g. data, variation) or a project work (e. g. an investigation). In the process of planning the lesson teachers and educators interchange ideas and information to convert the subject matter into learning goals and teaching tasks. Specifying learning goals is the first skill necessary for teachers to learn from their practice. By defining specific and explicit goals the teacher concentrates attention on what is to be taught and it is possible to investigate whether and how instruction facilitated or inhibited students’ achievement of the goals (Hiebert et al., 2007). A tangible result of planning lesson might be the design of a document (e. g. worksheet) that will serve for teachers to organize their teaching in the classroom context.

2. *Teaching the lesson*. Each teacher teaches the planned lesson while one person takes evidence of the teaching. Classroom video offers a tool for fostering productive discussions about teaching and learning; it captures the richness and complexity of classrooms and serves as a context for professional development programs (Borko et al., 2008). The main idea of this second practice is to develop the second analytic skill: conduct empirical observations of teaching and learning. Evidence can be collected about whether, and to what extent, each student is achieving (or not) the goals planned in the first practice.

3. *Analyzing the teaching*. Teachers and educators watch and discuss excerpts of videotapes from teachers’ teaching. Each teacher selects a short excerpt of the video to show the group. The excerpts of videotapes constitute a unit of analysis around which teachers can discuss and reflect on instructional events that appeared to facilitate or inhibit the intended learning. In this practice teacher should develop the third analytic skill: construct hypotheses about the effects of teaching on students’ learning. The subject matter provided in the first practice should be the lenses through which teachers are able to discuss and reflect on the instructional episodes.

4. *Revising the ongoing lesson*. Based on experience and evidence, teachers and educators improve the lesson and each practice is repeated. Here, the last analytic skill is to use analysis to propose improvements in teaching. Making revisions to improve the lesson is then a matter of following the hypotheses constructed.

In Wenger’s terms, the four practices described above imply forms of participation that encourage teachers to carry out joint tasks, take initiative and apply their experience, take responsibility for their actions, design instruments to connect their teaching practice and to explore

new ways of knowing and teaching. However, those forms of participation require reification in order to produce the negotiation of meanings. In the next section we describe the concept of reification.

### *Reification*

Reification refers to “the process of giving form to our experience by producing objects that congeal this experience into ‘thingness’” (Wenger, 1998, p.58). The term, reification, can refer both to a process and to its product. It covers a wide range of processes that include making, designing, representing, encoding, and describing, as well as perceiving, interpreting, using, reusing, decoding, and recasting. Reification can take a variety of forms including abstractions, tools, symbols, stories, terms, instruments, procedure and concepts. These forms then become a focus for the negotiation of meaning, as people use them.

The institutional curriculum -often prescribed by national governments-, textbooks, theories, models, and frameworks are examples of reification. They are the codification of knowledge into reified subject matter. They were designed for others, and then they are used to guide learning. In doing so, the original meanings of the authors should be transformed. As Wenger (1998) explains: “forms can take a life of their own, beyond their context of origin. They gain a degree of autonomy from the occasion and purposes of their production” (p. 62). We can see an example of reification of the institutional curriculum in Eichler’s paper. The author details a process of transformation of the written curriculum that involves interpretations and interactions of teachers and students’ learning. He states that teachers differ considerably concerning the objectives linked with the curriculum content (Eichler, 2011). Thus, institutional designs - including curriculum, textbooks, models, and frameworks on statistics education- could assist educators to guide teachers’ statistical learning in a professional development program.

Burrill and Biehler (2011) consider four approaches on statistics education, which represent diverse ways of thinking about teaching statistics: 1) a framework for statistical thinking, 2) the GAISE framework, 3) a framework for statistical literacy, and 4) the stochastic framework. Based on these frameworks the authors identify statistical ideas that seem to be fundamental for understanding and being able to use statistics in the workplace, in personal lives, and as citizens: *data, variation, distribution, representation, association and modeling relations between two variables, probability models for data and sampling and inference*. Both the four approaches and the fundamental statistical ideas are educational reifications. This kind of educational reification is used for teachers to know and convey in their instruction. In doing so, teachers produce meanings that extend, modify or confirm the meanings the statistical community has given them. For instance, Sánchez and Blancarte (2010) report the difficulties of teachers to understand and convey in their instruction the Problem (first element of the PPDAC cycle: Problem, Plan, Data, Analysis, Conclusion). Teachers conceived it as a pretext for students to collect data and focus on routine exercises rather than on exploring and understanding data to solve the Problem. In this sense, teachers modified the meaning of the Problem. During the teachers’ training, the meaning of the Problem was confirmed as teachers used it to make an investigation and apply statistics to solve the Problem. They also extended the meaning of the Problem when they produced local interpretations -meanings produced by teachers that determine their engagement and contribution to the original meaning of the Problem to be applicable to the class context- to adopt it: *the Problem should be interesting for students and applicable to class time* (Gómez, 2011). These local interpretations fall outside the understanding of the Problem in the context of statisticians’ practice to which it belongs.

### *The Complementarity of Participation and Reification*

The duality of participation and reification “provides a framework to analyze the various ways in which they are always both at once” (Wenger, 1998, p. 68). What is relevant in a design for learning is to balance participation and reification. The LSG provides activities where participation and reification can be combined in the appropriate proportion. On the one hand, institutional designs become the instrument around which the educator guides teachers’ learning. Institutional designs are institutional reifications in the service of learning and teaching practices; they create conditions for new meanings. On the other hand, in order for teachers to negotiate those

meanings and to create conditions for learning in classroom contexts, their participation should include meaningful activities such as planning, teaching and analyzing classroom lessons. These kinds of activities provide an application of what teachers have learned in training sessions because they move from training practice to teaching practice. The instructional material (such as lessons) produced in planning sessions, the teaching of lesson and the excerpts of videotapes from teachers' teaching support that moving.

#### FINAL REMARKS

In order to share a common understanding of teachers' statistical learning, our conception of learning needs to be firmly established. We have described two elements required for teachers' learning as a negotiation of meanings: participation and reification. These two processes help to decide what to do to both enhance and understand teachers' learning. Research in statistics education provides us educational reifications (e. g. statistical approaches and ideas) to guide statistics teachers' learning. However, in order for teachers to give meanings to these educational reifications, we should integrate such reifications with forms of participation to be part of the practice of teaching. Future investigations are needed to analyze how teachers' participations are connected with those educational reifications. We also need to better understand in which sense the negotiation of meanings, as a result of that connection, produces new kinds of understanding to the purpose of teaching and how it changes teachers' experience of teaching statistics.

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