Professional Learning Leading to Perspective and Practice Changes: An Integrated Model for Math Education Professional Development

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Abstract: *The purpose of the action research was to guide the teachers' practice and development and explore professional results of the approach. This paper presents and analyzes findings from the five teacher participants' interviews, their reflections, and their artifacts/assignments to reveal the scope and nature of the changes using transformative learning as a framework.*

Introduction and Overview

At a multi-disciplinary public university in metropolitan New York, several math education classes are taught the strategies of integrating math manipulatives, student talk-aloud, modeling, and mathematical concepts. This integrated, constructivist, and innovative approach has evolved over several years of formative development in order to achieve greater impact on teacher practice. The adult learning theory of transformative learning (Mezirow, 1990, 2000) was critical in providing a foundational framework for the research, analysis and interpretation. The specific research questions studied are: (1) Can a math education graduate course be designed which effectively incorporates elements of innovative, effective teaching strategies, action research and reflective practice while facilitating opportunities for teacher professionalization and potential transformation? (2) Is teacher understanding of student learning changed when they engage in action research study of innovative math education learning strategies? (3) If so, what changes do teachers experience as they engage in these experiences? (4) What additional characteristics become evident among the teacher educators? This research's significance is a new and effective model for the education of math educators which supports development of self-efficacy, professional leadership, and research, and professional learning perspectives.

Theoretical Framework

Integrated, Constructivist Approach for Foundational Algebra Thinking.

The math education courses studied used teacher-learner interactions with a specific integrated, constructivist approach to build foundational algebra thinking. This experiential and problem solving approach builds on the work of theorists such as Dewey (1938) and von Glanz (1991), as well as current math teaching models (Fosnot & Dolk, 2001). This instructional model also includes two other essential points (1) Teachers discover the math learning needs of students and (2) Students learn to articulate their math learning needs. There are several unique perspectives of students' math learning in this model, and the foundation builds upon 21st century learning and NCTM principles (2000). It dovetails with Lyublinskaya and Kerekes' (2009) approach to introduce problem solving, internalize number sense and facilitate the development of learners as agents of their learning. These math education elements inform and are transferable to ABE learning.

Teacher Professional Development as Transformative Learning Opportunities.

Research has revealed strategies for facilitating change of teacher practice and perspective (King, 2002, 2009; Kitchenham, 2006); this study extends these efforts to explore the impact of action

research projects to provide active learning and critical questioning. Consistent with the literature, this model of professional development describes how, in this setting, adults change their world views dramatically and reveals which specific approaches cultivated it: respect and incorporates extensive active learning, reflection, critical thinking, questioning, and dialogue (Brookfield, 1987, Cranton, 1994; Mezirow, 1990).

Action Research as Professional Practice.

Action research is the framing activity of the work with the participating educators; it entails posing research problems related to the professional context (Creswell, 2003; Hinchey, 2008). Addressing questions to specific contexts and findings assists in crafting better classes, instructional strategies, or assessments. These efforts integrate content and strategies; no longer, solely locked into isolation as theory, research and practice, teachers now experience, explore and question these critical elements in situ (Lave & Wenger, 1991).

Research Design

Mode of Inquiry and Data Sources.

The design of this research project is an important part of the inquiry and results. To demonstrate project design clearly, a diagram which illustrates the stages of action research and learning activities is provided and discussed. Included is the flow of instructional strategies used: (1) modeling of using manipulatives to pose real-life problem solving, (2) theory building, presentations and discussion, (3) lesson planning developing, feedback, editing, and dialogue, (4) small group and large group discussion, (5) class presentations, (6) class observations, (7) integration of instruction in class, and (8) journaling.

Research Method and Participants.

The research model for this study was a mixed-method action research project (Creswell, 2003), using qualitative analysis of the five teachers and their action research projects (which were mixed methods themselves). The context of the research is a multi-disciplinary public university in metropolitan New York, where several math education classes were taught the strategies of integrating math manipulatives, student talk-aloud, modeling, and math concepts. This integrated, and constructivist approach has evolved over several years of formative development in order to achieve greater impact on teacher practice. This study examines the experience of the professional educators in the integrative graduate seminar action research class. The mixed-methods approach was selected to incorporate all the data collected by the teachers in their individual projects and analyze the depth of the teachers' shared professional development experiences (Onwuegbuzie & Teddlie, 2003).

Data Analysis.

Based on the Sequential Mixed Methods Analysis (SMMA), the study used 6 of the 7 stages outlined by Onwuegbuzie and Teddlie (2003): data reduction, display, transformation, consolidation, comparison and integration. Data gathered from the teacher participants included journals, presentations, lesson plans, action research presentations, observations, and interviews. Teacher interviews were conducted, recorded and transcribed. Data analysis consists of tabulation, frequencies, and constant comparison for emergent themes pursued until theoretical saturation (Glaser & Strauss, 1967) with anticipation of possible grounded theory development (Glaser, 1992).

Findings

Extensive data displays were created to consolidate the variety and scope of critical data collected. Table 1 reveals the participant, class description, project description, findings, interview findings, and journal comments. Data displays led to developing figures which reveal aggregated data and individual trends by theme. The first product (Figure 1) is a macro level model that presents results across participants, and developing grounded theory (Glaser, 1992; Glaser, & Strauss, 1967). The three emergent themes which dominated the analysis were educators': 1) Changes in *Perspective,* 2) Changes in *Practice*, and 3) *Asking Questions* describing the predominate focus of these changes.

Table 1 Action Research Projects Summary Table- Five Teacher Candidates

	Lori	**Jose**	**Victoria**	**Janice**	**Lily**
Year of Project	**2008-2009**	**2008-2009**	**2008-2009**	**2009-2010**	**2009-2010**
Title of Project	Cooperative Team Teaching and Innovation	Cooperative Team Teaching (CTT) and Classroom Needs	Math Journal to Improve Learning	*The Creation of a Learning Framework For First Grade Mathematics*	Number Sense Development: Using Manipulatives, Think Aloud and Games
Research Questions	How does a Cooperative Team Teaching (CTT) environment impact the academic and social development of both the general education (GE) and the special education (SE) students in math setting?	How does a CTT environment impact the academic development of the general education student in math setting?	Did students benefit from using math journals and did their feelings change across the year? Did the teacher see benefits from math journal writing? What difference between 2007-2008 math state exam scores based on treatment? What barriers could have interfered with students' journal writing?	How do students determine what they already know? Are some naturally more gifted or have they acquired a learned knowledge base? Does brain-based educational instruction impact mathematical ability? Do manipulatives have a vital role in learning math?	What do young students do with math manipulatives? Can they develop greater number sense? What is their progression of use with manipulatives? What is their progression math learning?
Participants in Action Research	2 teachers Sixth grade CTT GE	25 students CTT 15 GE 11 SE	28 fifth grade students	Private school, k-8 gr 1st grade, 15 males, 14 females,	k-1st graders

Projects	SPE			5 teachers, questionnaire	
Method	Mixed methods (MM)	MM	MM	MM	MM

Figure 1 Experiences of Transformation among Teacher Candidates

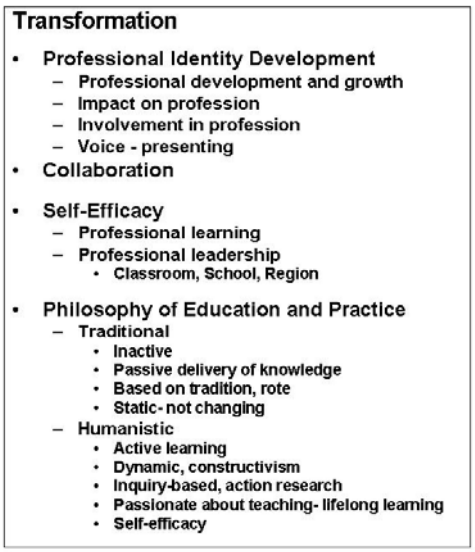


Figure 2 Teacher Questioning as Professional Learning

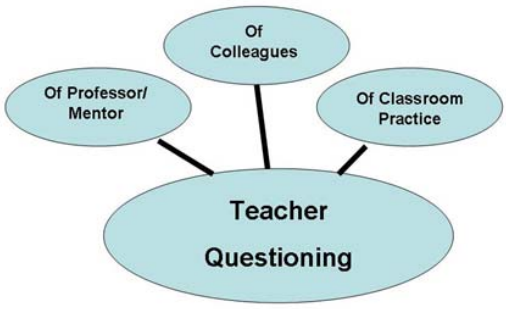
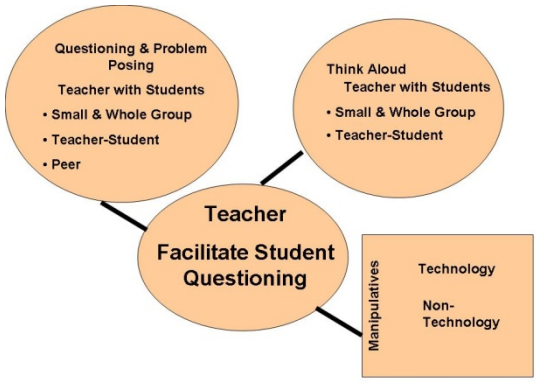


Figure 3 Teacher Candidate Questioning as Instruction



Analysis and Discussion

Changing Perspective and Practice.

The success of this professional development approach demonstrates the need to challenge teachers to rethink how they understand and teach math instruction (Fosnot, & Dolk, 2001; Glanz, 1998) and provides a robust foundation for their continued professional growth. Participating teachers develop a different personal experience with learning mathematics and about the teaching-learning process than they learned in traditional math education classes. This positive experience is especially

important because without a successful professional experience with these new teaching models, we have found that educators will return to their original ways of teaching when challenged (Lyublinskaya, & Kerekes, 2008) (See Figures 1, 2, and 3.)

Readiness for Change.

In this study, once educators engaged in action research in the instructional and theoretical areas where they have struggled, they developed a greater awareness, and readiness to change their perspective and practice. The teacher-researcher experience becomes a powerful turning point because it facilitates the development of a researcher standpoint, and internalizes the results of examining the validity and power of constructivist learning (Fosnot, & Dolk, 2001; Loucks-Horsley, et al., 1996).

Questioning.

Table 2 reveals the type of questions the teachers asked as they conducted teacher research and saw increased engagement, motivation and learning of students. This research reveals a theme of *Asking Questions* as pervasive across their professional development, classroom practice, and content knowledge. Instead of accepting knowledge as unquestioned fact, our participants moved to critical inquiry, questioning and self discovery (an advancement in professional expertise). Figures 2 and 3 illustrate details and patterns of participants' *Asking Questions* as professionals and teachers.

Table 2 Teacher Questioning

Domain	Specific Questions
Regarding Students	How they can better help students to change their thinking?
	How can students better internalize student numbers & number sense through the use of manipulatives?
	How do we continue to build ownership of student understanding of number relationships so they can generalize it?
Regarding Teaching Strategies	How can I better facilitate student's expression of their own thinking?
	How can I incorporate cooperative learning in math education?
	How can I incorporate journal learning in math education?
	How can I effectively use manipulatives to stretch and develop student mathematical and problem solving thinking?
	How can students better internalize student numbers & number sense through the use of manipulatives?
	Is there a better way than rote memorization?
	What is the role of technology?
Regarding Profession	How can I participate in my profession more?
	Am I capable of serving in professional leadership?
	How do I continue to learn and grow beyond graduate school?
	Why are not more teaching hungry for new learning?

Discovering Benefits- Professional Knowledge.

When participants used manipulatives with their learners, they discovered their questions about content learning and instruction could be answered. Moreover, their learners looked forward to math class because they were 1) involved in learning, 2) validated for their efforts, 3) free to discover new strategies for problem solving, 4) engaged in real-life problems, and 5) empowered through organic creation of math concepts. Many of these examples were connected to the real-life problem solving the learners modeled independently using the manipulatives. A figure revealing The Role of

Manipulatives reveals how the benefits differ based on the application to math learning will be presented in the session.

Diffusion of Innovation.

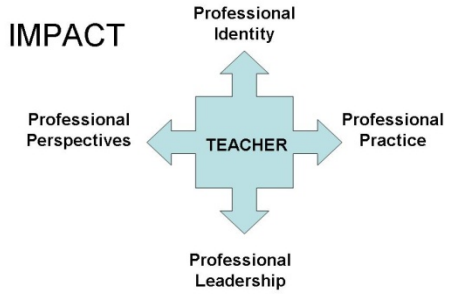
Professional leadership resulted from this PD approach diffusing. Educators in close proximity to the participants began to emulate the motivation and learning by borrowing research information, manipulatives, and strategies. The participants began leading school peer groups, all presented at a national conference and one became regional leader of her association. Rogers (2003) supports the finding that peer professional development (PD) and diffusion of innovative math instruction begins locally.

Specific examples of innovation for this content area (ABE, math learning and pre-algebra for young children) included: Students internalize a strong facility with "10's," "20's," and mathematical operations; students develop a personal problem solving strategy through the open number line to solve problems in the future; and, having accomplished this at a very young age, they have constructed their own algebraic thinking; this foundation is internalized and becomes the basis for understanding variables in algebra. Students also see number relationships through manipulations and problem solving rather than strange notation such as "x" and "y" and formalized rules (Fosnot, & Dolk, 2001).

Significance of the Study for Adult Education

This research reveals that coupling well-developed, integrated and constructivist active learning strategies with action research, reflective practice and peer dialogue can result in professional education formats and provide the basis for patterns of continuing professional learning, co-learning and instructional improvement. When such models and approaches are extended to adult education settings to immerse educators in using action research, new math learning approaches, manipulatives, and activities with their learners, we may expect results in achieving change in practice and perspective. The evidence is seen in prior studies which show the effectiveness of action research among adult education practitioners (Smith et al, 2002). There are also possibilities for community impact as the instructional impact of these methods spreads to other educators in their programs. (See Figure 4, IMPACT Model.) Peer validity is a powerful incentive for teachers to take risks. This study and presentation provides a framework and call for much needed research among adult educators of ABE Math instruction.

Figure 4: Model of Multi-Dimensional IMPACT of Professional Development Model



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