"ALL OF A SUDDEN THEY GOT IT":
Understanding preservice teachers' perceptions of what it means to know (in) math

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ABSTRACT

In a recent study at the University of Regina, preservice teachers were asked questions about their internship experiences of teaching mathematics. One question in the study focused on asking preservice teachers to recall their most meaningful experiences in the mathematics classroom during their internship, to which many responded with stories of how their students all of a sudden just "got" a concept and how this could even be visually detected. It is interesting to note the comparisons between their responses to this question about meaningful experiences and their responses to other questions concerning their images of math as a subject, their attitudes toward math, and their perceptions of what it means to know (in) math.

Factors other than ability influence students' approaches to challenges, their persistence (or withdrawal) when facing difficulties, and how they use cognitive skills. This paper explores goal theory and achievement motivation as a perspective for examining the issue of what it means to know (in) math. The question of the role of the teacher in how students focus their efforts in mathematics classrooms, or in setting the classroom climate, is also of significance to this discussion.

This paper presents implications for the changing needs of teacher education programs, including the contexts of mathematics education courses as well as critical issues in curriculum development and implementation in general.

Introduction

This presentation emerges out of a study with post-internship preservice teachers in a Canadian university. In this study, we surveyed twenty-seven preservice teachers who had recently completed their fourth-month internship in elementary and secondary schools. Preservice teachers were asked questions about their past experiences as students learning mathematics, and about their internship experiences of teaching mathematics. This presentation will present and discuss some of the implications of the responses to this survey, revolving around the theme of "what it means to know (in) math."

Goal Theory

Factors other than ability influence students' approaches to challenges, their persistence (or withdrawal) when facing difficulties, and how they use cognitive skills (Dweck, 1986). Researchers have demonstrated that nonintellectual dispositions, such as achievement motivation, may improve the prediction of academic success beyond intellectual dispositions. General academic success may rely "more heavily on the ability to adapt to new learning situations and to apply intellectual assets than on the level of academic aptitude alone" (Larose, Robertson, Roy, & Legault, 1998, p. 290).

Achievement motivation involves two classes of goals. Learning goals seem to reflect intrinsic motivation as individuals seek to increase their competence, to understand or master something new (Dweck, 1986). Competence is viewed as developing through effort (Anderman and Maehr, 1994). Students with learning goals tend to seek challenges, pursue task mastery, and persist despite difficulties and obstacles (Dweck, 1986). Performance goals, on the other hand, reflect extrinsic motivation as individuals seek to gain favorable judgments of their competence or avoid negative judgments of their competence (Dweck, 1986). Errors are viewed as evidence of lack of ability or worth (Anderman and Maehr, 1994). Therefore, students with performance goals may avoid challenges and withdraw when faced with difficulty (Dweck, 1986).

Meaningful Experiences in Mathematics

In our study, several survey responses drew our attention to a concern that many mathematics teachers and learners are emphasizing performance, rather than learning, goals. When asked about their most meaningful experiences during internship, several preservice teachers used terminology such as "get it" to describe their students' experiences of learning mathematics. For example, one respondent described her most meaningful experiences as "when my grade two's finally caught on to the concept of 'time'—it was like I turned on a light switch [and] they all of a sudden just 'got it'." This begs the question of how a teacher actually knows when her/his students reach the point of "getting it" in their learning. Perhaps even more importantly, the critical question is what exactly are they getting.

For the purposes of this paper, our interpretation of "getting it" closely relates to what we feel preservice teachers mean by understanding. With this in mind, it becomes critical to look at the connections between the visual detection of "getting it" and what it means to know or understand in mathematics.

> Understanding is not properly attributed to the recitation of steps in a proof, no matter how perfectly the steps unfold from premise to conclusion, but to the "seeing" that occurs when

> the products of reason are re-examined—looked at—by intuition for the purpose of discerning or creating meaning. (Noddings & Shore, 1984, p. 53)

The metaphorical use of a light switch being turned on is common for the portrayal of what is perceived as moments when a person reaches sudden understanding. Barnes (2000) describes such times as "magical moments" and adds as a point of clarification that "such occasions may best be described as illumination or insight rather than intuition" (p. 34). One characteristic of a magical moment is described as follows:

> There is a claim to sudden realisation of new knowledge or understanding. Usually this new knowledge is 'seen' with great clarity, or experienced with a high degree of confidence or certainty. (Barnes, 2000, p. 34)

Such an 'aha' or feeling of 'getting it' is believed to be a strong motivating force in a learner's continued participation and persistence in mathematics. These insightful and exciting feelings are important to the learner. As Burton (1999) states: "Far from understanding being something which is *only* driven by knowledge, there is both a *need* to know and an associated *pleasure* in knowing which is its own reward" (p. 29). Our claim, however, is that even though there can be a great deal of satisfaction and excitement in this insightful and pleasurable moment, it may be connected more to the performance of mathematics than to understanding. For example, in a recent secondary mathematics methods class, preservice teachers explored methods for solving quadratic equations. They were quite intrigued by a method that one of their classmates introduced for the process of completing the square; it was virtually a short cut that gave rise to a series of 'aha' responses. When the instructor (i.e., one of the authors of this paper) questioned the preservice teachers about their enthusiasm for understanding this new approach, it was apparent that their motivation merely stemmed from a desire to approach procedural understanding from a different perspective. When prompted for communication about their relational understanding between the algebraic representation and the concrete geometric representation of what it means to *complete a square* and solve quadratic equations in general, the students were not the least bit motivated to explore it further. Their own school experiences of learning and 'doing' mathematics focused primarily on the successful performance of mathematical questions and problem solving tasks. Insight into the how's and why's of such mathematical tasks had never really been a part of their 'illumination' or 'getting it' experiences. It is feared that such levels of understanding never *will* be a part of their teaching unless they experience, at some point in their careers, dissatisfaction with how and why they know mathematics.

In a recent study (Nolan, 2001), an elementary preservice teacher explained that she preferred learning math to learning science because she could see how the math pieces all fit together like a jigsaw puzzle, while her understanding of science did not feel quite so connected.

> Math is easy. It's a game. It's a puzzle. Math is yes or no… I know I'm going to get the right answer. Math to me seems like sort of a closed box (p. 102). I have success with math. When I uncover a piece in math I say, 'oh, that makes sense. That fits in with everything else I know.' (p. 184)

When questioned about the 'fitting in' relationships that she felt she understood, it was apparent that the pieces were predominantly understood as a puzzle would be; that is, procedurally.

We have discussed our concern that the 'getting it' or 'aha' moments might signify nothing more than procedural clarification, which is possibly void of a *deeper* understanding of mathematical meaning and relationships. We also have another critical concern associated with these insightful moments in coming to know. We are concerned that students possess a belief that knowledge and understanding of mathematics travel in waves of these magical and insightful

moments. A belief that such an emotional experience is a prerequisite to learning and knowing in mathematics has a profound impact on learners' attitudes and motivation. Barnes (2000) points out that "attitudes are more stable than an emotional experience, however intensely felt" (p. 39). While the 'aha' experience might foster greater motivation and persistence, the absence of such 'aha' experiences could, unfortunately, have an opposite (and detrimental) effect. Students faced with tasks in learning mathematics often embrace the view that you either get it or you don't; that you are either good at it or you are not, as if mathematical ability is innate. In addition to perpetuating an elitist attitude toward the knowing of mathematics, this view directly opposes the belief that a positive attitude and willingness to persist at a task will inevitably lead to greater success in the learning of mathematics. The emotional 'getting it' experience is mistakenly seen as a necessary precursor to learning, and that it will naturally occur if (and only if?) one has mathematical ability. This view, we believe, creates a dichotomous relationship between ability and persistence, as one becomes associated with strength and the other weakness.

In light of these critical concerns for what it means to know (in) mathematics and how learners experience the processes of coming to know, we are advocating the importance of critical epistemological reflection in teacher education programs. There is a need to reflect on learning experiences in order to acknowledge the problematic nature of knowing in mathematics, but not with an intention to focus on the preservice teachers' weaknesses in their knowing. If we acknowledge the problematic nature of knowing then it is more acceptable to critically question the differences between performing and learning mathematics. Davis, Sumara, and Kieren (1996) help illustrate the problematic nature of knowing and learning when they write:

> Learning should not be understood in terms of a sequence of actions, but in terms of an ongoing structural dance—a complex choreography—of events, which, even in retrospect, cannot be fully disentangled and understood, let alone reproduced. (p. 153)

It is critical that these moments of insight not be unquestionably accepted as indicators of a deeper, more relational understanding in learning when they may indicate only a deeper (or more expansive) understanding of procedures. While the feeling of 'getting it' is beneficial as a motivating episode, one must be critical of exactly *how* it is motivating and toward *what* end.

This discussion brings us to the issue of how we can encourage and develop reflective practices in teacher education—reflective practices on the parts of preservice teachers *and* teacher educators.

Reflective Teaching Practices

Many students (particularly women) do not view themselves as participants in the construction of math knowledge but instead see the teacher as an agent who delivers factual information, rules, and formulas which must be memorized (Seaman, Nolan, & Corbin Dwyer, 2001). The teacher plays a major role in creating "situational demands" which influence students' goal development. This may be the primary reason to promote reflexive teaching practices.

Internships may be considered a form of a mentoring program since preservice teachers complete a school practicum under the supervision of a more experienced teacher. When experienced teachers mentor beginning teachers, both report increased reflection on their teaching styles (Flockhart & Woloshyn, 2002). In order to be effective, both parties "must assume *active* [emphasis added] roles in seeking mentoring relationships that will satisfy, sustain, and fulfill them" (p. 51). Some preservice teachers, however, do not make connections between their internship and university courses (Dyson, 2000). As Meyer and Tusin (1999) remind us "teacher

educators must help preservice teachers make explicit links among their course work, field experiences, and their pedagogical beliefs" (p. 136).

Beattie (2002) offers a "Holistic and Narrative Pedagogy" in which "practices are focused on enabling prospective teachers to find their voices in relation to the theory and practice of teaching, to use them to articulate their questions and concerns, and take ownership and responsibility for their own learning" (p. 20). Through these practices, preservice teachers would come to new understandings about themselves, their students, their classrooms, their schools, and their communities. The preservice teachers in our study emphasized performance goals in their experience of students' ability to 'get it' despite being taught about learning goals in their education programs. This suggests that links among their course work, field experiences, and their pedagogical beliefs are not being made.

How do teacher educators help preservice teachers make these links? How do students, and teacher and students, relate to one another and what are the 'rules' for these interactions? What are people *really* saying to one another beneath the surface? For example, in spite of advocating a constructivist approach to teaching and learning, are errors (or, false starts) still being viewed as evidence of lack of ability? Are students still seeking, and teachers providing, external reinforcement of competence, particularly those who 'get it'? Teacher educator reflective practice is an essential starting point in making links between theory and practice explicit.

How do teacher educators engage in the process of reflective practice? Beattie (2002) has written about the important role of students' writing, and feedback from teachers, in achieving this. More recently, in a "self-study," she has explored her own writing and inquiry, and uses the feedback she receives from students as a source of her own insights and understandings (2002). Portfolios are another external artifact in which preservice teachers and teacher educators can engage to create new ideas and meanings (Corbin Dwyer & patterson, 2001). They help educators define good practice, stimulate reflection on their own teaching and learning, and acknowledge and refine their own teaching and learning practice (Lyons, 1999). "Portfolios offer particular opportunities for preservice teachers and their instructors to construct meaning about teaching and learning as well as to reflect on learning to teach" (Corbin Dwyer & patterson, 2001, p. 18). While the use of portfolios in teaching is not new, they can be used as simultaneous inter-collegial and self-initiated evaluation (Egbo, 2001).

Schön (1987) described "reflection-in-action" as "the kind of artistry that good teachers" (p. 1) display everyday. Reflection does not have to take only the form of words. Messages are sent from teacher educator to preservice teacher, from supervising teacher to preservice teacher, and from teacher to student "in doing, in performance…The student's performance, for example [says] 'This is what I make of what you have said. This thing that I'm doing now is what I make of what you have said.'" (p. 8). From our study, it appears that the preservice teachers' performance is speaking louder than their words. Many talk the language of learning goals in their description of what it means to know (in) math but their own approach to solving math problems, and to teaching math, indicate an emphasis on performance goals.

Implications for Teacher Educators

Schön (1987) examined what it means to "heal the splits between teaching and doing" (p. 13). We, too, are concerned about healing the splits—between theory and practice, between what preservice teachers say about what it means to know (in) math and what it means to teach math, between learning goals and performance goals. After all is said and done, however, are we, as

teacher educators, expecting preservice teachers, our students, to 'get it'—to 'get' that knowing (in) mathematics is not only a matter of magical moments but is also a matter of effort and persistence?

"The act of reflecting on the value of learning activities is another fundamental part of the teacher's work…The question for reflection becomes not, 'How can I get better results?', but 'Improve what, for whom, and how?'" (Tite, 1986, p. 21). As teacher educators, questions for our own reflection include: How can we promote the use of reflexive teaching practices so that teachers do not embed learning goal language within performance goal teaching? If the reality of our students' experience in our current educational system, particularly in university, rewards high grades and uses comparative evaluation, are we being contradictory in our message of the importance of learning goals in the mathematics classroom? How can we, as teacher educators, help them to "walk the talk?"

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