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Mathematics Education and Special Education: Searching for Common Ground and the Implications for Teacher Education

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This article examines research literature that overlaps the fields of mathematics and special education, with a particular focus on students with disabilities at the middle and high school levels. We report the results of this literature by describing some of the inconsistencies or contradictions between the fields as well as the commonalities that exist in the research and recommendations. Finally, we address implications for preparing future mathematics and special education teachers to work with their students, each of whom will have unique learning strengths and needs.

As faculty members at a middle-sized, Midwestern university in the United States, we are charged with fostering effective relationships among partner schools and districts in our geographical area. As members of John Goodlad's National Network for Educational Renewal (Goodlad, 1994), we understand the benefits of simultaneous renewal resulting from dialogue and reflection among teacher educators, K-12 clinical faculty, and faculty from the arts and sciences. This article is the culmination of one such effort, that of a mathematics educator and a special educator, both of whom prepare teacher candidates for licensure in their respective fields.

While observing and interacting with interns, student teachers, and clinical faculty in partner schools, middle schools in particular, university faculty are repeatedly challenged to examine the extent to which knowledge, skills, and dispositions from university coursework generalise to actual practice in the classroom. While we believe each of us understands the research and recommendations for best practices in our particular fields of mathematics education and special education, and while we believe we teach such practices to our licensure candidates, we are less sure that these practices are optimally and consistently implemented in our local schools and classrooms. Furthermore, as we spend more time discussing our concerns, we begin to question our own understanding of "best practice" in relation to the other's field of expertise. For example, if research and recommendations for best practice in special education call for access to the general education curriculum for students with exceptional learning needs while maintaining adherence to direct instruction methodology, then special education may be in conflict with research and recommendations in mathematics education, which focuses on learning environments grounded in inquiry and student-centred problem solving.

The purpose of this article is to re-examine, through a shared lens, the literature base informing the fields of mathematics education and special education in an effort to reach a more common understanding about how university faculty can best prepare teacher candidates to meet the diverse learning needs of all their students in inclusive general education classrooms, specifically middle and high school mathematics classrooms. While many of the ideas discussed here will be applicable to educators and programs in other countries, this effort is derived from the beliefs and experiences of American university faculty whose research is situated in the United States. The conclusions, therefore, rely on our own locale and may not always be directly relevant to all readers.

In this particular work, we examine the differences that seem to separate the fields of special education and mathematics; and we search for common ground that offers promise of a more unified approach to teacher education as a whole. The aim of this discussion between a mathematics educator and a special educator is to re-examine preconceived notions of our particular teaching philosophies and consider how the different perspectives of teachers and teacher candidates influence the decisions they make in inclusive classrooms. For example, if special education teachers in the United States are taught from one dominant philosophy the mandated individual education plans (IEPs) they write for students placed in inclusive classrooms will undoubtedly reflect this philosophical viewpoint. Such plans may not be relevant to or consistent with the goals and aims of the mathematics teacher, who may structure a classroom according to a very different philosophy.

We recognise the need to maintain areas of expertise—the deep content knowledge of the mathematics teacher and the extensive ability of a special educator to individualise and strategise are invaluable—but can the two work together, under a common framework that supports the development of all? If so, how can we, as teacher educators, maximise our students' efforts to become collaborative partners in the education process?

The Practice of Mathematics Education

Much of what has been researched and recommended in mathematics education over the last 25 years focuses on students' conceptual understanding and their proficiency with mathematical processes. While this work and its recommendations do not reduce the importance of procedural knowledge, it is clear from the literature that teachers must have a broader focus than just students' abilities to memorise basic facts and carry out routine procedures. Recent standards documents from the National Council of Teachers of Mathematics (NCTM 1989, 2000) in the U.S. as well as recommendations from organisations such as the National Research Council (2004) promote a broader view of what it means to do mathematics. These documents include the importance of procedural knowledge: that students can make accurate computations and carry out traditional algorithms. They also, however, promote understanding the concepts behind those computations and algorithms, as well as mathematical processes such as reasoning and communication.

Standards for Excellence in Teaching Mathematics in Australian Schools (Australian Association of Mathematics Teachers (AAMT), 2006), describes standards for mathematics teachers in Australia that are consistent with those of the United States. Australian mathematics standards include three domains: professional knowledge, attributes, and practice. For example, in Domain 3: Professional Practice, the learning environment standard states, "The psychological, emotional and physical needs of students are addressed and the teacher is aware of and responds to the diversity of students' individual needs and talents. Students are empowered to become independent learners" (AAMT, 2006, p. 4). The teaching in action standard emphasises the complexity of sound mathematics instruction. "As facilitators of learning, excellent teachers negotiate mathematical meaning and model mathematical thinking and reasoning. Their teaching promotes, expects, and supports creative thinking, mathematical risk-taking in finding and explaining solutions, and involves strategic intervention and provision of appropriate assistance" (AAMT, 2006, p. 4). Clearly, the intent of current best practice is to move beyond the mundane memorisation of facts into a much richer study that will absorb, motivate, and prepare students for a lifetime of engagement in mathematics.

Current materials designed by curriculum developers are consistent with standards documents and research in that they are also focused on improving students' conceptual knowledge and proficiency with process standards. For example, programs created in the United States during the 1990's with National Science Foundation (NSF) grants address this broader view of mathematics (Hirsch, 2007). These materials require a greater cognitive demand from both teachers and students, and an approach to teaching that is different from one typically used with more traditional textbooks. Teachers who use these NSF-funded materials become guides to inquiry as they help their students reach a deeper understanding of important mathematical concepts, certainly moving beyond only simple recall and basic carrying out routine procedures (Hirsch, 2007).

The Practice of Special Education

Federal special education legislation in the USA, such as the Individuals with Disabilities Education Act (IDEA) (most recently reauthorised in 2004), has mandated the right of students with disabilities to have access to the general education curriculum in the least restrictive environment (LRE). The law stipulates that, to the maximum extent appropriate, students with disabilities are to be educated with their peers who are typically developing, unless education in the general education classroom, even with supplementary supports and services, cannot be achieved satisfactorily (Hocutt, Martin, & McKinney, 1990). The special education process determines exactly what the supplementary supports and services for each student will look like. Students who meet the legal definition of disability are entitled to an individualised education program (IEP). The IEP is a process centred on the assessed strengths and needs of a particular student. It incorporates baseline data from multiple sources, including general educators. The IEP describes current levels of student performance, identifies and prioritises the student's needs, and generates specific, measurable annual goals and objectives that address those needs. The IEP also documents individualised supports, services, accommodations and modifications as needed to address the adverse effect of the disability on the student's learning. Finally, the IEP determines the student's LRE, which most often should be the general education classroom. Until recent years, however, many students with disabilities continued to receive the bulk of their education in segregated placements. It was not until the passage of the No Child Left Behind Act (NCLB) in 2001 and the 2004 reauthorization of IDEA that schools became accountable for the actual achievement of all students, including those receiving special education services. For students with "mild" disabilities, such as specific learning disabilities, the increased emphasis on quantitative test scores as proof of achievement has actually resulted in a higher likelihood of being included in higher-level mathematics.

In Australia, the Disability Discrimination Act (1992), while broader in scope than America's IDEA, nevertheless provides the framework for a set of Disability Standards for Education (2005), the philosophy of which is similar to that of IDEA. The Disability Standards emphasise the rights of a student with special education needs to the same quality of education as that received by students who are typically developing. The Standards require students with disabilities enjoy equal privileges with regard to, among others, flexible participation and support within curriculum areas and programs. These students are also entitled to reasonable adjustments in areas of delivery, learning activities, and materials (Australian Association for Special Education, 2005). A 2004 position paper by the Australian Association for Special Education (AASE) further defines a quality education for students with special needs, pointing out that "special education is not a place but rather provides an intensive analysis of curriculum instruction and the school environment in order to maximise learning outcomes for students with special education needs" (AASE, 2004, p. 1). The Disability Discrimination Act and the Disability Standards are affecting Australian secondary schools just as IDEA and No Child Left Behind have influenced schools in the United States. More and more students with disabilities are included in classrooms and teachers are expected to provide them with a high quality education, just as they do all of their students (Kuhl & Pagliano, 2009), an almost impossible task without the collaboration of special educators.

Special educators are ultimately responsible for the learning of students with disabilities. Essentially, it is their job to analyse the impact of the disability on the student's ability to learn and then design curriculum that circumvents the adverse effects of the disability. These special educators have traditionally been prepared for this task by teacher education programs that adhere to a teaching philosophy that Kozioff, LaNunziata, Cowardin, and Bessellieu (2001) have labelled instructivist. Instructivist theorists are interested primarily in students' behaviour as it relates to their learning. "Learning is change in behavior (feeling, thinking, acting) that results from interaction with the environment" (Kozioff et al., 2001, p. 57). Special educators typically view their roles as helping students acquire knowledge and skills. Typically they see this best done by teaching with clear and focused knowledge objectives in mind; teaching concepts, principles, strategies, and operations explicitly and systematically; and paying careful and continual attention to students' learning" (p. 54). Examples of instructivist teaching practices, all of which are commonly used to teach students with disabilities, include applied behaviour analysis, precision teaching, and Direct Instruction. Each of these has been validated in the literature as a successful approach to learning. Applied behavioural analysis, for example, is commonly used in providing intervention to students with autism or other pervasive developmental disorders (Ellison, 2006). Precision teaching (Lindsley, 1993) focuses on the need for students to be able to develop behaviors that are fluent (automatic, effortless, fast, and accurate) (Kozioff et al., 2001). Direct Instruction is based on the work of Englemann, Bereiter, and Becker (cited in Kosioff et al., 2001). Direct Instruction adheres to the guiding principle that students can only learn well if the teacher teaches well. Direct Instruction curriculum is specifically and thoroughly defined; the aim is for teachers to follow the curriculum exactly, often with use of a script. Kozioff et al. (2001) point out, however, that Direct Instruction is not rote learning, but "focuses on cognitive learning—concepts, rules, cognitive strategies, and problem solving" (p. 57). The goal of all instructivist approaches is mastery.

Mathematics and Special Education Practices at Odds

Examining literature from the two fields of mathematics education and special education reveals a contrast in pedagogy. For example, while mathematics education typically focuses on a student-centred learning which includes "constructing" knowledge and understanding through exploration and tapping into students' background knowledge, special education methodology is more likely to emphasise task analysis and specific, measurable objectives, often appearing to target procedural rather than conceptual skills. The propensity of special education to use these approaches is not surprising, given some of the common characteristics of students with disabilities, who often struggle in areas such as short-term memory, visual and auditory perception, and executive functions (Finnane, 2008; Miller & Mercer, 1998). Furthermore, past research in the field of special education demonstrates more effective outcomes for students with disabilities when more teacher-directed instruction is used (Kroesbergen & Van Luit, 2003).

When considering the broader view of what it means to do mathematics, we found it difficult to locate literature over the last 25 years that examined students with disabilities in reference to their conceptual understanding and proficiency with mathematical processes. This was especially difficult when we narrowed our search to a consideration of middle and high school mathematics, and included topics such as algebra and geometry. In two separate reviews of the literature, Miller, Butler, and Lee (1998) and Butler, Beckingham, and Novak Lauscher (2005) found that most of the research in this area focuses on students' computational skills and step-by-step procedures, and not on supporting students' deeper conceptual understanding. Two recent papers from Australian literature confirm the propensity of researchers to focus on facts over process (Finnane, 2008; Graham, Bellert, & Pegg, 2007). Even literature that on the surface recognises the importance of problem solving reduces such a process to a set of steps to follow. The level of mathematics in these studies narrowly focused on students' abilities to memorise a procedure and practice using it.

This narrow view of what it means to "do mathematics" is not uncommon practice in middle and high school mathematics classrooms (Stigler & Hiebert, 1997). Indeed, perhaps special education literature is aimed primarily at these lower level skills specifically because these have been the expectations students typically face in their high school mathematics classrooms. If students with or without disabilities are to be independent thinkers and doers they must have opportunities to develop metacognitive skills—pondering their choice of strategies within the day to day context of understanding to help them rise to the challenge of problem solving, whether it be in mathematics, literacy or another content area (Paris, Lipson, & Wixson, 1983).

In our review of literature, we found a few examples of research that examined the broader view of mathematics and how it fits with, or otherwise affects the education of students with disabilities. For example some of the ideas promoted by Carnine (1997) begin to shift the focus. His work discusses the necessity to teach "big ideas", promoting the idea that while there are many procedures to be learned in mathematics, some of them involve the same mathematical concepts, and therefore can be taught at the same time. He provides an example using the concept of volume. While prisms and cylinders can be thought to have different formulas for finding the volume, they both can be thought of as taking the area of the base times the height. So for a cylinder, $V = \pi r^2 h$, and for a rectangular prism, $V = lwh$, can really be seen as the same formula with πr^2 and lw the areas of the respective bases.

While Carnine's "big ideas" recommendation promotes some connections between various procedures in mathematics, his work here stops short of pushing into the importance of conceptual understanding. In his example, the concept of volume is still reduced to knowing the right formula. Being able to recognise how the formulas are related depends on students' more basic understanding that volume is the amount of three-dimensional space that an object will hold. His example wants students to see that these formulas often presented as isolated from one another are very much connected to one another. When students consider the concept of volume as an amount of three-dimensional space, they can connect the abstract formulas to efficient ways of calculating the amount of three-dimensional space. Making the connections between the concrete representation (counting cubes) and the abstract representation (formula) is suggested in other special education literature as a way to enhance students' understanding of specific mathematics content. This is an alternative to recalling the correct formula, plugging the numbers in mindlessly, and getting an answer that doesn't make sense. These are important connections for all students, and only in recent literature have they been studied and brought to light for students with disabilities.

Until recently (5-10 years) the overlapping literature in special and mathematics education has been almost exclusively focused on procedural knowledge. Teaching practices and suggestions for effective instruction in mathematics for students with exceptionalities focused on modelling how to carry out the procedure and giving ample opportunity for guided practice. Procedures are taught discretely; while generalization is recognised as an area of concern, connections among procedures tend not to be the focus of instruction. "Learning mathematics" translates to learning sets of isolated, discrete skills and procedures. Some literature specifically denounces theories of constructivism and the focus on students' ability to use mathematics to solve problems, to communicate mathematically, and to reason mathematically (Jones, Wilson, & Bhojwani, 1997).

This is an important distinction to remember when considering equity and the types of mathematics curriculum and instruction to which students with disabilities have access. If general education teachers are being prepared to teach students to develop deep conceptual understanding and are proficient with mathematical processes such as reasoning and communication, while special education teachers are prepared primarily to help students learn procedures; how will students with disabilities master conceptual understanding or achieve proficiency with deeper mathematical processes? Does such a dichotomy promote a widening achievement gap between students identified as having disabilities and those without disabilities (Butler, Beckingham, & Novak Lauscher, 2005)?

The Need for a More Common Focus

Professionals and researchers in special education are beginning to see mathematics as more than just a set of procedures that students must be able to apply effectively (Smith & Geller, 2004). Carnine (1997) advocates for students to develop the ability to know what the formulas/procedures are, how to apply them, and WHEN to apply them. When does it make sense to use a certain algorithm or procedure? These problem solving strategies are similar to those posed by Miller, Butler, and Lee (1998), but now we recognise that knowing *when* to use each of these problem solving strategies is crucial to understanding.

Recently, others have also begun researching and writing about the apparent dichotomy in the literature of special education and mathematics education. Butler et al. (2005) assert, "It is hard to disagree with the position that mathematics instruction should foster a deep understanding of mathematics as a field of study, rich conceptual knowledge about mathematics, and the ability to apply mathematical concepts adaptively and flexibly to solve complex problems" (p. 156). The authors examine the issue further by pointing out recent research that appears to support the NCTM standards, such as the general agreement that students with disabilities need a deeper conceptual understanding of mathematics if they are to be efficient problem solvers; and the caution to avoid teaching students with disabilities mathematics by way of procedural components without understanding of the necessary foundational constructs. Butler et al. (2005) also note the tendency of past special education research to focus predominately on basic skills areas rather than on conceptual understanding. Finally, these authors acknowledge the agreement in the United States between NCTM standards and special education research that supports use of metacognitive strategies, particularly those of self-instruction, self-questioning, and self-monitoring/self-regulation, which have the end goal of developing responsibility in students for their own learning. "One challenge is that a mainstay of empirically validated instruction in special education is the direct teaching of concepts, skills, and/or strategies. Teachers and researchers therefore struggle to articulate methods to engage students in constructive learning without compromising the explicit, systematic support that is most often recommended" (p. 158).

Knight (2002) and Karp and Voltz (2000) point out the benefits and drawbacks to adhering to only one philosophy or teaching strategy. Each describes in detail the benefits of classrooms organised around constructivist theories of learning and behaviourist theories of learning. These authors point out the importance of interweaving teaching strategies that are grounded in each of these theories so that students' benefit from the strengths that each has to offer.

We contend the dichotomy (referred to above) that appears to exist between the fields of mathematics education and special education is, at least in part, false. The philosophies of the two fields are more similar than may be supposed at first study, and upon closer examination may even have many consistencies. For example, both acknowledge the role of students' foundational knowledge in the teaching of new skills. Both emphasise the need for learning that is relevant to the students' lives. The tendency of special educators to focus on more teacher-directed methodology may be more of a reaction to poorly designed and delivered mathematics instruction in general education classrooms of the past than to any fundamental differences in their beliefs about how students learn. Special education teachers are advocates for their students; they have had to be, due to past inequitable experiences of many students with disabilities or other disadvantages. Students with disabilities who receive their mathematics education in the general education classroom have mathematics goals on their IEPs written primarily by their special educators, again those who may or may not be trained in mathematics but are very likely well versed in writing goals and objectives from an instructivist (behavioural) perspective; a perspective directly at odds with what mathematics educators prepared in a constructivist philosophy are taught to do. Consequently, there is likely to be conflict between teachers whose teacher education experiences may have been very different, even while their goals—high achievement in mathematics for their students—are the same. To add to the confusion is the very real phenomena in the USA of over-identification of students in special education, especially in the category of specific learning disability and a disproportionate identification of students from minority backgrounds in the categories of mental retardation and emotional disturbance (Artiles & Zamora-Duran, 1997). How many students labelled as having a disability actually have one and how many are victims of an educational system unprepared to meet the diverse needs of a wide range of students (Zevenbergen, Grootenboer, Niesche, & Boaler, 2008)?

One premise that emerges from the chaos is this: If mathematics teachers were adequately prepared to teach their content using current research-based practices, which include a constructivist, *student-centred* philosophy with the goal of increased conceptual *understanding*, fewer students would actually need *specialised* services. Another premise is this: Those students who truly do have a specific learning disability or other mild form of disability, will also benefit from quality mathematical instruction in inclusive classrooms, provided they have sufficient access to the curriculum through accommodations (i.e., accessible text, assistive technology, organizational and study skills, or positive behavioural supports). As Ginsberg (1998, p. 56) states in chapter two of Pedrotty Rivera's (1998) *Mathematics Education for Students with Learning Disabilities*, "A learning disability is not an incurable disease with no remedy. Research should investigate various methods for helping children overcome learning disabilities. One such approach involves bypassing learning disabilities". *If* current mathematics practitioners can engage their students, those with and without disabilities, in the kind of mathematics instruction described by the recommendations of NCTM (1989; 2000) and AAMT (2006) as "best practice;" and *if* special educators can collaborate with those mathematics practitioners to ensure students with disabilities have any needed supplementary specialised services to which they are entitled by US and Australian law, *then* many students with disabilities (as well as those without disabilities) in effective inclusive classrooms may achieve the levels of proficiency ascribed to by mandates such as NCLB, IDEA, and the Disability Discrimination Act.

Conclusion and Recommendations for Teacher Preparation Programs

The challenge for teacher educators and researchers alike is two-fold: first we must make sure that all of our teacher candidates, both in special education and in mathematics education, learn to teach high quality mathematics instruction that adheres to the most current research and recommendations for best practices for teaching mathematics; and second, we must ascertain whether or not students identified with disabilities can reach high levels of learning when taught with the same type of research-based instruction that is used to teach their peers who do not have exceptional learning needs.

One common theme on which the recommendations in both fields can agree is the issue of equity. We know that the research, recommendations, and practices of teacher educators have not sufficiently guided teacher candidates toward a common understanding of their role in the mathematical lives of their students. If equitable learning opportunity (as described by mathematics standards and special education literature) is one of our goals and another is moving closer together through common research, what do we, as teacher educators, do to reach our aim of mathematical power for all students?

The challenge to teacher educators is significant. Pre-service mathematics teachers are provided experiences that attempt to broaden their beliefs about mathematics, seeing mathematics as more than just carrying out routine procedures. Mathematics teacher educators help pre-service mathematics teachers see the importance of providing their students with a deeper understanding of mathematics. Teacher candidates are often asked to expand their view of mathematics and to relinquish the methods most likely used by their own mathematics teachers in middle and high school in order to embrace the best practices they learn in their professional preparation programs. To accomplish these goals, pre-service teachers require ample time to work under the supervision of cooperating teachers and supervisors who are skilled and experienced in these practices. Mathematics education teacher candidates who will be successful in teaching all students also need to be more versed in the art of understanding their students' strengths and needs, particularly of those students who have disabilities, something that was typically relegated to special educators in the past. Knowledge of mathematical content is not enough; they must also know their students.

Similarly, special education teacher candidates, whose aim it is to teach at the middle or high school levels, also need to broaden their beliefs and understanding of mathematics. Teachers of students with disabilities must see mathematics as more than just basic skills and routine procedures; they need to understand mathematics must also include conceptual understanding and abilities in mathematical processes. While methods courses for mathematics teachers attempt to broaden teachers' beliefs about what it means to do mathematics, one must ask what experiences pre-service special education teachers receive to help them acknowledge this broader view. In some ways, this is not a new concern. The No Child Left Behind (2001) legislation has increased requirements for special education teachers to have more content knowledge in mathematics. This focus, however, may not be broadening teachers' view of mathematics as described above, but merely giving teachers access to more advanced skills and procedures while perpetuating their limited view of all of mathematics as procedural. While special education teachers' primary role will remain that of providing individualised, specialised instruction to their students with disabilities, special education teachers' grasp of mathematical content and methodology needs to support their role rather than hinder it. Knowledge of their students is not enough; they must also know mathematical content.

Other essential skills for both mathematics and special education teacher candidates include a strong ability to collaboratively problem-solve with a variety of professionals as well as parents; and an ability and willingness to engage in co-teaching relationships. Co-teaching is an essential component of effective inclusive classrooms in the United States and any teachers new to either the field of mathematics or special education should realise they will be expected to co-teach. The practice of "behind closed doors" teaching is no longer sufficient to meet the diverse needs of students and teachers in today's schools (Friend, 2007).

Currently, pre-service mathematics and special educators in American universities are trained according to discrete sets of standards (i.e., NCTM and Council for Exceptional Children). Must mathematics and special educators be completely prepared "on separate pages?" On the contrary, there is a need for mathematics teacher educators and special education teacher educators to work together. This must extend beyond merely understanding each other's work (although even this effort is a novel endeavor in some settings). Those preparing mathematics teachers and special education teachers must begin providing common experiences for each set of teachers they prepare. Candidates from both fields should develop a broader understanding of the mathematics they will be teaching and a thorough understanding of the challenges students with disabilities face when learning such mathematics.

We suggest a shared mathematics methods and intervention course as a way to support a more common understanding. As pre-service mathematics and special education teachers enhance their understanding of specific mathematics content, and explore specific concrete materials and methods for teaching this content, they would also consider explicitly the accommodations and other interventions students with exceptional learning needs require to support them in mastering challenging content.

A specific example within the course could be the study of proportional reasoning, a very important mathematics concept during the later middle school years. Teacher candidates might begin with doing activities from a problem-based and student-centred curriculum used in seventh- or eighth-grade. Candidates would enrich their own understanding of proportional reasoning beyond the over-simplified notion of "cross-multiply", see how one set of materials approaches this specific content, and learn about some typical representations and strategies to help teach proportional reasoning. In addition, candidates would explore the specific accommodations, interventions, and cognitive strategies to help students with disabilities develop proportional reasoning. Much of what is described above might typically happen in a mathematics methods course, with very little attention given to the last part of considering students with disabilities. Conversely, the last part typically occurs in a special education methods course, but not specific to teaching proportional reasoning or other specific mathematics content.

As part of this combined methods/intervention course, teacher candidates would also have a common field experience, where both a pre-service mathematics teacher and pre-service special education teacher would be placed in the same classroom where inclusive co-teaching in mathematics is taking place. If good inclusion practices and co-teaching are goals of programs preparing mathematics and special education teachers, what better way to teach about working collaboratively than to actually have them do it as part of their field experience and/or course work.

We acknowledge that our suggestions, and others, may already be implemented in some teacher preparation programs in the United States and internationally and we applaud those efforts. Very little, however, has been written about how mathematics teachers are specifically prepared to work with students with disabilities, and how special education teachers are specifically prepared to teach mathematics. We invite others to respond with their own creative efforts to address this potential divide. We encourage an ongoing dialogue as we begin our labour to create a set of common experiences for our pre-service teachers.

Recommendations for Future Research

As we embark on this work, we have numerous questions worthy of further investigation. One area, for example, centres on the modifications and accommodations typically made for students with disabilities who are in general education mathematics classes. Many of the suggestions for accommodations and modifications cited on IEPs seem to pre-suppose that instruction is very teacher-centred and the main focus of mathematics content is on procedural knowledge. Do modifications and accommodations need to be different when instruction is problem-based, student-centred, grounded in constructivist learning theory, and focused more on conceptual understanding than procedural knowledge? Are accommodations, common in current classrooms (extra time on tests, shortened assignments, use of calculator, preferential seating) and teaching strategies such as guided notes and mnemonics only effective for classrooms structured around instructivist, teacher-centred learning theory? Or, are these approaches to scaffolding appropriate, regardless of the structure of the classroom or the focus of the content? Where does scaffolding more common in constructivist oriented classrooms, such as facilitated dialogue (Knight, 2002), fit on an IEP (or does it?)? It seems special educators and mathematics teachers need to engage in collaborative problem solving on a student-by-student basis in order to ensure suitable accommodations/modifications that are also feasible in a student-centred classroom.

This leads us to another area of questioning. Where do pre-service teachers learn to collaborate effectively with those from teaching fields other than their own? Do teacher education programs see collaboration as a priority? It must be if effective learning communities are to be successful in K-12 schools. We have offered one suggestion for a course that could offer special education teacher candidates and their mathematics partners practice in collaboration. What other courses and experiences need to be a part of a common preparation program for them to competently navigate both fields and help all students do significant mathematics? DeSimone and Parmar (2006) suggest pre-service teachers have time to observe and student teach in inclusive classrooms. Certainly this is a valid assertion, particularly for those inclusive classrooms where mathematics teachers and special educators collaborate through effective co-teaching. Could field experiences be more systematically and thoughtfully planned to include co-teaching experiences? Indeed, are there even enough placements in the field that model best mathematical and inclusive practices to serve the needs of a pre-service program? If not, what is the responsibility of higher education faculty to address this additional need among practicing teachers? What is their responsibility to raise administrators' awareness around this topic? Clearly, our work in this critical area has just begun.

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