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Abstract

The US National Council of Teachers of Mathematics, in their Principles and Standards for School Mathematics publication, outlined six principles that reflect basic perspectives on which educators need to consider for reforming mathematics teaching/learning and classroom social interactions. These Principles establish a guideline for school mathematics programs by considering the broad issues of equity, curriculum, teaching, learning, assessment, and technology (NCTM, 2000). Affecting these six principles considerations is the teachers own belief system concerning how mathematics should be taught and how students can best learn its several and integrated concepts. The focus of this case study is to describe a secondary mathematics teacher's evolving beliefs and practices relative to these NCTM six Principles. Mathematics reform requires teachers who are willing to rethink their beliefs in light of the six Principles for school mathematics. They need to be willing and ready to change their traditional methods of teaching to align with strategies and processes that work for today's students. In addition, the paper discusses the implication for teacher education, curriculum change, and school transformation.

Keywords: Teacher’s Beliefs and Practices, Teacher Change, Curriculum Change, School Reform

Academic Discipline: Education

Subject Classification: Mathematics Education

Type (Method/Approach): Qualitative, Descriptive and Interpretive

Introduction

In 2000 the US National Council of Teachers of Mathematics published Principles and Standards for School Mathematics (NCTM, 2000). The Principles and Standards publication is the culminating effort adapting and expanding previous NCTM publications dating back to the beginnings of the standards based reform movement in the late 1980's. In this publication
the NCTM outlined six principles that reflect basic perspectives on which educators need to consider for reforming mathematics teaching/learning and classroom social interactions. These Principles establish a guideline for school mathematics programs by considering the broad issues of equity, curriculum, teaching, learning, assessment, and technology (NCTM, 2000). Teachers base their educational decision making on a variety of issues. This guidance from the NCTM, intended to focus on that process, is helpful. Affecting these six considerations is the teachers own belief system concerning how mathematics should be taught and how students can best learn its several and integrated concepts.

Much research has shown how teacher beliefs affect classroom practices but little has been done to illuminate how these beliefs impact these six Principles and what is needed to effect change in practices concerning these principles. In this paper we demonstrate that teachers need and would welcome professional development experiences, whether informal or formal, that utilizes discourse among peers as a means to grow professionally and to help teachers embrace newer and alternative forms of classroom pedagogy and assessment. In our survey of the relevant literature we found indication that in each of these six Principles teachers would benefit from professional development that focused on discussion of issues, peer feedback, and collaborative discourse. In our discussion with the participating high-school mathematics teacher we confirmed what this survey had shown us. Professional discussion in the big ideas surrounding these six Principles is necessary to both affect teacher beliefs about mathematics as well as to change the practice of teaching it.

The Equity Principle states that meaningful mathematics teaching necessitates high expectations and strong support for all students (NCTM, 2000). The Principle strongly conveys the need for every student, regardless of background or personal limitations, to receive the highest quality education possible. The Principle also recognizes the need for “well-supported” personnel (NCTM, 2000). Without this strong support teachers are unable to meet these expectations adequately. In fact, inadequate teacher preparation, lack of teacher interest in teaching mathematics, [and] lack of opportunities to share ideas are all listed as factors seriously affecting mathematics instruction (Banilow, Smith, Weiss, Malzahn, Campbell, & Weis, 2013). The ability to share and discuss the issues of equity and practice with professional colleagues is a needed component toward the goal of providing excellence to every student in the classroom.

The Curriculum Principle states that a coherent curriculum ought to focus on important mathematics in an articulated manner across the grades (NCTM, 2000). The Principle makes the case that mathematics is a cumulative subject, that is, it requires knowledge to be built upon knowledge. In order for this to be done in a school setting it is very important that curriculum be designed to ensure a steady construction of knowledge from basic concepts to advanced theorems. It becomes important then for teachers to have discussion with one another across grade levels and to have dialogue concerning reform based innovations in mathematics education to better ensure the deeper construction of mathematical knowledge in students.

The Teaching Principle emphasizes on the significance of starting from what students already know and providing them with opportunities to learn new concept (NCTM, 2000). The Principle goes on to encourage the formation of communities of teachers dedicated to discussing the issues involved in bringing the best teaching to their mathematics classrooms. McDonald (2010) discusses the impact of rigorous and reflective lesson planning and delivery in a school wide professional learning community on student outcomes and teacher belief and pedagogy. Both of these elements, building a professional culture and the encouraging of reflection among teachers, are necessary elements needed to reach the goal set forth by the Teaching Principle.

The Learning Principle asserts Students must learn mathematics with understanding (NCTM, 2000). In a discussion about the mismatch of beliefs that can occur between teacher and student, Sexton (2010) theorizes from his review of literature that there are two primary ways that students see their mathematics teachers: they see them either as facilitators of their learning or as mere transmitters of information. In the latter case students generally respond to their teachers with ‘passivity’, whereas in the former case the students have been found to see their teacher as a mentor and come to take ownership of their learning. This understanding of the facilitative role of the teacher is one that stands in opposition to traditional teacher-directed lesson planning and instruction. In order to understand this role better, teacher would benefit from the sharing of ideas among colleagues.

The Assessment Principle states that the main purpose of any assessment ought to be fostering learning and informing instruction (NCTM, 2000). In a study of the use of writing in peer assessment for both students and pre-service teachers, Beaver and Beaver (2011) found that this activity was useful in raising student awareness of thinking and of opening their understanding to the thinking of others. The activity helped pre-service teachers to reflect on their teaching and students’ learning and move away from traditionally teacher-centered approaches to teaching mathematics to more student-centered approaches. The opportunity to work with colleagues on a common problem such as assessment and in the planning of common instructional goals is beneficial to the change needed to meet this objective.

The Technology Principle states that computers and calculators are necessary tools for mathematics. Technological tools increase students’ persistence on problem solving and it builds student self-confidence (NCTM, 2000). Research shows that while Standards in mathematics increasingly call for the use of technology in classrooms, many teachers do not incorporate technological tools during their instructions due to the lack of skills and confidence as well as their beliefs relative to use of it (Benison & Goos, 2010). In order to effectively incorporate technology into lesson plans and instruction, teachers need the opportunity to work in partnership with each other and be able to discuss the unique issues technology brings to the classroom.

Mathematics reform requires teachers who are willing to rethink their beliefs in light of the six Principles for school mathematics. They need to be willing and ready to change their traditional methods of teaching to align with strategies and processes that work for today's students. Professional discourse is needed to support teachers in this reflection and discourse. Among peers, about the big ideas of teaching mathematics as outlined in the Principles, and dedicated
to providing a forum for open discussion and the envisioning of possibilities for students and one's own teaching, has been shown to be an effective means of teacher transformation (Vetter, 2012). Teachers who engage in these sorts of reflective practices and discourse see the effectiveness of their practices and this grants them a greater sense of self-efficacy which has been shown to motivate them to pursue change more readily (Gabrielle & Joram, 2007).

The Study Design
This qualitative and descriptive case study of a secondary mathematics teacher is part of a larger study focusing on two Introduction to Calculus classes taught by the same teacher (Wachira, Pourdavood, &Skitzki, 2013). The study is grounded in constructivist inquiry (Guba& Lincoln, 1989, 1994; Lincoln & Guba, 1985; McCracken, 1988); as such, the research is context specific, namely the participating teacher’s beliefs and practices in two Introduction to Calculus classes. The study does not intend to generalize the findings to all settings. Rather, it intends to share the ideas and experiences, and practices of the classroom teacher in the hope that readers may identify with the research context and apply the findings to their own particular settings. In addition, the study of the participating teacher is an example of how other teachers may be reflective in their teaching relative to the NCTM six principles so that the implementation of mathematics reform ideas can be effective.

The focus of this paper is to describe a secondary mathematics teacher’s evolving beliefs and practices relative to the NCTM six Principles. In addition, the paper discusses the implication of teacher’s beliefs and practices for teacher education, curriculum change, and school transformation. Data sources include transcripts of audio tape recordings from one-on-one interviews with participating teacher, from classroom observations, students’ written responses to various non-routine problems, and the field notes of the researchers.

The Teacher
Prior experiences of the participating classroom teacher explain the context for this study. More specifically, discussion of the teacher’s conceptual framework, a social vision, and a theory of learning develop over time and help the classroom teacher to understand students’ thinking, to build personal relationships, to encourage intellectual interaction and, thereby, to shape the culture of the classroom. The classroom teacher uses a conceptual framework to shape a classroom culture that invites students to think like mathematicians. The framework is inspired in part by the 1969 Cartwright lecture, Mathematics and Thinking Mathematically (Cartwright, 1970). He uses an overarching social vision to shape a classroom culture that invites students to believe that anyone can think, speak, and write like a mathematician. The vision of access and equity in mathematics education is inspired in part by the 1987 National Colloquium in Washington, D.C. Notes from the colloquium recall a time when fewer than 25% of the students who attempted calculus each year in the United States survived the calculus filter to enter the science and engineering pipeline. The notes also recall that the elite who survived the filter were too uniformly white, male, middle class and ill-suited to meet the mathematical challenges of the 21st Century (Steen, 1988). Furthermore, the classroom teacher uses a theory of learning to shape his classroom culture that invites students to communicate like mathematicians. The theory is inspired in part by Umbrellas, a long term elementary school mathematics reform project (Cowen, et. al., 1990). The reform project is significant because the elementary school teachers relied on professional literature and collaborated with the principal, the assistant principal, a middle school mathematics teacher, a high school mathematics teacher, and a professor of mathematics education; the project is also significant because the team focused on big mathematical ideas and deliberately used classroom strategies that engaged students in problem solving and communication. By talking, drawing, and writing about problems, students and teachers alike clarified their thinking and became more confident in their mathematical abilities (Pourdavood, et al., 1999).

The Students
For many years the Participating classroom teacher taught the ninth grade classes for students who failed all of their middle school mathematics. The other classes that he taught were the advanced placement classes, and would encounter students on both ends of the spectrum. In 1989, after publication of the National Council of Teachers of Mathematics Curriculum and Evaluation Standards for School Mathematics (NCTM, 1989), he started working with local elementary school focusing on implication of the Standards. In addition, he looked very carefully at the importance of teaching, learning, assessment, curriculum, technology, and equity. After teaching ninth grade classes and advanced placement classes, he started teaching students who would fall in the middle level. Those students either failed out of the higher-level track of students or they chose to drop out of that higher level. They were the students who felt that they couldn’t compete with the students in the advanced placement tracks.

Many of those students who didn’t feel competent in that high-powered mathematics track wanted more mathematics. Not so much because they liked more mathematics but because they believed their councilors and their parents and their teachers. They would tell these students that ‘You have to take four years of math if you want to be successful.’ So they were the students who were taking a fourth year of mathematics, trusting somebody else’s judgment and not expecting a whole lot from themselves. The classes that those students took was called Introduction to Calculus and the way the program planning guide works, the only way that a student could possibly get to the point of electing that class would be to have failed out or dropped out of a higher level mathematics class sometime during the high school experience. So, they were not necessarily failures. Those students had gone on to be anything but failures. However, they did think of themselves as being less successful or less competent than their peers which explains a lot about their beliefs and attitudes. We discuss the classroom teacher’s practices and beliefs relative to the NCTM six Principles in the context of the Introduction to Calculus class. In addition, we explore implications for teacher education, curriculum change, and school transformation.
Teacher’s Beliefs Relative to NCTM Principles

The participating teacher’s first five years of teaching at a seminary shaped his perspectives on mathematics teaching, learning, assessment, and curriculum. During those first five years of teaching, his professional development opportunities occurred naturally at the lunch tables where he had time to exchange ideas and information with his colleagues at the seminary. The lunch was the main meal of the day and the faculty ate in the same room as the students and it was very much family style. As a young man rubbing shoulders with intellectual giants, he was engaged in dialogues with his colleagues about big ideas relative to teaching, students learning, assessment, and curriculum. It was during this time that the idea of some alternatives to textbook kept recurring in his mind. “We spend more time talking about ideas and making connections. A lot of these ideas then came out 10-15 years later in the NCTM Professional Teaching Standards for School Mathematics[refereeing to NCTM, 1991 publication]” (Participating Teacher’s Interview). The focus was on connections, discourse, and numeracy.

His epistemology on how students learn mathematics evolved through those years. The notion of access and equity in mathematics learning was tangible to him. “My heart would always go out to the students who fell through the cracks” (Participating Teacher’s Interview). He believes there are some alternative ways to sitting in rows and doing the odd numbered problems for homework, having parents do the odd numbered problems for homework, or copying the solutions from someone else. “What evolved from that is my own belief that that kind of learning; those alternative kinds of strategies aren’t reserved for the kids who fell through the cracks” (Participating Teacher’s Interview). He believes it would make a lot of sense if students experiment with the activities and see relationships and have some informal understanding of what is happening before assigning vocabulary words and algorithms. He is convinced if students create their own algorithm instead of memorizing someone else’s algorithms they develop deeper conceptual understanding of those mathematical relationships in which help them to become more confident in their own mathematical abilities. He asserts that students ought to be invited to present their perspectives and have dialogues. He sees his role as a facilitator of classroom mathematical activities and values classroom environment as a caring learning community.

The participating teacher’s perspective on access and equity for mathematics learning is closely related to his notion of curriculum change and use of technology. The turning point on his curriculum change in this public school started in 1985. Prior to this year he had questions about the existing curriculum, appropriate use of textbook, and the school policy on using technology (i.e. graphing calculators). During that time he was teaching advanced placement mathematics which was more extensive curriculum. He started with a group of students in tenth grade and the same group was with him for 11th and 12th grade. At the end of the third year, all but four students “washed out” of the advanced placement mathematics class. The other students settled for or elected to take the more limited mathematics curriculum. “So I managed to weed out all but four of the students who were in my more extensive curriculum. That’s what we did in those days. It just didn’t make sense to me” (Participating Teacher’s Interview).

The seed of change in his curriculum occurred when he was invited to participate in a national meeting in Washington, D.C. In that meeting the participating teacher started talking about calculus as a pump rather than a filter. He found it just fascinating to be sitting at the table once again and it reminded him of that table at the seminary. The conversations were focused on what he had been thinking: why he was “weeding out” his students. From that critical moment he started changing the way he looked at calculus. “The veteran teachers at that time had apprehensions ‘that’s not the way we do it’. But they didn’t object” (Participating Teacher’s Interview). The school included more students taking advanced placement mathematics. The number of students tripled and the school had parents who supported their children in those classes. The school system transformed from very homogenous group of students taking advanced mathematics to more heterogeneous, more inclusive group. In addition to the 1985 event, another pivotal year was the 1989 publication of the Curriculum and Evaluation Standards (NCTM, 1989). The school community then was allowed to talk about big ideas surrounding mathematics education.

“We’re no longer required to have our course outline be like the table of contents from a textbook where we list topics. Instead, we’ll list the strands that flow through the entire course rather than the checklist of skills. That was empowering. So, all those things came in rapid successions” (Participating Teacher’s Interview).

During this time the secondary mathematics teacher made a connection with a local elementary school’s principal and his assistant principal in the same school district. They started talking about big ideas for reforming mathematics teaching and learning and transforming culture of elementary school mathematics. “We always used textbook. It’s required. But I always looked for a way to remove the textbook. I tried to minimize the role of textbook and the teacher being the center and authority in the classroom. I tried to put the students’ role as central to our classroom activities” (Participating Teacher’s Interview). After 37 years of teaching in this school he established his credibility in a way that he has the luxury of being able to use his professional judgment for designing his own curriculum that he is convinced would be well-suited to his students’ needs.

Teacher’s Practice Relative to NCTM Principles

The participating classroom teacher deliberately plans lessons that engage students in problem solving and communication. The lessons are best described in terms of four pedagogical strategies described in Hufferd-Ackles, Fuson & Sherin (2004). As such, Strategy 1, Establishing Expectations, dominates the classroom discourse for roughly the first six weeks of the school year; the classroom teacher communicates his expectations regarding how to talk and write about mathematics. Strategy 2, Mathematics Language, dominates the classroom discourse roughly from week seven through week twelve; the classroom teacher encourages students to shift from using informal language riddled with pronouns to using more formal language clarified with standard mathematical vocabulary. Strategy 3, Mathematics
Community, dominates the classroom discourse roughly from week 13 through the end of the first semester; students formalize their language and become more confident in their abilities to solve problems and communicate mathematically. Strategy 3 and Strategy 4, Establishing Formal Discourse, are prominent throughout the second semester; students exhibit a sense of mathematical empowerment and communicate their ideas using the more formal mathematical language that is established by the classroom community. The four pedagogical strategies not only guide mathematical discourse in the classroom but also enable students to construct the bridges that connect problem solving with their mathematical dispositions.

From beginning of each school year, not all of his students respond positively to his vision and methods of teaching and learning mathematics. His students come to the classroom with their prior beliefs and attitudes towards mathematics teaching and learning. Some students are resistant to his methods of teaching, some are passive, and some are doubtful. However, as year progresses, particularly from the second semester of the year, more students take ownership of their learning. They participate in and contribute to the classroom activities.

Early in this process, if I were to ask a student a question, I would lightly get a response, 'I don't know' or 'I know but I just can't explain'. So to ask a student to write a paragraph on his/her thinking and reasoning is silly. They have difficulty verbalizing their thoughts. But if I ask students to draw a picture or to make a table of what's going on and explain the picture or the table, then the students come with verbal explanations of their own work (Participating Teacher's Interview).

The teacher asserts a viable way to assess students' understanding is asking them to explain their thinking and reasoning the way that would make sense to them. He argues that asking students to verbalize their thinking their own ways would fulfill three objectives, meta cognition (i.e. thinking about thinking), communication with teacher and their parents about their understanding of mathematical meaning, and assessment of students' conceptual understanding of mathematical ideas (Tsuruda, 1994). He believes establishing classroom social norms with students from very beginning of the school year is absolutely crucial for creating a safe learning environment for all students. He incorporates small group cooperative learning as a source for creating learning opportunities for all students. He communicates with students about his expectations relative to problem solving, reasoning and communication.

When students are working in groups I communicate with them: (1) they are responsible for their own learning and behavior. (2) They must be willing to share their thoughts with their groups and actively listen to each other's presentation of solutions. (3) They must ask their peers first if they don't understand or have difficulties solving problems. (4) It is expected of them to be able to defend their ideas when they are asked to do so. And (5) they ask teacher for help only if it is the group problem (Participating Teacher's Interview).

He asserts that establishing the social norms of the classroom is both challenging and rewarding. Particularly for the first quarter of the year, not all students would respond to this type of rules, roles, and expectations.

Connected to his curriculum transformation and classroom social norms is the notion of access and equity in mathematics learning with respect to use of technology. It was the time that Texas Instrument (TI 83) came to market. Students who could afford to purchase a graphing calculator could hold it in their hands. During that time the participating teacher became the chair of mathematics department. He suggested instead of buying new textbooks for the students, the school purchases calculator. Also, he suggested that at the end of each school year the students either turn them to the department or they pay the fines. His suggestion was supported by the district superintendent and assistant superintendent and it became official. The school provided all students graphing calculators. Those teachers, who used the calculators, loved the idea. Those teachers who were intimidated by the calculators, hated the idea. As time passed, all teachers became more comfortable with the new technology and the students were exited using them in their mathematics classrooms. "When everyone in class has a calculator and understands the syntax and can translate among standard mathematical notations and can write some elementary programs, the conversation just starts to flow" (Participating Teacher's Interview).

Technology is a crucial element of his classroom teaching and learning practices. He believes the future of education is at a crossroad with respect to the notion of access, equity and use of technology. On the one hand, he is hopeful that future of education and public schools will transform positively and remain like a social economic hub of their communities. On the other hand, he is fearful that they may go the other road and future is uncertain and unknowable. He asserts the challenge for young teachers is to look very carefully and critically to these complex interplay processes and transformations that are in the works. He cautions the young minds that they need to decide whether these changes affect positively the well-being, creativity, and the development of their students or these changes would focus on someone's agenda who may not necessarily care about individual students' achievements and successes. He believes by seeing those differences and critically analyzing them may make a huge difference in future of public education.

Discussions

The NCTM's Curriculum and Evaluations Standards (1989), along with the Professional Standards for Teaching Mathematics (1991) and Principles and Standards for School Mathematics (2000) have been of important value in mathematics education for national, state, local frameworks and curriculum guide, assessment, and everyday classroom instruction (Ferrini-Mundy, 2001). Teacher educators in mathematics education face dilemmas and challenges in preparing teachers for classroom consistent with these principles. Many documents such as NCTM portray teachers as developing learning environments, encouraging students in mathematical inquiry, understanding, and sense-making (Nicol, 1999). Callahan (2011) points that engaging students in meaningful mathematical discourse can be rather daunting as it requires teachers to make careful pedagogical choices and decision in instructional process. The focus of
the Principles largely is constructive and involves the improvement of mathematics teaching and learning. The six Principles for school mathematics are equity, curriculum, teaching, learning, assessment, and technology (NCTM, 2000). The NCTM argues that mathematics students and classrooms ought to be active and engaged in the learning process. Research has indicated that teacher's beliefs and values drive their teaching of mathematics and their teaching practices (Hart, 2002; Stipek, Giwn, Salmon, & MacGyvers, 2001), thus encouraging researcher to focus on teacher's motivation and beliefs towards mathematics education. Since most of the beliefs are constructed due to individual experiences, constructivist theory asserts that teacher beliefs can be nurtured by facilitating new teachers in making sense of their experiences focusing on learning and teaching mathematics (Hart, 2002; Perrin, 2012; Stipek, et al., 2001). Similarly students also learn mathematics through the experiences teachers provide (Graham & Fennell, 2001). The need to access these beliefs is high as research using the ‘inquiry-oriented’ mathematics instruction highlights that teachers filter what they learn new ideas through their already existing traditional values and beliefs, making professional development programs mostly ineffective (Cohen & Ball, 1990; Stipek et al., 2001). Wachira, Pourdavood, & Skitzi (2013) highlight some components of inquiry-based learning like exploring, conjecturing, generalizing, and communication.

Perrin (2012) emphasizes that to make NCTM's Principles effective in classroom teaching it is essential that teacher change their 'traditional' teaching methods. These beliefs have a profound effect on the decision making process of teaching. Studies have highlighted the connection between the exposure of NCTM's vision and beliefs in that vision, therefore it is important to familiarize teachers with the NCTM's Principles documents and encourage discussion throughout the academic year. The reforms, with NCTM's Principles in mind help facilitate students learning, conceptual understanding, and develop positive attitudes with respect to mathematics (Staples, 2007).

Teaching Principles highlight the needs of knowing and understanding mathematics, students as learners, pedagogical strategies, challenging and supportive classroom environment, and continually seeking improvement (Graham & Fennell, 2001, p. 319-320). As these Principles have implication at pre-service teacher preparation and professional development for teachers, they point toward the career-long process of development concluding that one-time mentoring is not beneficial or substantial. The needs arise not only for mathematics development but also due to the burnout experienced by teachers on a large scale where there is a shortage of teachers (Addington, Clemens, Howe, & Saul, 2000). Stipek et al. (2001) refer ‘traditional beliefs’ as teachers’ responsibility to transfer mathematical rules to students through step-by-step training, and provide problems for practice. Inquiry-oriented mathematics teachers approve mathematics education as a continually changing area of study. Teachers' role here is to support and guide the process of communication, engagement, creativity, applying ideas constructively. The incongruity between teacher beliefs and practice can be explained by the agitation and unpredictability of classroom education and the external pressures put on teachers, highlighting the importance of congruence between teacher beliefs and practice (Handal, 2003). The NCTM Principles foster classroom teaching encouraging more student initiation and strategies, and less teacher control. Staples (2007) studied the instructional methods to encourage students' participation in class discussions. In her study, the components that stood out in classroom teacher were eliciting student ideas, scaffolding the production of student ideas, creative contributions, creating a shared context, continuity over time, and guiding high-level task.

Addington et al. (2000) in their reactions to NCTM Principles highlighted the teacher shortage experienced by most urban schools in large states. They also emphasized that teachers need time to learn new materials, modify the ways of teaching; however, highlight that often school districts do not recognize the fact that teachers need time on a regular basis to discuss and reflect on the mathematics teaching with colleagues. This poses the question of how can all teachers be on a compatible position relative to understanding and implementation of the guidelines. Stipek et al. (2001) address that the NCTM Principles encourage teachers to provide students with opportunities that facilitate communication of mathematics problem solving and dialogues with others, foster mathematics engagement with self-confidence and interest, value and reward students' attempt and endurance. Adding ton et al. (2000) point that the Principles are prepared for non-pedantic and easy to read by mathematics teachers, supervisors, local and state level educational administrators, parents, politicians, community leaders, and those interested

Stipek et al. (2001) cited that student motivation is enhanced by teachers’ beliefs are consistent with the students’ concerns where teachers’ are more accepting of individual efforts, process of learning, and understanding of mathematics concepts, and reinforced risk-taking. Stipek et al. (2001) study pointed that teachers’ with more traditional beliefs had lower self-confidence and enjoyed mathematics teaching less than teachers’ with inquiry-oriented beliefs. Mathematics coursework has been a gateway to technological literacy and advanced education. Mathematically literacy should be the aim for all students and a national duty to insure that all students had access to high quality mathematics learning (Schoenfeld, 2002). What makes this an issue of equity? Students with disenfranchised identities, low socio economic status, students of color such as African-American, Latino, and Native America students drop out of mathematics as they perform poorly on test of mathematics competence and therefore denied economic and other enfranchisement. Therefore it is essentially not only for students to learn, but also ensure that all students have opportunity to learn. As wealth has been unequally distributed in the USA market, similarly in mathematics education the emphasis on Equity Principle to provide accommodations and promote access and completion for all students has increased. It is important for all students have access and benefit from high quality education (Addington et al., 2000; Schoenfeld, 2002).

Another important area to pay attention to the teacher self-belief as related to their capabilities to affect the learning outcomes of students including those with low motivation. Teachers with high self-belief are argued to have more capability to use instructional strategies effectively, ensure student participation, and more successful classroom environment (Ozder, 2011). Technology has been an important part of the effort to improve the teaching and learning of mathematics. It helps in a global, online, interactive, multimedia platform on which one can build and deliver powerful educational experiences, and create a vast database of information and resources (Keller, Hart, &Martin, 2001).
al. (2007) emphasize the strong relationship between teachers’ beliefs and the instructional decisions and practices in the classroom. Teacher are often more inclined to base their beliefs upon past experiences rather than on research, due to lack of information or mistrust, emphasizing the need of teachers to be more aware of use of technology and research available about successful technology innovations including calculators use in mathematics classroom.

Mathematical usage relying on technology not only in the curriculum but also in classroom instruction (Niesse, 2005). Wachira, Pourdavood, & Skitzki (2013) assert that NCTM Principles foster communication as an important part of mathematics education, with using the mathematics language to grasp the concepts better. Schoenfeld (2002) observes that the NCTM (2000) Principles address the importance of access and equity for all students. In addition, NCTM Principles focus on the importance of teacher preparation programs where there is an expectation of pre-service teachers to develop a deeper and thorough knowledge in mathematics (Niesse, 2005). Understanding that teacher’s role is critical in the improvement and advancement of mathematics education, it is essential to provide the teachers with support to carry out the role effectively (Graham & Fennell, 2001).

Implication

The importance of mass access and equity in mathematics education cannot be unheeded. It is essential that all students get equal access and opportunity for mathematics education, especially understanding the social and economic implications. It is essential for future mathematics teachers to effectively implement the NCTM Principles in everyday classroom teaching, and having consistent beliefs and practices in classrooms. Mathematics teachers ought to get to know their students and work on establishing a relationship to help facilitate learning by creating a positive, comforting, secure, and effective learning environment. The need to stay updated with the recent research is an important area of growth for all mathematics educators, in relation to technology advancements, self-efficacy and confidence building in students. Teacher education focusing on mathematical discourse is essential in future teacher training. Mathematics teachers need to move away from the typical teacher’s questioning and feedback process of learning. The need to engage in back and forth communication in which students actively construct meaning is important. It increases in dialogue that is in the context which is student-driven and encourages further thinking and exploration, instead of focusing on only the teachers’ point of view. The need to allow and encourage students to value understanding of concepts rather than just getting the right answers should be emphasized (Wachira, Pourdavood, & Skitzki, 2013). There is an ever-widening gap between what students learn in the classroom and what they do in real life. Students need to be encouraged to develop creative imaginations, sense of wonder, curiosity, speculating, engage in problem solving, reasoning, communication, critical thinking, and establishing connection between school activities and wider social learning (Pourdavood, 1997). Teachers along with others in the community such as: school staff, families can work towards the common goals of making school a meaningful place of education.

This case study identifies several challenges facing school leaders who support reforming mathematics education consistent with spirit of NCTM Principles. One challenge is epistemological differences among teachers and students. Effectively implementing NCTM Principles requires a teacher to possess a deep understanding of mathematics and curricular materials as well as a deep understanding of how students think, reason and develop proficiency. The current structures of schools, however, seem to mediate against this kind of teaching (Staples, 2007; Wu, 1999; Chazan, 2000; Askey, 1999). Teachers need to know their students and build relationships with them to facilitate their learning.

The staying power of conventional instruction is another challenge. Conventional instruction still dominates the educational landscape, especially in secondary school mathematics classes. “[T]he most critical shift in education in the past 20 years has been a move away from a conception of ‘learner as sponge’ toward an image of ‘learner as active constructor of meaning’” (Wilson and Peterson, 2006, p. 2). Multiple factors contribute to the staying power of conventional instruction and to the lack of implementation of NCTM Principles. One such contributing factor is faulty implementation of NCTM Principles. For example, teachers frequently demonstrate sample problems during a constrained time period, assign the remaining problems as homework, and then discuss the solutions by providing the correct answers in a subsequent class period. Faulty implementation allows for only a limited exploration of adequate mathematical ideas so that students are forced to memorize the correct answers. To successfully implement NCTM Principles, teachers ought to manage a delicate balance; that is, teachers need to centralize and guide students’ thinking while simultaneously being careful not to overpower the meaning making and discursive process (Nathan & Knuth, 2003). When teachers respond only to group questions, i.e. questions that no one in the class is able to answer, teachers implicitly position students to consider one another’s questions, responses, and ways of reasoning.

The disconnection between what is emphasized in pre-service professional development and what is actually needed by school teachers in the classroom is also a challenge. The disconnection explains why traditional K-12 schooling focuses mainly on developing a little skill on routine problems. Teacher education programs need to emphasize the facilitation of mathematical discourse in the classroom.

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