THE POTENTIAL OF A GROUNDED THEORY APPROACH TO STUDY TEACHING PROBABILITY

Andreas Eckert
Linnaeus University, Sweden
Andreas.eckert@lnu.se

An important part of teaching probability is teachers interacting with students about probability. Most of these interactions do not occur anywhere else but inside the classroom so that is where we should research teacher knowledge for future development of teacher training and professional development. To accomplish this I propose a research methodology founded on the theoretical assumptions of symbolic interactionism combined with a grounded theory approach. The purpose of this paper is to outline such a research methodology that focuses on teaching as classroom interaction between teachers and students. The discussion aims to emphasize the possibilities by this way of studying teachers' knowledge for teaching probability and refine the methodological construct. Examples used are from lessons where two teachers work with unknown sample spaces and interact with students regarding chance, variation and the importance of sampling.

To research mathematics teachers and teaching with the purpose of enhancing students' learning is not a new phenomenon. One approach has been to study teachers' knowledge as a predictor of students' achievements. Well into the eighties, the prominent view was that teachers needed advanced knowledge of mathematics in order to improve their practice and students results. In the specific case of probability, Shaughnessy (1992) suggests that teachers avoid teaching probability because of their lack of subject knowledge. Kvatinsky and Even (2002) adressed this by developing a theoretical framework of what "adequate" teacher subject knowledge in probablitity might be in order to further study teacher knowledge specific to probability. Even though there is little known of the specifics of teacher subject knowledge in probability in this matter, studies in non-topic specific mathematics education have shown that the link between teachers' mathematical proficiencies and students' results is weak, at best (e.g. Monk, 1994; Mullens, Murnane, & Willett, 1996). Shulman (1987) proposed that researchers and teacher educators should extend their focus beyond teachers' knowledge of mathematics with pedagogical content knowledge, calling it the missing paradigm. The main view has since then been that the teachers' level of mathematical content knowledge is not enough to explain students' results and promote good practice.

Ball and her colleagues have continued developing the idea that teachers' mathematical content knowledge needs to be complimented by pedagogical content knowledge (e.g. Ball & Bass, 2000; Ball & Bass, 2003; Ball, Thames, & Phelps, 2008), referring to this joint set of knowledge as mathematical knowledge for teaching (MKT). Hill, Rowan, and Ball (2005) provided evidence in their survey that MKT is a strong teacher related predictor of students' achievements. By measuring mathematical knowledge for teaching, they did not only survey teachers' computational skills or amount of courses undertaken in mathematics. It shows that it is more fruitful to consider the combination of pedagogical and mathematical knowledge rather than mathematical knowledge by it self, that one should not separate content from method since this distorts teacher knowledge as Dewey (1964) argued.

I would like to take argument that we should not separate content from method one step further, that content and method should not be studied separate from practice because of the risk to distort teacher knowledge. The MKT framework postulates that teachers *use* knowledge while teaching, much like one might use a tool. The results might be different if we instead focus on the process of teaching as it occurs in interaction between teachers and students within a social setting. During these interactions teachers constantly interpret the context, students' intention and their own meaning assigned to the indicated object of focus in what Blumer (1986) calls symbolic interaction. Teachers' *use* of knowledge becomes an interpretative action with the complexity of a situated view of teaching and requires a research methodology that focus on process instead of charting steady state assets and deficits in teachers' repertoire.

In K. Makar, B. de Sousa, & R. Gould (Eds.), *Sustainability in statistics education. Proceedings of the Ninth International Conference on Teaching Statistics (ICOTS9, July, 2014), Flagstaff, Arizona, USA.* Voorburg, The Netherlands: International Statistical Institute. iase-web.org

OPERATIONALIZING THE METHODOLOGY

By reframing teachers' knowledge for teaching probability as subject knowledge being interpreted in the process of a social interaction, the idea is to construct theory of teachers' assigned meanings to probability theory in instruction using trials and empirical data. This aim presents three methodological challenges; what is *meaning*? what is *interaction?* and what does it mean to *construct* (grounded) *theory* within this context?

Mead (1934) identified two different forms of social interaction, now termed non-symbolic interaction and symbolic interaction. Non-symbolic interaction is when actors respond to actions and gestures (indication of action) without interpretation, a reflex is an example of a non-symbolic interaction. Symbolic interactions are the compliment, all social interactions that involve a response shaped by an interpretation of others' actions and gestures. In this work, the symbolic interactions are the ones in focus as they comprise all interactions in the classroom that are guided by teachers' assigned meanings and potentially could result in students assigning meaning.

According to Blumer (1986), people act towards objects directed by interpretations of their assigned meaning of that object. An object refers to anything that the mind can focus on and name, concrete or abstract. Meanings are personal constructs, though they are derived out of social interaction, which means that a person brings his or hers own set of assigned meanings into each social interaction. In the case of teachers' knowledge for teaching probability, the approaches to probability could for example be such objects essential for teachers (Even & Kvatinsky, 2010) and everything the teachers ascribe these objects (properties, behaviors, computational techniques etc.) are their personal assigned meanings.

Meaning is derived from, modified through, and handled in an interpretative process (Blumer, 1986). People assign meaning and modify their pre-existing ones by interpreting the actions of other actors. Students assign meaning to mathematical objects by interpreting the teacher's and classmates' actions towards these objects. These actors in their turn handle their own assigned meanings by constantly interpreting them during symbolic interaction. They interpret their own assigned meaning by engaging with the object in an internalized symbolic interaction with them selves, and where the outcomes become a guide for action. As in the situation of instruction, where a teacher acts toward a mathematical content by engaging in an explanatory example together with the class. The teacher first engages with the mathematical content in a self-interaction where meanings, perhaps assigned during the teacher education courses, are interpreted within the context of the classroom. The teacher also interprets the other actors (students) in the interaction by taking the role of the other. This role-taking involves an interpretation of how the others might interpret the interaction. The result of the self-interaction and the role-taking then determines how the teacher acts towards this object during the course of the explanatory example.

When constructing grounded theory, one studies the processes of the social world (Charmaz, 2006). In the emerging methodology, that means focusing on and studying teachers' symbolic interactions occurring in the classroom. While comparing different interactions one strives to let the "why?" emerge by addressing the "what?" and the "how?" (Charmaz, 2008b). It is not only the assigned meanings (the what), but also the interpretations themselves that become an important part of what it means to teach (the how). By constructing theory of what meanings teachers assign to key concepts of probability theory and how they interpret this knowledge in the process of teaching there are grounds for taking the theory further than a descriptive framework. The goal is a grounded theory with explanatory properties, a construct of categories and how they relate to each other that can be used to analyze lessons concerning experiment based probability (the why).

Both symbolic interactionism and constructivist grounded theory rely on the principles of open (interpretative) inquiry (Blumer, 1986; Charmaz, 2006). As the research process proceeds, there is an emphasis on interacting with the data and remaining open towards the twists and turns of the analysis. This openness could be both a blessing and a curse, it gives the opportunity to experiment with any idea and keeps the researcher close to the data but it also leaves the researcher very vulnerable in the beginning of the process as it gives little guidance. Symbolic interactionism offers a solution by bringing sensitizing concepts into open inquiry (Charmaz, 2008a). It offers places to begin exploring the data by allowing previous research act as a guide in the beginning of

the analysis without constricting it. By engaging our ideas as well as the empirical world we actively interact in the theorizing practice.

THE METHODOLOGY IN ACTION

The following examples are from the second lesson in a lesson sequence with 4th-graders, and this lesson sequence is their first encounter with probability in the school context. Lesson one revolved around an opaque bottle with an unknown amount of colored balls inside. As the bottle is turned over, one colored ball becomes visible. Based on the questions raised about chance and being able to influence the outcome of the experiment, the second lesson revolves around a see-through bottle. There were a lot of questions during the first lesson about what governs the outcome, and one dominant belief was that something was off with the bottle that influenced the results. The students worked in groups, generating two samples with 25 observations in each and answered questions from a worksheet. The questions were design to challenge students' ideas of chance by focusing them on specific events like the longest series of the same outcome and provide fuel to whole class discussions. The two short transcripts are from whole class discussions during this lesson where the teacher interacts with the class about the concept of chance. I would like to center the attention on chance as the object the teacher and students act upon, notice how the teacher interpreted the meaning of chance differently in the two situations.

- Teacher: When I do like this (turns the bottle over), all balls have the same…
- Student: Space?
- Teacher: Space, or probability to fall down.

- Teacher: We know that in this experiment, the outcomes are white, blue or red, but we do not know in which order they will appear. Because that is ch…?
- Class: Chance!

In the first situation, the discussion is still focusing on the ideas from the previous lesson where the students believed that there could have been some kind of mechanism that affected the outcome. The teacher refutes this idea by showing the see-through bottle and presents the condition of fairness as a quality of chance. Another view of chance is put forward later in the same lesson. In the second situation, the teacher acts towards chance as something outcome oriented and unpredictable. These two interpretations of chance, being a prerequisite condition or an outcome oriented unpredictability factor, become analyzable through constant comparison of the teacher's symbolic interactions. By comparing more interactions revolving the same object and actively look for more data through theoretical sampling we can start building an interpretative understanding of teachers' knowledge of teaching probability with empirical data.

Both transcripts contain a situation where the teacher takes the role of the other, in this case a group of students, by interpreting how the students might interpret the object and their attached meanings. We can see that this role-taking is unsuccessful in the first case since the teacher is expecting a certain answer that she does not get and have to fill in herself. There could be several reasons why, her interpretation of the students' meanings attached to this object might be off or perhaps her actions are unclear so the students misinterprets her intentions. The role-taking in the second situation is more successful since the teacher gets the answer she wants. One possible explanation is that the students adjusted their assigned meanings during the lesson according to how the teacher has acted. Another possible explanation is that the teacher is more clear in what type of answer she is expecting and in her way of indicating what object is in focus, both in her way of acting now and with the actions throughout the lesson as background.

The richness of the data is an important factor whether to achieve satisfying trustworthiness through these comparisons or not. The distinction between different interpretations of chance in the transcripts above does not emerge without the background that helps the researcher to take the role of the other, in this case the teacher. As the methodology relies heavily on the researcher being able to interact with the data, rich data becomes a prerequisite both to ensure the depth of the analysis and the trustworthiness of the results.

SUMMARY

Teaching is viewed as an action, a symbolic interaction, taking place in the classroom. As teachers and students participate in this symbolic interaction they constantly interpret the world and the actors in it to assert meaning from the actions of others. To study teaching, one must step into that world of symbolic interaction and start interacting with it from an analytical researcher perspective. Rich data allows the researcher to take the role of teachers and students to start interpreting their worlds and actions.

The proposed way forward to construct theory concerning teaching experiment based probability is with the help of constant comparisons of teachers' symbolic interactions and the sensitizing concepts from earlier research on teacher knowledge. Analyzing and constructing theory of teachers' assigned meanings and the different ways they interpret those meanings ensures a depth of the theory. It opens up a way forward from being merely descriptions of what teachers know, into theory with explanatory properties of teaching experiment based probability.

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