Special Educators’ Math Instruction
for High School Students with Significant Intellectual Disabilities

BY

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THESIS
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To my husband, Nels, thanks for being a true partner. I could not have made it through this without your support. To my beautiful boys, Alex and Jacob, thank you for your understanding during the many days I was not home, for working hard, and for giving me a hard time to get this done before you get college degrees. I am so proud of you. I hope I am making you proud too.

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<td>AYP</td>
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<td>CAI</td>
<td>Computer-Assisted Instruction</td>
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<td>CBM</td>
<td>Curriculum-Based Measures</td>
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<td>CCSS</td>
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<td>CEC</td>
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<td>CPS</td>
<td>Chicago Public Schools</td>
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<td>Concrete-Representational-Abstract</td>
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<td>IEP</td>
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<td>ISBE</td>
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<td>LD</td>
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<td>LRE</td>
<td>Least Restrictive Environment</td>
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<td>Abbreviation</td>
<td>Full Form</td>
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<td>NSTTAC</td>
<td>National Secondary Transition Technical Assistance Center</td>
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<td>SID</td>
<td>Significant Intellectual Disability</td>
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<td>SIM</td>
<td>Strategic Instruction Model</td>
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<td>STEM</td>
<td>Science, Technology, Engineering, and Math</td>
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<td>WWC</td>
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SUMMARY

All students are entitled to receive mathematics instruction using curriculum aligned to grade-level, general education standards. However, for students with significant intellectual disabilities, the curriculum is almost exclusively functional life skills. While a few studies offer insight regarding elements affecting access to the general education curriculum for students with significant intellectual disabilities, they do not specifically target factors that complicate efforts to align mathematics curriculum and instruction to the National Council of Teachers of Mathematics and Common Core State Standards at the high school level. This study extends the limited research by specifically examining the perceptions of secondary special education teachers who deliver mathematics instruction to students with significant intellectual disabilities.

A statewide sample of 75 Illinois secondary special educators completed a survey that examined their perceptions related to the implementation of national mathematics standards and evidence-based practices in the areas of: (a) knowledge and familiarity with mathematics topics, (b) beliefs about mathematics instruction for students with significant intellectual disabilities, (c) preparation in mathematics instruction, (d) enactment of mathematics content and instructional strategies, and (e) challenges to teaching effective mathematics instruction.

Teacher responses were analyzed using descriptive statistics, correlation analysis, and hierarchical linear modeling, depending on the research question. The results revealed that almost all special educators taught students with significant intellectual disabilities in special education instructional classrooms or self-contained settings. Teachers indicated they primarily taught functional math skills, such as time and money.
Though no predictors were found that contributed to the content taught, there was a significant positive correlation between how often each content area was taught and the level of importance teachers believed each content area was for their students with SID. Further, special education teachers determined the curriculum in isolation, with limited opportunities for collaboration. Interestingly, teachers believed they were highly prepared despite having limited training in mathematics. This could be attributed to the fact that they are teaching functional math skills and thus feel qualified to teach it. The data suggests a need for more training, professional development, and curricular resources. The limitations of the study as well as considerations for research and practice to improve teacher knowledge, student outcomes, collaboration between general education and special education staff, and resources are discussed.

Key terms: intellectual disability, math instruction, special education teacher, significant intellectual disability, severe disability, survey
I. INTRODUCTION

A. Defining Students with Significant Intellectual Disabilities

Before discussing the research itself, it is important to define the population of focus. This dissertation studies mathematics instruction for students with significant intellectual disabilities (SID). The term significant intellectual disability is broadly used to describe learners with intellectual disabilities ranging from moderate to profound – a label previously referred to under the category of cognitive disabilities or mental retardation. Though state and federal categorical names have changed over time, the term significant disability has generally remained constant. As such, the term was useful keyword to find research for this population.

In 2010, President Obama signed legislation, referred to as Rosa’s Law, to replace the term mental retardation with intellectual disability (U.S. Government Printing Office, 2010) and the term is now reflected in the amended regulations of most states, including Illinois, and also in current research in the field. As the term intellectual disability can be used to describe a wide range of cognitive abilities, researchers will often define an individual’s level of disability with the range of mild, moderate, severe or profound. Intellectual functioning is usually measured by an IQ test, and individuals with IQs below 70-75 are defined as having intellectual disabilities (American Association on Intellectual and Developmental Disabilities, 2011). The Diagnostic and Statistical Manual of Mental Disorders defines the severity levels for intellectual disabilities as: Mild = IQ 55-70; Moderate = IQ 40-55; Severe IQ 25-40; Profound IQ < 25, plus or minus 5 points for as a margin of measurement error (American Psychiatric Association, 2013). In research
studies, IQ is used as one means of identifying students who have significant intellectual disabilities.

Educators also identify students with significant intellectual disabilities through statewide assessment practices. The Individuals with Disabilities Education Act (IDEA, 2004) defines students with SID as those students for whom regular assessment, even with accommodations, are inappropriate measures of student achievement. These students account for an estimated 1% of the students in the state who are assessed in a given subject (U.S. Department of Education, 2005).

B. Outcomes for Students with Significant Intellectual Disabilities

Mounting concerns about poor student outcomes, particularly for students with SID, uncovered a need for higher expectations and accountability (McLaughlin & Thurlow, 2003; Newman, Wagner, Cameto, Knokey, & Shaver, 2010). Post-secondary education and employment outcomes for students with significant intellectual disabilities remains abysmal. A mere 15% of students with intellectual disabilities attend some type of postsecondary education, as compared to 37% of students with all disabilities, and 78% for all high school graduates (Blackorby & Wagner, 1996; Wagner, Newman, Cameto, Garza, & Levine, 2005). Students with intellectual disabilities also demonstrate the lowest rate of paid employment (29.8%) among all students with disabilities (Newman et al., 2010). The majority of students with intellectual disabilities attend segregated day programs where individuals with disabilities work in a facility with other individuals with disabilities, usually earning less than minimum wage (Browder & Spooner, 2011; Newman, Wagner, Knokey, Marder, Nagle, Shaver, & Wei, 2011;
Shattuck, Narendorf, Cooper, Sterzing, Wagner, & Taylor, 2012; Shogren & Plotner, 2012; Spooner, Browder, & Uphold, 2011).

Until recently, little was known about the positive impact that access to the general curriculum has on post-school outcomes of students with significant intellectual disabilities (Spooner, Dymond, Smith, & Kennedy, 2006). Researchers emphasized the need to investigate effective academic interventions to ensure students with significant intellectual disabilities are making progress in the general education curriculum and generalizing these skills for enhanced student outcomes (Browder & Spooner, 2006). Emerging research indicated that access to the general education curriculum is a significant predictor of post-secondary achievement. The National Secondary Transition Technical Assistance Center (NSTTAC) conducted a two-part review of literature, first looking at experimental studies, and then examining correlational research (Test, Mazzotti, Mustian, Fowler, Kortering, & Kohler, 2009). The researchers identified 16 evidence-based predictors of post-secondary education, employment, and independent living, one of which was inclusion in the general education curriculum. Six years later, one of the researchers joined another set of colleagues to conduct a study that confirmed those earlier results and found four new predictors (Mazzotti, Rowe, Sinclair, Poppen, Woods, & Shearer, 2015). This later study confirmed that inclusion in the education curriculum was a strong predictor of all three post-school outcomes. Findings such as this led to a push for access to the general education curriculum, even for students with intellectual disabilities.
C. Accountability for Student Achievement

Historically, academic expectations for students with SID have been low (Agran, Alper, & Wehmeyer, 2002; Wehmeyer, Lattin, & Agran, 2001). No expectation existed for students’ participation and progress in the general education curriculum or for their inclusion in accountability measures. The curriculum for students with SID mirrored the expectancy, focusing solely on life skill instruction (Browder, Spooner, Ahlgrim-Delzell, Harris, & Wakeman, 2008; Dymond & Orelove, 2001; Orelove & Dymond, 2001; Shurr & Bouck, 2013). It was not until the 1997 reauthorization of the Individuals with Disabilities Education Act that the U.S. Department of Education explicitly stated that students with disabilities were to “be involved in and progress in the general curriculum” (IDEA 1997, 34 C.F.R.§ 300.347(a)(1)(i)). Despite the federal mandate, teachers serving students with SID did not perceive that the general education curriculum had much relevance (Agran, Alper, & Wehmeyer, 2002; Ruppar, Dymond, & Gaffney, 2011). Until 2004, instruction for students with SID continued to focus primarily on daily living skills (Browder et al., 2008), and access was interpreted as referring to the location in which a student was educated, rather than to the nature of the curriculum and instruction (Ryndak, Moore, & Orlando, 2010).

In addition, there was no oversight to ensure the intent of the law was carried out. Students with SID were not held to the same standards, nor were they included in state or district accountability measures (Gordon, 2006). Suffice it to say, the mandate did not have an effect on educational practices for students with SID, that is until the No Child Left Behind (NCLB) Act of 2001 (NCLB, 2002) and the Reauthorization of the
Individuals with Disabilities Education Improvement Act of 2004 (IDEA; 2004) coalesced, and students with SID were included in school reform.

The No Child Left Behind Act of 2001 (NCLB, 2002) profoundly changed the standards of education by holding states and school districts accountable for the achievement of “all” students in reading and mathematics linked to the state’s academic content standards (Yell, Drasgow, & Lowrey, 2005). States were no longer permitted to exclude students from assessments used to calculate annual yearly progress (AYP). Students who were unable to participate in regular state assessments completed alternative assessments linked to grade-level standards (U.S. Department of Education, 2005). Consequently, it raised expectations and ensured increased accountability for the progress of students with SID.

The Reauthorization of the Individuals with Disabilities Education Act (IDEA; 2004) mirrored the language of NCLB (2002) and underscored the rights of students with disabilities to be involved in and make progress in the general education curriculum. NCLB and IDEA 2004 dramatically shifted the focus of instruction for students with disabilities. Together, these pieces of legislation increased emphasis on academic achievement and mandated that districts find ways to help students with disabilities achieve the same common core standards in mathematics.

Changes in federal policy have promoted important advancements in giving students with SID improved access to the general education curriculum, accountability for academic progress, and, consequently, predicted improvement in post-school outcomes. The inclusion of students with severe and profound disabilities in high-stakes
assessments and school reporting has administrators paying attention to this population of students.

D. Evidence-based Practices

With growing emphasis on results, NCLB (2002), and more recently, the Every Student Succeeds Act (ESSA; 2015) emphasize the use of scientifically based strategies and methods for improving student achievement (Etscheidt & Curran, 2010; Yell et al., 2005). The law defines scientifically based research as “research that applies rigorous, systematic, and objective procedures to obtain relevant knowledge” (NCLB § 1208 (6)). In response to legislation, a number of different standards were developed for identifying evidence-based practices. The What Works Clearinghouse (WWC), a 2002 initiative of the U.S. Department of Education’s National Center for Education and Evaluation and Regional Assistance within the Institute of Educational Sciences (IES), provides a central source of critical scientific evidence for “what works” in education, including effectiveness of programs and interventions (What Works Clearinghouse, 2013). Until recently, WWC did not include interventions for students with disabilities in their reviews.

The identification of evidence-based practices (EBP) in special education is a relatively new practice (Courtade, Test, & Cook, 2014). After IDEA 2004 declared that a child’s individualized education program (IEP) must be based on “peer-reviewed research to the extent practicable to be provided to the child” (Section 1414(d)(1)(A)(i)(IV)), researchers began to grapple with defining EBP in special education. Odom, Brantlinger, Gersten, Horner, Thompson, and Harris (2005) conceptualized the development of quality indicators and guidelines for identifying
evidence-based practices in special education. Most recently, the Council for Exceptional Children (CEC), an international community of professionals in the field of special education, provided a set of standards, exclusively for special education, for determining EBP (Council for Exceptional Children, 2014). In developing the standards, CEC drew from WWC and the work of Gersten et al. (2005), who presented quality indicators for experimental and quasi-experimental studies in special education. CEC also used the work of Horner et al. (2005), who outlined quality indicators for single-subject research – the most predominant methodology used in research for students with SID in special education – to evaluate the merits of completed studies and standards for determining whether a practice is evidence-based.

According to Horner et al. (2005), practices are considered evidence-based if five studies spanning multiple researchers and regions and meeting quality guidelines can be identified in support of the practices. Prior to 2008, no evidence-based practices in core content areas had been identified for students with SID. Based on the guidelines set forth by Horner et al. (2005) and Gersten et al. (2005), Browder et al. (2008) spearheaded a comprehensive literature review and meta-analysis on mathematics instruction and students with significant intellectual disabilities. They synthesized 68 studies, finding strong evidence for using systematic instruction and for using in vivo settings (e.g. teaching purchasing skills at a store in the community). Spooner et al. (2011) identified time delay instruction and task analytic instruction as evidence-based practices for students with SID. Hudson, Browder, and Wood (2013) found that embedded-trial instruction with the use of constant time delay was an EBP for teaching academic skills
to students with moderate to severe intellectual disability in general education settings. These studies offered effective methods for teaching mathematics to students with SID.

Though research has demonstrated that instructional procedures such as constant time delay are effective, few examples exist for teaching content linked to grade-level mathematics standards to students with SID (Browder, Trela, Courtade, Jimenez, Knight, & Flowers, 2010). Most existing literature focused on functional mathematics topics (e.g. money and time) or on basic numbers and operations of addition and subtraction for younger students (Browder et al., 2008; Spooner et al., 2011). Research is still limited for other mathematics content areas, especially at the secondary level, and much work remains to identify evidence-based practices for teaching grade-aligned mathematics content to students with SID and to bring that research forth into practice (Browder, Jimenez, & Trela, 2012; Spooner & Browder, 2014).

E. Highly Qualified Special Education Teachers

A significant factor contributing to the gap between research and the use of EBPs is the quality of the teacher (McLeskey & Billingsley, 2008). Brownell, Sindelar, Kiely and Danielson (2010) noted that special education teachers had content knowledge that was connected to their classroom practices in mathematics. With increased awareness of historically poor outcomes for students with disabilities, national attention is focused on improving the teacher quality (Holdheide, Browder, Warren, Buzick, & Jones, 2012). A key goal of NCLB (2002) stipulated that every student would receive instruction from a “highly qualified” teacher. To be highly qualified, teachers had to hold a minimum of a bachelor’s degree, be fully credentialed in their state, and be able to demonstrate subject matter competency in the core academic subject areas that they teach (NCLB, 2002). In
addition to increased expectations under NCLB, legislation under IDEA 2004 also mandated that teachers be “highly qualified.” The laws required, among other things, that all teachers be certified in all subject-areas they teach.

For special education teachers, this implies that not only do the teachers have to maintain the proper special education certification, but they must also demonstrate academic subject-matter knowledge. This deviates significantly from traditional special education teacher preparation that has focused on developing effective strategies and behavioral interventions, as opposed to content, for teaching students with disabilities (Blanton, Pugach, & Boveda, 2014; Sindelar, Brownell, & Billingsley, 2010; Murphy & Marshall, 2015). Only recently has the special education profession included standards for subject-matter content knowledge (CEC, 2008). Still, the current competencies emphasize knowledge of the individual student over content knowledge (Council for Exceptional Children, 2014). The need for deeper content knowledge is now necessary for special education teachers charged with teaching the Common Core State Standards (CCSS) (Murphy & Marshall, 2015).

Certification changes for special education teachers also impact teachers’ qualifications to instruct students with SID. For instance, in Illinois, as a result of the 1992 Corey H. v. Board of Education of City of Chicago lawsuit, the Illinois State Board of Education (ISBE) was required to revise certification policies and procedures. In this case, several Chicago Public School (CPS) students with disabilities brought forth a class action lawsuit in an attempt to address a pervasive failure to educate students in the least restrictive environment (LRE) and placement decisions based on student’s category or severity. The result was a finding of non-compliance by not only CPS but also the ISBE.
The court noted that ISBE erred in certifying teachers by categorical labels associated with particular disabilities, thus precluding them from serving students in more inclusive environments. Ultimately, the state decided to settle the case. The terms of the agreement included language requiring ISBE to redesign its teacher certification policies effective July 1, 2001. The distinctions that once existed regarding a teacher’s training and expertise in a particular area of disability (learning disability, emotional disability, intellectual disability, etc.) were replaced with a cross-categorical credential system denoting teachers as learning behavioral specialists (LBS1). Presently, Illinois special education teachers have an LBS1 endorsement added to their teaching license.

As a result, special education teachers in Illinois are responsible for teaching students with disabilities across a broad spectrum of exceptionalities in a number of subjects across all levels of severity, from ages 5 through 21. This has affected both depth of content knowledge in academic content areas and methodologies for students with SID. For example, high school special education teachers may teach reading, mathematics, science, social studies, life skills, and vocational training, to students from 9th grade through age 22 with a range of disabilities, whereas their general education colleagues have expertise and teach in one subject area, such as math.

F. Relationships between Teachers and Mathematics Instruction

As student learning is highly dependent on teachers (Ball & Forzani, 2009; Karvonen, Wakeman, Flowers, & Moody, 2013; McLeskey & Billingsley, 2008), it is important to understand the myriad factors that may influence special education teachers’ effective math instruction and design for students with significant intellectual disabilities. The following section details four factors that emerged from existing research that may
affect the nature of mathematics instruction for students with significant intellectual
disabilities. These factors served as a basis for developing a survey of special education
teachers who teach mathematics to students with SID.

1. **Teacher beliefs and attitudes about students**

   Teacher beliefs and attitudes have been identified as predictors for the use
of EBPs and for instruction in standards-based curriculum (Klehm, 2011; Ryndak, Taub,
that expectations for students with intellectual disabilities have historically been low
(Wehmeyer, Latin, & Agran, 2001), it is not surprising that some teachers question the
relevance of the general education curriculum for students with significant intellectual
disabilities (Agran, Alper, & Wehmeyer, 2002; Petersen, 2016). To illustrate, the
National Longitudinal Transition Study-2 reported that teachers do not believe that
students with significant intellectual disabilities can benefit from or participate fully in
the general education curriculum (Wagner, Newman, Cameto, Levine, & Marder, 2007),
and that teachers do not implement what they do not see as being beneficial to students
(Nolen, Horn, Ward, & Childers, 2011). This may be one of the variables that influence
the continued overemphasis on life skills instruction for students with significant
intellectual disabilities.

   Another possible explanation may be found in the recent debate reflecting
concern that standards-based curriculum will overshadow instruction in functional life
skills that are important to improved adult outcomes (Ayres, Lowrey, Douglas, and
Sievers, 2011; Courtade, Spooner, Browder, & Jimenez, 2012). The argument is
especially pertinent at the high-school level, where strong emphasis is placed on the
approaching transition to adulthood. If special education teachers perceived access to the
general education curriculum as a significant predictor of post-secondary success, they
might be more likely to teach it in conjunction with the life skills that they feel are vital
for post-school independence.

Research has demonstrated that students with significant intellectual disabilities
can learn and benefit from academic content, including mathematics (Browder et al.,
2008). However, the reported lack of teacher buy-in and continued low expectations for
student achievement presents a major challenge for states working to support access to
the general education curriculum, especially in the area of mathematics instruction
(Agran et al., 2002; Petersen, 2016). In a survey of general and special education
teachers’ beliefs on teaching practices and potential achievements of students with
disabilities, Klehm (2014) noted that attitudes of reading teachers were much more
positive than those of math teachers. Furthermore, the reading teachers reported using
evidence-based practice more often than math teachers. Similarly, focus group
interviews conducted in a study by Petersen (2016) revealed that teachers’ beliefs
affected their decision-making. Most participants in the study expressed opinions that
access to the general education curriculum was not appropriate. This was illuminated by
one teacher’s comment that “I can teach them the core and then leave out the skills they
need, but since my kids are all about ready to graduate, a lot of times I just forget the
core. I don’t care if they can figure out a plot in a novel. I care if they can read a bus
schedule” (Petersen, 2016, p. 26). The perceptions expressed from the 21 special
education teachers provided some insight into teacher perceptions in general, but only
two of the participants were teaching mathematics in 9th-12th grade. Thus, more research
is needed to identify the basis for teacher perceptions and to identify ways to address teacher concerns, particularly addressing the unique factors at the secondary level in mathematics.

2. **Familiarity and knowledge of mathematics content and strategies**

   As previously mentioned, special education research and practice has focused more on teaching the “how” of instructional strategies and less on teachers’ understanding of the “what” of academic content knowledge (Blanton, Pugach, & Boveda, 2014; Sindelar, Brownell, & Billingsley, 2010). As such, it is not surprising that research indicates that special education teachers report feeling more prepared to implement instructional strategies than general education teachers (Gagnon & Maccini, 2007). Conversely, special education teachers report that they are less familiar than general education teachers are in the area of mathematics content knowledge (Gagnon & Maccini, 2007; Murphy & Marshall, 2015). Only a handful of studies were found that examined teacher preparedness to teach the general education curriculum to students with SID (Olson, Leko, & Roberts, 2016; Petersen, 2016; Ruppar et al., 2016; Ruppar, Roberts, & Olson, 2017; Timberlake, 2016).

   a. **Math content.**

   Murphy and Marshall (2015) found that special education pre-service teachers expressed a superficial level of understanding of CCSS and view the standards as a mandate rather than as a critical component in educational planning.

   Studies of in-service special educators indicate teacher uncertainty about the CCSS and about how to provide instruction that is aligned to the standards (Petersen 2016; Ruppar, Neuper, & Dalsen, 2016; Timberlake, 2016). This is similar to previous studies in which
special education teachers reported that they were unfamiliar with the general education curriculum (Maccini & Gagnon, 2002; Otis-Wilborn, Winn, Griffin & Kilgore, 2005).

Findings gathered from observing special education teachers’ instruction were consistent with perceptions that teachers are not instructing on the math standards. Restorff and Abery (2013) observed academic instruction in 39 classrooms of students with significant intellectual disabilities, noting an absence of age-appropriate materials in all of the classrooms, a finding they concluded might “illustrate a paucity of materials that bridge the gap between challenging grade-level content and a reduction in the complexity of the material that does not compromise age-appropriate presentation” (pg. 289). Clearly the research, or lack thereof, reflects a need for increased teacher preparation, and the need for more research focusing on students with significant intellectual disabilities, an extremely under-represented group (Ruppar et al., 2016; Spooner & Browder, 2014).

There are some, albeit infrequent, examples of classroom instruction in the general education curriculum for students with SID. Olson et al. (2016) observed students with SID accessing the same content as their general education peers in one suburban middle school in the Midwest. Ruppar, Roberts, and Olson (2017) interviewed 11 “expert teachers” students with SID, three of which taught at the high school level. They found that the teachers in the study consistently emphasized access to age-appropriate academic content, including algebra. Their study was the only study that included some perceptions of high school special education teachers working in the field with students with SID and that specifically referenced math content. All other studies examining teachers’ perceived knowledge specifically in the area of mathematics have
focused on teachers of students with learning and emotional disabilities, and not teachers of students with significant intellectual disabilities (Ruppar, Neeper, & Dalsen, 2016).

b. Math strategies.

Although researchers have identified a number of effective instructional strategies for students with significant intellectual disabilities (e.g. systematic and explicit instruction, peer tutoring, visual representation, and prompting) (Browder et al., 2008), teachers struggle to determine how to make the curriculum accessible and are concerned about aligning evidence-based practices with Common Core Standards (Murphy & Marshall, 2015; Petersen, 2016; Ruppar et al., 2016). Greenway et al. (2013) conducted semi-structured interviews of nine special education teachers of elementary-aged students with intellectual and developmental disabilities. They found that the teachers had varied beliefs, understandings, and perceptions of the nature of evidence-based practices. The teachers wanted to know that the existing research had been conducted on similar students with similar needs. Teachers did not name specific evidence-based practices in response to the question, but described some practices when explaining a student’s day. The researchers concluded that the teachers’ failure to identify these practices might be one reason that reported use was low. The teachers also articulated two other ideas: significant autonomy and lack of accountability. They identified greater freedom to use their professional judgment to make instructional decisions and write their own curriculum and did not have much oversight from administration. The researchers noted that despite the intention of NCLB to raise achievement, it appeared that the legislation had little effect on classroom practices for students with intellectual disabilities. This is especially problematic when most students
with significant intellectual disabilities are receiving academic content from special
education teachers in self-contained classrooms (Bouck, 2011; Browder et al., 2008;
Kleinert et al., 2015; Spooner et al., 2011). It is important to gain a wider perspective
from special education teachers of students with SID to substantiate findings that
influence decision-making, including teacher familiarity and knowledge of mathematics
content and strategies, as it can affect the curriculum and instruction used in the
classroom (Greenway, McCollow, Hudson, Peck, & Davis, 2013; Klehm, 2014; Maccini
& Gagnon, 2006; Murphy & Marshall, 2015).

3. Preparation to teach standards-based mathematics instruction

The preparation of teachers occurs along a continuum, extending from the
pre-service years into experienced teaching (Blanton, Pugach, & Boveda, 2014). With
the adoption of the CCSS comes a need for special education teacher training. Most
teacher preparation programs do not adequately prepare special educators to teach
standards-based academics content, including mathematics, to students who have severe
disabilities (Flowers, Ahlgrim-Delzell, Browder, & Spooner, 2005; Spooner, Dymond,
Smith & Kennedy, 2006; Murphy & Marshall, 2015). A number of factors may
contribute to insufficient teacher preparation. First and foremost, faculty in higher
education expressed low self-efficacy to teach CCSS. In a collective case study, Murphy
and Marshall (2015) synthesized the interviews with nine professors – five in special
education and four in general education – from five institutions of higher education in
two southeastern states. They found that special education professors expressed a sense
of inadequate preparation in the CCSS. The majority expressed concern regarding their
ability to help pre-service teachers address the standards and align the CCSS to evidence-
based practices. A main concern they had was how to address IEP goals and students’ needs relative to the CCSS, especially for students with moderate to severe disabilities.

Similar to the research showing that reading teachers had more favorable attitudes than math teachers regarding the achievement potential of students with SID, Murphy and Marshall’s (2015) study determined that special education pre-service teachers felt more comfortable with English Language Arts (ELA) standards than with math standards. Conversely, they reported that the grade-level mathematics standards were more difficult to address (Murphy & Marshall, 2015). Though they discussed the importance of teaching to the CCSS, they also noted the need for better preparation in applying evidence-based practices to content standards and in adapting the standards to students’ needs across service delivery models.

Clearly, teacher preparation programs can have an impact on teacher preparation. Gagnon and Maccini (2007) found that the number of methods courses taken by teachers was a predictor of teacher confidence and of teachers’ use of instructional strategies consistent with National Council of Teachers of Mathematics (NCTM) standards. Special education teachers of students with learning disabilities (LD) and emotional disabilities (ED) took an average of two general education methods courses. No studies could be found related to teachers of students with significant intellectual disabilities. Therefore, research is needed to examine how teacher licensure affects perceptions of preparedness to teach students with SID (Ruppar et al., 2016).

Finally, little attention has been paid to developing the mathematics knowledge of experienced special education teachers (Faulkner & Cain, 2013), and even less attention has been paid to development the mathematics knowledge of teachers of students with...
SID (Yoon, Lee, & Shapley, 2007). Thus, it can be purported that all special education teachers who are not adequately prepared and who are now responsible for teaching grade-aligned mathematics to students with SID will learn about the content through in-service professional development; very few have the licensure or preparation to instruct in academic subjects, including mathematics (Karvonen, Wakeman, Browder, Rogers, & Flowers, 2011).

4. **Instructional decisions**

Special education teachers of students with SID may operate with relative autonomy and discretion in curriculum and instructional decision-making (Greenway et al., 2013; Timberlake, 2014). Research suggests that their curriculum design tends to be driven more by IEP goals than grade-level standards (Soukup, Wehmeyer, Bashinski, & Bovaird, 2007). Though assessment should drive instruction, it is not often the primary factor guiding special educators’ instructional decisions (Olson, 2003). There is some evidence to suggest that compliance with Alternative Assessment based on Alternative Achievement Standards (AA-AAS) or other policy messages may impact curricular and instructional decisions (Karvonen, Flowers, & Wakeman, 2013; Timberlake, 2014).

5. **Resources available**

The challenges special educators face in teaching mathematics can be immense. In addition to a lack of preparation and confidence, many special education teachers report that a primary barrier to teaching the general education content is the lack of curriculum materials available (Carpenter, 1985; Fitzmaurice, 1980; Greenway et al., 2013; Maccini & Gagnon, 2002; Maccini & Gagnon, 2006; Otis-Wilborn, Winn, Griffin & Kilgore, 2005). The limited studies pertaining to students with significant intellectual
disabilities have identified similar barriers (e.g. uncertainty about content), lack of age-appropriate general education curriculum and materials, lack of easy access to research in the field, and the need for relevant professional development and support (Greenway et al., 2013; Lee, Browder, Flowers, & Wakeman, 2016; Restorff & Abery, 2013). Further, teachers report that evidence-based practices may not be used to instruct students with disabilities due to a lack of time and available resources, or political influences (Klehm, 2014), and the ability to apply evidence-based practices to content standards including the Common Core State Standards (Murphy & Marshall, 2015).

One researcher group sought to address the gap by providing resources to special education teachers of students with SID. Lee et al. (2016) provided 125 special education teachers with online mathematics content modules for building their content knowledge of mathematics and providing guidance for making grade-level mathematics accessible for students with SID, and then surveyed participants on the usefulness of the resources. The majority of participants (84%) found the modules helpful, and 77% indicated that such more resources are needed. Resources are not readily available for special education teachers of students with SID.

6. Summary

Federal mandates are outpacing research in the field of special education teacher education. There are no shared expectations or curriculum to prepare teachers to instruct in math (Ball, Sleep, Boerst, & Bass, 2009), and many special education teachers, feeling unprepared to teach the content (Flowers et al., 2005; Murphy & Marshall, 2015; Maccini & Gagnon, 2002; Spooner et al., 2006), are seeking more resources for teaching students with significant intellectual disabilities (Lee et al., 2016).
Prior to Ruppar et al.’s (2016) study, no studies were found that focused on special educators’ perceptions to teach students with SID at the high school level. In the last year, there was a small but growing body of research that took a general look at special education teachers’ perceptions of preparedness to teach students with significant intellectual disabilities (Lee et al., 2016; Olson et al., 2016; Petersen, 2016; Ruppar et al., 2016; Ruppar et al., 2017; Timberlake, 2016). Though not specifically focused on mathematics content and instruction, these studies began to examine special education teachers’ perceptions regarding access to the general education curriculum for students with significant intellectual disabilities. They also suggested that additional research to evaluate special education teacher perceptions of preparedness to teach students with SID, including increase the scope of participants across states (Petersen, 2015) and examining how licensure affects preparedness (Ruppar et al., 2016).

Further, there is limited research specific to mathematics instruction for students with SID. The few studies that have examined special education teacher perceptions specifically in mathematics curriculum and mathematics instructional strategies have focused on students with LD or ED (Gagnon & Maccini, 2007; Greenway et al., 2013). Greenway et al. (2013) provided some insight on the ways that teachers perceive evidence-based practices for students with significant intellectual disabilities. Though informative, their research focused on elementary-level teachers and evidence-based instructional strategies, not mathematics content. As math is perceived as more difficult to implement, especially at the secondary level, it is critical to understand the unique contexts and perspectives that special education teachers have for students with SID at
the high-school level in order to move ideas from policy and research to practice and improve outcomes for students.

G. Purpose of the study

The purpose of this study was to explore mathematics instruction for students with significant intellectual disabilities, and specifically to identify factors (e.g. perceptions, competency knowledge, training, resources, organizational factors) that influence special education teachers’ math instruction and curriculum design at the high school level, as well as to determine barriers that may interfere with the delivery of standards-based math instruction. The current study was designed to answer the following research questions:

1. What is the content being taught to students with significant intellectual disabilities (e.g. functional skills, secondary course topics)?

2. What evidence-based practices do special education teachers reportedly use during mathematics instruction for students with significant intellectual disabilities?

3. How was the mathematics curriculum and instruction determined? Was it based on the individual (attributes, assessments, and/or goals), on teacher variables, and/or on organizational influences?

4. How reportedly knowledgeable are secondary special education teachers of mathematics content and instruction? Is there a relationship between the perceived knowledge that teachers possess and their curriculum and instruction? Where do high school special education teachers learn about curriculum and instructional strategies for teaching mathematics to students
with significant intellectual disabilities (e.g. college courses, professional development activities, consultation with general education teachers)? What are the perceived barriers to teaching standards-based math content for high school students with significant intellectual disabilities and what are the possible resolutions?

5. How much variation in mathematics content (e.g. algebra, life skills) is accounted for by teacher-level characteristics (licensure, coursework, attitudes, perceived preparation and knowledge, location, and classroom setting) above and beyond years of teaching experience?
II. REVIEW OF THE LITERATURE

A. Theoretical Framework

The Ecological Systems Theory and its five environmental systems provided a useful context for considering environmental influences on student development and outcomes, including influences of personal characteristics, teacher-student relationships, and influences external to the immediate context, such as federal policy (Bronfenbrenner, 1994; Ruppar et al., 2017; Sontag, 1996). The environments consist of a hierarchy of systems: microsystem, mesosystem, exosystem, macrosystem, and chronosystem. The microsystem is the most proximal level and represents “a pattern of activities, social roles, and interpersonal relations experienced by the developing person in a given face-to-face setting” (Bronfenbrenner, 1994, p. 39), which in school would be characterized by the teacher-student dyad. The mesosystem “comprises the interrelations among two or more settings in which the developing person actively participates” (Bronfenbrenner, 1979, p. 25). The exosystem also includes two or more settings, however, the one does not typically contain the student but have an indirect influence. The macrosystem “consists of the overarching pattern of micro-, meso-, and exo-systems characteristic of a given culture or subculture, with particular reference to the belief systems, bodies of knowledge, material resources…” (Bronfenbrenner, 1994, p. 40). Finally, the chronosystem includes a third dimension, the passage of time. Problems in the “micro” context of student-teacher interactions in classrooms can often be the result of “macro” contextual variables, such as the larger organization or externally imposed national agendas.
It appears that the research for students with SID follows a model presuming that if we can demonstrate how students learn through the use of evidence-based practices (e.g. systematic instruction), then we will know how teachers should teach. Most research studies for students with SID have focused on teaching discrete skills to students using an evidence-based practice (e.g. task analytic instruction). Though research on individual skills adds to resources available to special education teachers, it does not take into account other factors that may affect instructional practices. Focusing in a microcosm at an individual level ignores the interrelations between hierarchically structured systems that help support and guide human development (Bronfenbrenner, 1994). It is important to understand larger contextual factors and their effects on teachers’ implementation and use of knowledge. Bronfenbrenner’s theory provides a framework to examine the interrelation between the classroom context including teacher characteristics and the practice of teaching, and also offers guidance for understanding the conditions of practice and processes for improvement. This process may involve organizational changes (e.g. redefining curriculum, changing the delivery model, or developing systems of professional development) and it may involve learning more about what shapes teacher practice, such as teacher attitudes and beliefs about students with SID and instruction and supports needed to apply evidence-based interventions (Malouf & Schiller, 1995).

Greenway et al. (2013) developed a conceptual model for understanding the complex web of organizational, social, and instrumental factors that impact teacher decision-making about practice (see Figure 1, Appendix C). Using semi-structured interviews, they collected perspectives from nine elementary-school special education
teachers of students with intellectual and developmental disabilities to understand the teachers’ perspectives on evidence-based practices and decision-making. They found that organizational factors influenced teacher autonomy, reduced accountability, and limited access to tools and resources. It emerged that special education teachers lacked access to the general education curriculum and tools. Grounded by Bronfenbrenner’s Ecological Systems Theory, their model provided a way to examine the influence of individual factors, interaction effects, and system-level factors on the use of evidence-based practices for students with intellectual disabilities. The conceptual model, which encompasses variables identified by Gagnon and Maccini (2007) as well as other potential factors, was used to understand factors that influence use of grade-level mathematics content standards for students with significant intellectual disabilities at the high school level. Factors explored through the survey included people (students and teachers), tools (curriculum, resources, training), and organizations (professional organizations, district, state, and federal) and the influences of those categories on teacher decision-making for the mathematics curriculum and instruction for students with SID.

Using an ecological perspective, this current study sought to investigate the relationship between special education teacher attitudes/perceptions, preparation, knowledge, and access to resources and mathematics instruction for students with SID. Special education teacher responses can serve as a guide for evaluating the individual needs of students with SID and evaluating their opportunities for access to general education curriculum, instruction, and design in mathematics (Hunt, McDonnell, & Crockett, 2012) by considering the beliefs, skills, settings, and relationships that support participation in general education.
Described by Greenwood, Carta, & Atwater (1991) as an extension of behavior analysis with the access to systems and contexts added, the Bronfenbrenner theory is very applicable to the unique personal characteristics of students with SID. Static child characteristics such as IQ or type of disability are often used as a predictor variable of teacher attitudes. Considering the broader “macrosystem” or social context (belief systems and resources) that affect the individual is critical to understanding the relationship of research knowledge and special education teacher practice (Malouf & Schiller, 1995; Sontag, 1996). Sociocultural factors outside of the classroom can influence the achievement and outcomes of students with SID. Taking a broader look at people, organizations and tools can provide much greater insight and direction to bridge policy and research to practice.

Figure 1. A Conceptual Framework of Practitioner Understanding of Evidence-Based Practices

B. NCTM and CCSS

Current federal policies such as NCLB and IDEA 2004 have mandated that states and districts help students with SID achieve grade-level state standards in mathematics. In the area of mathematics, the NCTM provides a comprehensive set of standards for all 5 areas of mathematics: (a) number and operations, (b) measurement, (c) data analysis and probability, (d) geometry, and (e) algebra (NCTM, 2006). The principles of NCTM describe, “a future in which all students have access to rigorous, high-quality mathematics instruction” and where “knowledgeable teachers have adequate support and ongoing access to professional development” (NCTM, 2006) Further, most states adopted a national set of standards, the Common Core State Standards (CCSS).

The CCSS is a set of high-quality academic standards in mathematics and English language arts/literacy (ELA). These learning goals outline what a student should know and be able to do at the end of each grade. The standards were created to ensure that all students graduate with the skills necessary for college and career-readiness, regardless of where they reside (CCSS, 2012). The standards in mathematics, aligned with NCTM, emphasize the need for all students, including students who are well below grade level expectations, to learn the same material and meet the same high standards.

These policies raise the bar for students with SID and consequently hold schools accountable for their performance, educational progress, and post-school outcomes. However, implementing the guiding principles in the law has been a challenge. A limited scope of research exists that aligns mathematics instruction to the general education curriculum and learning standards for students with significant intellectual disabilities.
C. **Intervention Studies on Math Instruction for Students with Intellectual Disabilities**

A review of existing research revealed 35 studies on mathematics instruction for students with significant intellectual disabilities conducted during the last decade (see Table 1). The keyword search included four electronic databases – Academic Search Premier, Sage Premier Full Text, Primary Search, and Education Resource, Information Center. In addition to searching by terms, a search was conducted of the authors referenced in key articles. Finally, there was a manual search of seven specialized journals: Research and Practice for Persons with Severe Disabilities; Exceptional Children; Focus on Autism and Other Developmental Disabilities; Remedial and Special Education; Teacher Education and Special Education; Education and Training in Autism and Developmental Disabilities; and the Journal of Special Education. The scope of this search was based on specific inclusionary and exclusionary criteria. For purposes of this study, publications were limited to those identifying at least one participant as having a significant intellectual disability, and those with a study focus on teaching math. The search was broadened to include all school-aged students (kindergarten through 12th grade) with significant intellectual disabilities in an attempt to find more research on effective instructional methods across all areas of math. All 35 studies were published between 2006 and 2017, focusing the literature review on the last decade of research since an extensive meta-analysis was conducted on studies that were published before that time, between 1975 and 2005 (Browder et al., 2008). A number of themes emerged.
First, despite recent legislation mandating that students with intellectual
disabilities be educated in the general education environment, most received instruction
in self-contained classrooms, in separate schools, or in separate testing rooms (Bouck,
2011; Kleinert, Reeves, Quenemoen, Thurlow, Fluegge, Weseman, & Kerbel, 2015;
Kurth, Morningstar, & Kozleski, 2014). Few of the 35 studies were conducted in the
general education classroom (n = 3) or community setting (n = 6). (See Table 1 in
appendices for the list of studies.) In recent years, only two studies focusing on
mathematics and on students with significant intellectual disabilities were conducted in a
general education classroom (Browder, Jimenez, Spooner et al., 2012; Heinrich et al.,
2016). This was true for students with both moderate and severe to profound intellectual
disabilities included in the studies. This means that special education teachers often serve
as the mathematics content specialists given that most students are taught in self-
contained classrooms.

Another theme that emerged was the limited research targeting students with
severe or profound disabilities. Most studies included participants in the mild to
moderate intellectual disability range. Only four of the studies included students with
more severe or profound disabilities (Browder, Jimenez, & Trela, 2012; Browder, Trela,
Courtade, Jimenez, Knight, & Flowers, 2012; Everhart et al., 2011; Horn et al., 2006).

A third theme that emerged was the limited research across grade levels.
Research on mathematics and students with significant intellectual disabilities was
particularly sparse at the secondary level (Yakubova & Bouck, 2014). Teachers have few
models for teaching high school students with significant intellectual disabilities,
especially for mathematics (Browder, Jimenez, & Trela, 2012). Only 13 of the studies identified in this literature review focused on the high school population.

1. Mathematics content areas

In addition to limited research across grade levels, research was limited across mathematics content areas. As mentioned in Chapter 1, NCLB and IDEA 2004 have raised accountability for all students, including students with SID, to demonstrate progress on grade-level content standards. This prompted a slight shift in research and practice regarding students with SID—specifically moving from a focus on life skills instruction to an academic focus (Dymond & Orelove, 2001; Spooner et al., 2011; Jimenez & Kemmery, 2013; Shurr & Bouck, 2013). The literature in this review reflected that shift. Thirteen studies of the 35 studies were focused on numeracy skills applied to life skill instruction, including telling time, purchasing items, and completing banking activities (see Table 1). Most of the studies addressed number concepts and basic operations, while only a handful covered higher-level content standards. Very few of the studies related to the grade-level general education curriculum. Broken down into NCTM components, most studies focused on numbers and operations or measurement.

a. Numbers and operations.

Research indicates that children can exhibit early math knowledge and principles in areas such as counting, number concepts, and strategies for solving basic mathematics problems. To develop a conceptual model for building early numeracy skills of students with moderate intellectual disabilities, Browder et al. (2012) conducted a pilot study in two settings to teach early numeracy skills to six 3rd through 5th graders with moderate intellectual disabilities and autism. The first setting provided
small group instruction in a special education classroom using a literacy-based approach, while the second setting employed embedded instruction delivered by an instructional assistant in the students’ respective general education classrooms. None of the students had been included in general education classrooms for core academic content prior to this study. Systematic prompting and feedback was employed, and students were provided with graphic organizers and materials. The dependent variable was the number of correct items on a curriculum-based assessment targeting nine objectives. The study yielded encouraging outcomes for early numeracy instruction within the general education setting. Based on the results of the six individual case studies, researchers determined that all students showed a positive trend line across units and noted that students performed more skills correctly during embedded instruction, as measured by the percentage of skills performed correctly during trials.

Extending the research in early numeracy for students with SID, Jimenez and Kemmery (2013) studied the effects of a “numeracy treatment package” on five elementary-aged students with moderate intellectual disabilities in their self-contained classrooms. The treatment package included story-based math problems, systematic instruction (using time delay and least-to-most prompting), graphic organizers, and multiple exemplar training. The researchers applied the Attainment Company’s Early Numeracy Curriculum assessment to measure the targeted math skills embedded into each lesson, and employed a research design consisting of a staggered, multiple probe across three groups of students. The results of comparing the percentage of non-overlapping data demonstrated that the treatment package was effective for all students, reinforcing research findings that systematic instruction, literacy-based lessons, and
graphic organizers are evidence-based practices for teaching mathematics skills to students with moderate intellectual disabilities.

Skibo, Mims, and Spooner (2011) also used a prompting system (a system of least prompts) to teach early numeracy, but they paired the prompting system with the use of response cards – also referred to as active student responding – to teach number identification to students with moderate to profound disabilities. The response cards are boards that are simultaneously held up by students to actively exhibit their response to a question presented by the teacher.

Three students between the ages of 7 and 10 participated in the study, which was conducted in a self-contained classroom in a separate public school. Researchers used a procedure of multiple probes across participants. The dependent variable was the number of correct responses to questions on number identification for the numerals one through five. The level of verbal, gestural, or physical prompting was also recorded. All students’ responses increased with the use of systematic instruction and response cards, and all three maintained the skill during the maintenance phase.

Number identification skills were also studied by Everhart, Alber-Morgan, and Park (2011) in their examination of the effects of computer-based practice on the acquisition of basic academic skills. Using computer-assisted instruction (CAI), which has been shown to increase student engagement and performance, two students with moderate to intensive needs ages six and nine were taught three skills – number identification, letter identification, and color word identification. The researchers used a multiple baseline across skills design in a self-contained classroom in a public elementary
school. The number of correct responses was the dependent measure. The results indicated a functional relationship between computer practice and skill acquisition.

The next set of studies examined the numerical operations of addition, subtraction, multiplication, and division. According to Djuric-Zdravkovic et al. (2011) attention deficits in children with intellectual disabilities can hinder the absorption of mathematics knowledge. The purpose of their study was to evaluate the influence of attention on mastering addition and subtraction operations. Sixty students with mild to moderate intellectual disabilities participated in the study. The students, 56.7% of whom were male, and 43.3% of whom were female, ranged in age from 12 to 14 and attended a separate primary school in Serbia. To evaluate the students’ attention levels, they used the Trail Making and Double Letter Cancellation tests, finding a significant difference in the relationship between the development of attention and the comprehension of content of math operations involving addition and subtraction.

Comparing two strategies – number lines and TouchMath touch points – Cihak and Foust (2008) evaluated the academic performance of students with intellectual disabilities in solving addition problems. Prior to intervention, none of the three elementary students (ages 7, 7, and 8) could correctly calculate single-digit addition problems. The study took place in each student’s resource room. An alternating-treatment design was used to examine the differential effects of the touch points. The percentage of correct problems completed independently was the dependent variable. The researchers concluded that touch points were more effective than number lines for solving single-digit addition problems, findings that support earlier studies suggesting
that touch points were a promising method for teaching single digit addition to students with intellectual disabilities and autism.

Shortly thereafter, Fletcher, Boon, and Cihak (2010) replicated and extended the research to examine the effectiveness of TouchMath compared to a number line strategy for students at the middle school level. Three 13- and 14-year-old students with moderate intellectual disabilities participated in the study, conducted in their self-contained classroom. As was the case in the previous study, Fletcher et al. (2010) evaluated students’ performance on the percentage of single-digit mathematics problems performed correctly. Results from the alternate treatment design revealed once again that students showed more significant progress using touch points than number lines. Students averaged 92% correct when using touch points, compared to averaging only 30% correct when using the number line strategy. The study also demonstrated the touch points were a more efficient method than number lines for computation.

Jolivette, Lingo, Houchins, Barton-Arwood, and Shippen (2006) focused their research on the impact of the mathematics fluency program Great Leaps on addition and subtraction computation skills. Great Leaps is a supplemental math program designed to build fluency in the basic facts, including addition, subtraction, multiplication, and division (Mercer, Mercer, & Campbell, 2000). The prescribed lesson plan is discussed in the sections of this study that outline the study design and present the methods used for data collection.

Three students participated in the supplemental intervention using Great Leaps. Two were third grade students identified with developmental disabilities, with one noted as having SID. The third student was a second grader identified as ADHD. Though the
students continued to receive math instruction in the general education environment, the study was conducted one-on-one in the resource room of a rural, southeastern elementary school. During baseline, students were shown 25 single-digit addition facts on flashcards in random order and were given one minute to verbally answer as many as possible. Students then participated in a daily session that lasted approximately 5-7 minutes per participant. Each session followed the prescribed five-step strategy of (a) greeting the student, (b) reviewing previously presented material, (c) providing instruction/practice with error correction and the use of manipulatives as needed, (d) administering a one-minute probe, and graph the results. Data was collected using a multiple-probe-across-student design, recording the number of correct and incorrect responses each participant made within the one-minute probe. A response was scored as correct if the student independently answered the math prompt within three seconds. If the student made an error but self-corrected within the three-second window, the answer was counted as correct. The number of correct probes per minute was graphed by the teacher and student at the end of each session. A “leap” occurred when students had 25 correct responses and no errors per minute.

The results varied among the three participants. Though all three students made gains in oral fluency of math facts, the students progressed at different rates, and only one student completed the written fluency for addition and progressed to subtraction. Interestingly, the researcher reported that the two students that required more administrations of the probes prior to making “leaps” were both previously taught to use the counting dots strategy as a means of solving basic math problems. Though deemed
appropriate for acquisition of the skill, it may have negatively impacted students’ performance on timed tests.

The preceding article studied student progress through the use of a specific curriculum. Shen (2006) examined the use of a specific tool to teach math calculations. The research, conducted in China, examined the effects of mental abacus training on the mathematics achievement of children with mild and moderate intellectual disabilities. According to the researcher, there are three phases of instruction that enhance rapid math calculation. In the first phase, repeated practice is used on a physical abacus until the person becomes highly skilled. In the second phase, the student performs operations while looking at, but not touching, the abacus. In the third phase, the student visualizes the abacus and performs the operations on this “mental” abacus (Tang, 1993). Previous research showed that students can make math calculations efficiently and accurately using mental abacus calculation (Miller & Stigler, 1991), and that the use of mental abacus calculation can acquire number concepts, increase efficiency, improve concentration and memory, and strengthen self-esteem (Huang et al. 1994). For this study, Shen (2006) focused on number concepts, computation skills, and application to real-life situations.

Eighty first-grade students from four special education schools in a large urban setting in China participated in the study. All students were diagnosed with intellectual disabilities on the Chinese version of the WISC-R, and had IQ scores ranging from 54 to 78. Fifty-five of the students were male, and 25 were female. Students were randomly assigned to experimental and control groups. Experimental groups used a special education math curriculum that included preparation in using the mental abacus. The
control group used the same conventional math curriculum without mental abacus training, and the researchers used a pretest-posttest design, with unit tests administered by participating teachers to assess progress. An application subtest simulating real world situations was administered to assess application, and t-tests were performed to determine whether there were statistically significant differences between control and experimental groups.

A significant difference existed between groups. Overall, the mean score of the posttest for the experimental group was almost 10 points higher, findings suggesting that mental abacus training, when embedded into an appropriate mathematics curriculum, can be an effective method for teaching math to students with intellectual disabilities. Though promising, the results should be interpreted with caution. Prior to beginning instruction, the experimental group received training in the curriculum with the abacus, but the control group did not receive any training. While the teachers for both the experimental group and control group used manipulatives, teachers for the control group tended to stop using manipulatives before students fully mastered the concepts. It could be argued that the use of the abacus was less relevant to findings and more relevant to instruction and continued use of manipulatives and/or abacus.

Miller, Rule, and MacEntee (2008) examined the efficacy of using manipulatives to teach high school students with intellectual disabilities the four subtraction situations of take away, comparison, completion, and whole-part-part. The authors constructed this mixed methods case study using two conceptual frameworks – first employing the concept that students more readily learn abstract tasks through concrete representations using manipulatives, and second, designing their study to include four criteria for
intrinsic motivation based on the work of Malone and Lepper (1987) and others. Teacher-made, hands-on sets of materials were created to provide challenge, control, curiosity, and fantasy. Two male high school students with intellectual disabilities participated in the study. It was not specified if the students had mild or more significant intellectual disabilities. The study was conducted in a life skills class within a rural high school setting. Both students took a pretest on subtraction story problems eight weeks prior to instruction. For the study, the students then participated in 12 half-hour lessons over a period of two and a half weeks, taking an identical post-test after the final lesson. The pretest and post-test, as well as qualitative teacher observations, were used to triangulate the data and determine the effectiveness of the approach.

Both students scored an 8 out of 8 on the posttest. From the observations and data, the author concluded that the use of concrete manipulatives assisted the students, and thus recommended that “students be given the opportunity to work with hands on materials whenever possible to improve their math skills” (pg. 9). The authors also noted that the hands-on activities were motivating, and the materials and methods were determined to be effective. Though the positive results might indicate a causal relationship, the two students had very different errors on the pretest. One student could not solve any of the problems because he interpreted four problems as addition, subtracted others incorrectly, and was confused by the wording. The other student was able to solve three of the eight problems on the pretest, and his errors were simply due to incorrect counting. Lastly, though more emphasis was placed on motivation during math activities then on the method of instruction, this study does support the idea that students with intellectual disabilities can learn the four situations for subtraction.
The use of manipulatives is a component of the concrete-representational-abstract (CRA) sequence, with the concrete stage using objects such as manipulatives. Flores, Hinton, Strozier, and Terry (2014) used CRA and the strategic instruction model (SIM) to teach addition and subtraction computation skills to 11 elementary students ages 5 through 12 with mild to moderate intellectual disabilities, autism, and developmental disabilities. To assess the effectiveness of CRA-SIM, researchers used a paired-samples t-test statistical procedure to evaluate differences in student progress across curriculum-based measures (CBM) over the course of the study. Researchers also conducted a one-sample t-test to compare student performance to weekly growth rates established by Fuchs and Fuchs, and also examined effect size in order to evaluate statistical significance. Results indicated that students made significant progress across the study as measured by the three CBMs. Of particular note was the fact that students who participated in the study made progress at or above the expected rate of progress for students without disabilities.

A study by Root, Browder, Saunders, and Lo (2017) combined the use of modified schema-based instruction with manipulatives, comparing concrete manipulatives (plastic, round chips) to virtual manipulatives (blue circles on an iPad 3) for teaching compare-type (more/less) word problems to three elementary-aged students with significant autism and mild to moderate intellectual disabilities. The study took place in a small tutorial room down the hall from the students’ self-contained classroom. Following baseline, the researcher provided training in each of the nine steps of a task analysis using a model-lead-test format and a system of least prompts. Students received copies of the task analysis that contained text and pictures to use as a self-instruction
sheet, and were also provided with a graphic organizer (schema diagram) on laminated paper or on the iPad depending on the treatment condition. On the iPad, students dragged the virtual manipulatives onto the graphic organizer. The graphic organizer looked identical in both forms.

During baseline, intervention, and maintenance, data was collected on the number of steps that students were able to complete independently. The researchers used a multiple probe across participants design, with an alternating treatment design for the concrete and virtual manipulatives conditions. The dependent variable was the total number of points the students received following the steps of the task analysis. For steps one through eight, students received one point for each step they completed independently. They received two points independent completion of step 9, which was to solve a word problem and write the answer. All students improved their performance on completing word problems following the intervention. Two of the participants performed more correct steps in the virtual condition, while one student performed similarly under both conditions. Based on the data, the researchers concluded that a functional relationship existed between schema-based instruction and mathematics problem-solving for compare-type word problems. Social validity was also strong. Teachers indicated responses of mostly agree or completely agree to questions regarding the effectiveness of the intervention. One teacher preferred the concrete materials, but all students, when given a choice, preferred the virtual materials.

Building on the limited research regarding the use of schema-based instruction combined with systematic instruction to teach students with SID to solve word problems, Root, Saunders, Spooner, and Brosh (2017) conducted a study with three middle school
students with moderate intellectual disabilities to evaluate the effectiveness of schema-based instruction for teaching students to solve two-digit word problems using a calculator. The word problems were focused on the real-life skills of adding a tip or reducing a price to reflect a discount. This study, as well as the procedures and materials used for it, were part of a multi-year, federally funded research grant. The instructional materials included: a word problem worksheet with pre-drawn graphic organizer; an equation template with the plus and minus sign with the words “sale” and “tip;” a task analysis used by the students as a self-instruction sheet; and a calculator. Students used a handheld calculator (TI-15 Explorer) for all conditions except generalization. During generalization, the calculators on iDevices were used.

During baseline, students were given a verbal prompt to “show me how to solve this problem” (Root, Saunders et al., 2017, p. 9). No prompting or feedback was provided. Next, students received training on the use of the calculator and explicit vocabulary instruction, using a multiple probe across participants design. During intervention, students used the calculator in three phases: change addition problems, change subtraction problems, and change mixed problems. Similar to the previous study conducted by Root, Browder et al. (2017), student performance was measured by the total number of points a student received for independently completing each step of the task analysis. If students independently answered the final step correctly, they received three points for writing the answer in the correct position in the equation, putting the decimal point in the right place, and stating the correct answer aloud. If the student did not respond within a 10-second interval, teachers employed a system of least prompts.
During the generalization phase, students often required additional prompting for completing addition or subtraction operations on the iDevice.

Visual analysis revealed an immediate effect from baseline to intervention, and students were able to demonstrate generalization from the handheld calculator to the iDevice. Two students demonstrated the ability to maintain the skill. The third student did not have an opportunity to demonstrate maintenance due to the school year ending. In summary, the study results established a functional relationship between the use of modified, schema-based instruction using a calculator and participants’ abilities to solve word problems involving addition and subtraction for “personal finance.” (Root, Saunders et al., 2017, p. 5).

The final study that evaluated the ability of students to solve change problems using addition and subtraction incorporated the use of video prompting to teach real-world math problems in simulated situations with finger-counting strategy in order to determine its effects for students with moderate intellectual disabilities. Saunders, Spooner, and Ley Davis (2017) pointed out in their review of relevant literature for this study that “finger counting alleviates working memory demands and provides visual cues, but no research exists on its use for this population” (p. 2). There is mounting research on the effects of video prompting, and a number of studies in this literature review used video prompting to teach students money skills (Cihak et al, 2006; Weng & Bouck, 2014).

Video prompting is a form of video-based instruction where the student views a skill or chained task in segments, with the opportunity to perform each sequence in a step before moving on to the next. It is different from video modeling, which typically shows
the task in its entirety, not broken down into separate frames (Banda et al., 2011). For this study, a total of 285 real-world, change-type problems were developed and filmed with adult actors in various settings such as a grocery store, a pet store, and a backyard. The videos were displayed to students on a laptop.

Three middle school students with moderate intellectual disabilities participated in the study. Generally, the students received academic instruction in a self-contained classroom and were included for electives. To minimize distractions and to help students pay attention to the videos, sessions for this study occurred in a conference room. During baseline, the researcher pulled students individually and asked them to solve four problems on their own, following the viewing of a video simulation. Next, students were taught finger counting and instructed on how to use it during the training videos. The training videos were embedded with explicit, step-by-step procedures of task analysis, and each was modeled visually and narrated. Following an instruction such as “create the initial set using finger counting,” students were given an opportunity to immediately perform the step (Saunders et al., 2017, p. 6). Following the training videos, students were then assessed on their independent completion of four video problems without prompts or narration. If students got a step wrong, error correction procedures of least-intrusive prompting were provided, but answers with error correction were not scored.

As in previous studies, the total number of independent steps performed on the task analysis was the dependent variable. Each problem included six steps. Students were scored on four problems per session, totaling a possible score of 24. Results indicated a functional relationship between students’ ability to solve subtraction word problems and the use of video prompting with finger counting, systematic instruction,
error correction and feedback. A limitation of this study was the lack of opportunity for in-vivo experiences for generalization.

As illustrated in this literature review, there are different ways to teach arithmetic. Rao and Mallow (2009) studied the effectiveness of simultaneous prompting procedure for teaching students with moderate intellectual disabilities to automate recall of multiplication facts. The study was conducted with two students – one 8th grade male student with mild intellectual disabilities, and one 7th grade female student with moderate intellectual disabilities. The study took place in the students’ special education classroom. In addition to simultaneous prompting, researchers used flash cards for instruction and assessment. A multiple-probe design with multiple sets of math facts replicated across the subjects was used to assess the effectiveness of simultaneous prompting on the recall of multiplication facts. The dependent variable was the number of correct responses to novel facts. The results indicated that simultaneous prompting was an effective strategy to improve automaticity of multiplication facts across setting, materials, and people.

Two other studies targeted multiplication skills, but neither met criteria for inclusion in this literature review. The studies conducted by Bouck, Bassette, Taber-Doughty, Flanagan, and Szwed (2009) and by Hayter, Scott, McLaughlin and Weber (2007) were limited to improving the multiplication skills of students with mild intellectual disabilities.

b. Measurement

Thirteen (or 37%) of the studies covered concepts of time and money in the measurement domain, combining core content with functional life-skill
instruction. Most focused on money concepts such as calculating tips, figuring sales tax, or paying for a purchase. Browder et al. (2012) focused measurement lessons on story-based purchasing problems at a middle and high-school level. After reading a brief story, students were asked to show how dollars you give to the cashier. Collins, Hager, and Galloway (2011) focused on the computation of sales tax, but uniquely within a general education, middle-school math context. Cihak and Grim (2008) examined the use of counting-on strategies of arithmetic to enhance independent purchasing skills.

Between 2006 and 2015, research began to slowly emerge on the use of technology to teach functional mathematics, including purchasing and banking skills, to students with significant intellectual disabilities. At the time, only three studies existed. Ayres, Langone, Boon, and Norman (2006) used computers and video technologies with simultaneous prompting to teach four middle school students to make purchases using the dollar-plus purchasing strategy. Similarly, Hansen and Morgan (2008) used computer-assisted instruction with simultaneous prompting to teach three high school students with moderate intellectual disabilities how to purchase items at a grocery store. Also evaluating the effectiveness of technology, Cihak et al. (2006) compared the use of static pictures and video prompts projected on a screen for teaching purchasing and banking skills to six middle school students with moderate intellectual disabilities in the special education classroom. Researchers taught students to pay for two items with a debit card and to use an automatic teller machine, and then asked students to generalize the skill in the community without video-prompts, but with the support of a least-to-most verbal and gestural prompting hierarchy. The researchers found that both interventions were equally effective.
The previous studies focused on the use of computer-assisted instruction. Though computer-assisted instruction was shown to be effective, using a desktop computer or large screen video is not practical for real-life activities. The use of a mobile device could provide increased independence, but before 2014, no published studies assessed the effectiveness of using a mobile device for the acquisition purchasing skills for students with SID (Hsu et al., 2016). The only earlier example was a study that employed a mobile audio device to help students identify and locate items on a shopping list (Bouck, Satsangi, Bartlett, & Weng, 2012). While helpful to the researchers’ future study in 2014, the 2012 study did not involve mathematics instruction.

As referenced, Weng and Bouck (2014) extended research on video-modeling using a hand-held iPad device to teach the math skill of price comparison to three students with autism and intellectual disabilities. The first student was an eleventh-grade male with autism and a moderate intellectual disability, the second was 15 years old, in eighth grade, and identified as mildly to moderately autistic, and the third student was a 15-year-old eighth-grader with autism. Based on the third student’s score on the Adaptive Behavior Assessment System, the researchers identified him as having a moderate disability.

The study took place in the students’ special education classrooms and at local grocery stores. In both settings, students were asked to compare three different brands of toothpaste and identify which was the lowest-priced item. For the intervention, the researchers identified and created video clips for the 18-step task analysis, and embedded the clips into an iPad using an iBook format. To receive the video-prompt with audio cues, students navigated page-by-page with their fingers to play the clips for the separate
steps. Within the task-analytic procedures, students were directed to circle the number that appeared prior to the decimal for the price of each item on a paper-based number line. In the last two video clips, students were told to “point to or say which circled number is closest to 0;” and then to “pick up the lowest-priced item and place it in the basket” (Weng & Bouck, 2014, p. 1409).

The researchers used the last step to calculate the mean percentile of independently selecting the lowest-price grocery item per session (the dependent variable) for baseline, treatment, and generalization. Researchers used a multi-probe, multiple-baseline design across participants to evaluate the effectiveness of video prompting versus adult verbal direction provided during baseline. If students did not benefit from video prompting after 10 trials –as defined by independently completing 50% of the determined critical task analysis steps –then the researchers employed the addition of most-to-least prompting.

Visual analysis illustrated that the use of video-prompting was effective for the first student, ineffective for the second student even with prompting, and effective for the third student with most-to-least prompting. While the results of this study failed to identify video-prompting using an iPad as an effective intervention; later studies revealed that video-modeling can be an effective tool for teaching price comparison to students with SID.

In 2016, three studies assessed the effects of video-prompting using mobile technology for teaching purchasing or price comparison skills to students with significant intellectual disabilities. Hsu et al. (2016) compared the use of the one-more-than technique and a mobile purchasing assistance system for teaching purchasing skills to
students with moderate intellectual disabilities in Taiwan. Four high school students participated in the study. Except during the training phase, which occurred in the self-contained classroom, data were collected in the community at local grocery and convenience stores.

The researchers used real money and the one-more-than technique—a technique in which students “count-on” and pay one more coin or bill than the amount of the purchase—to compare a traditional teaching approach for the technique with the same technique embedded in an app on a mobile device. The app, referred to as the mobile purchasing assistance system (MPAS), was an Android-based app written by Hsu, the lead author of the study. Scaffolding was embedded in the software application to help students who had inconsistent money-counting skills. Unlike the traditional method, the software provided support for procedure, number and calculation, and transaction tracking.

Researchers randomly assigned the four students to one of two groups, and used a multiple-treatment design across three price ranges and community settings. The dependent variable was the students’ abilities to make independent purchases across the three price ranges, and researchers compared the effects between the two alternating methods. The results revealed that students were much more successful with the MPAS intervention ($M = 93\%$, compared to $18.5\%$ using the traditional method). Additionally, the support of the device enabled students to maintain and generalize the skill to new sites. Further, the MPAS was socially validated, with all teachers, cashiers, and parents responding positively.
Adding to the research, Weng and Bouck (2016) compared the effects of paper-based and app-based number lines to teach number and price comparisons. Three high school students with moderate intellectual disabilities participated. All students typically received instruction in the special education classroom for more than 60% of their school day. The intervention took place in a small room adjacent to the students’ primary classroom. A simulated grocery store was created in the room for the generalization phase. Researchers used an alternating-treatments design to evaluate the use of the paper-based and app-based number lines in conjunction with a system of least-to-most prompts and constant time delay. Students were given pairs of single-digit numbers, taught to use the two number lines to plot the numbers on the line with a circle, and then asked to identify which number was bigger or smaller. The dependent variable was the percentage of correctly answered questions. Researchers also collected task completion times. The visual analysis revealed that both interventions were effective, though the app-based intervention yielded more stable outcomes.

Cost is one barrier to the use of iPads for instruction, as many schools and families may not be able to afford to purchase one. On the other hand, video-prompting on iPads may increase student independence and be more socially desirable than paper-based number lines when making purchases in the community (Weng & Bouck, 2016). In an attempt to address these concerns, Bouck, Satsangi, and Bartlett (2016) studied the effectiveness of using a lower-tech audio recording device in lieu of an iPad. The researchers used an alternating-treatment design to compare the effectiveness of using audio prompts on the device versus using a paper-based number line. The design and variables were similar to the Weng and Bouck (2016) study, but Bouck et al. (2016) used
different settings and students of different ages. The participants in this case were high school students between the ages of 18 and 21, and the generalization phase took place in an actual grocery store rather than in a simulated one within the school. The results of this study were mixed. For two students, the audio recorder was found to be most effective for independence, but it only proved more accurate than the paper-based timeline for one of the students. The third student showed the best independence and accuracy using the number line. Though the results provide some support for the use of a less-expensive technological device than an iPad, given the lack of separation in the data, a functional relationship could not be established for price comparison.

The mathematics measurement skill of telling time was the key academic skill taught in two studies. Karl et al. (2013) compared hand-raising techniques to the use of response cards during small group instruction to teach time telling. Falkenstine, Collins, Schuster, and Kleinert (2009) investigated the use of constant time delay to teach discrete and chained tasks, including telling time and setting a watch.

Most measurement studies included in this literature review addressed money-related math skills. Approximately one-third of the studies included high school-aged students and young adults in the study populations, and focused research on student populations with intellectual disabilities ranging from mild to severe, but the vast majority targeted students on the lower end of the severity scale – those with mild to moderate intellectual disabilities. Despite the focus on money and purchasing skills, most studies occurred in a classroom setting, with just six of the 13 taking place in the community. Systematic instruction continued to be the most implemented evidence-based strategy for students with SID, and there is a growing body of research on the use
of technology and video prompting to increase students’ independence skills in completing tasks.

**c. Algebra.**

Though mathematics instruction has shifted from a focus on life skills (e.g. telling time and making purchases) to a focus on instruction aligned to grade-level standards, there were only five studies during the review period that focused on the mathematics subject area of Algebra (Browder, Jimenez, & Trela, 2012; Browder, Trela, Courtade, Jimenez, Knight, & Flowers, 2012; Heinrich, Knight, Collins, & Spriggs, 2016; Jimenez, Browder, & Courtade, 2008; Jimenez & Staples, 2015). Jimenez, Browder, and Courtade (2008) were one of the first to assess and teach algebra to students with moderate intellectual disabilities. The researchers used a concrete-to-representational-to-abstract (CRA) model. In addition to the CRA model, they used systematic instruction to teach three students with moderate developmental disabilities to solve a simple, linear algebraic equation. The setting of this study was a self-contained classroom within an urban, public high school. The teacher conducting the study used a single-subject, multiple-probe-across-participants design. The results varied for each participant, but all students were able to master the concrete representation of an algebraic equation.

The study, which was very thoughtfully constructed and implemented, functions as a model for research and instruction for high school students with SID. The researcher sought out consultation from a general education mathematics teacher, and they worked together to identify the foundational skill of solving a simple equation as the target for the study. The author also chose to use a time delay strategy that could be implemented by
peers or teachers, building in opportunities for generalization by varying numbers and materials, and extending the study into the general education environment. The study served two purposes: (a) to demonstrate that students with intellectual disabilities can access and progress in grade-level, general education curriculum, and (b) to determine the effect of systematic instruction with a concrete representation on the acquisition of an algebra skill for students with moderate developmental disabilities.

Browder, Trela et al. (2012) extended the research by evaluating mathematics and science interventions that linked to the general education content through a literacy-based approach using graphic organizers, manipulatives, and task-analytic instruction. Employing a quasi-experimental group design, participating middle and high school special education teachers were randomly assigned to either a math or science treatment group. The teachers in the math group implemented four math units representing four of the five national math standards – algebra, geometry, data analysis, and measurement – to 16 students aged 14-20 and with moderate to severe disabilities. Results revealed that the mathematics instructional group had a higher percentage of gain on the mathematics test and a lower percentage of gain on the science test than the science instructional group. This study was one of the first to illustrate how alternative achievement standards in mathematics could be targeted and taught. Browder, Jimenez and Trela (2012) found similar instructional methodologies to be effective for teaching algebra, geometry, measurement, and data analysis to four younger students between the ages of 11 and 13. The researchers employed a multiple-probe-across-unit design to examine the effects of the math instruction on the number of steps completed for each of four mathematics standards aligned to middle school mathematics standards. This single-subject method
provided evidence of individual student learning and extended the research on teaching upper-level mathematics standards to students with moderate and severe intellectual disabilities.

Since then, Jimenez and Staples (2015) applied the research on literacy-based lessons with systematic instruction embedded to support new CCSS for mathematics areas including algebra and geometry. Researchers again focused on a younger population—three students, ages 10 and 11, with moderate intellectual disabilities. While all students made gains, it should be noted that the focus was on the effect that students’ early numeracy skills have on their ability to learn grade-aligned content, and therefore did not explicitly teach to the grade-aligned standards. For example, the teacher provided plot numbers to a student and said “move the chip over ___ spaces,” but did not attempt to have the student plot numbers on a graph. Thus, the results cannot be generalized to teaching grade-aligned mathematics standards.

The final and most recent study in this area was conducted by Heinrich et al. (2016), and provided a model for teaching science, technology, engineering and math (STEM) content, including algebra and geometry concepts, to high school students with SID in an inclusive, general education classroom with the support of a paraprofessional or peer tutor. Using simultaneous prompting procedure, three students with mild to moderate intellectual disabilities as well as other disabilities learned discrete and chained STEM tasks. The target skills for the female student included solving linear equations and identifying geometric shapes, while the two male students focused on the STEM areas of science vocabulary and internet research. The teacher conducted baseline, intervention, maintenance, and generalization probes in the special education classroom,
but provided instruction in the general education setting with the support of a peer tutor or paraprofessional. Although the female student typically attended a general education choir and art class but received the rest of her instruction in the special education classroom, she was included in a sophomore algebra class with the support of an 11th grade peer for the purpose of this study. Similarly, the first male participants typically only attended a general education drama class, but for this study, he was included in an 11th grade biology class. The second male participant was enrolled in a general education computer class, and that same class was used for the study.

Prior to beginning instruction in the general education classroom, the peer tutor for the female student received training in simultaneous prompting until reaching 100% accuracy for one session. Following baseline, the peer tutor conducted daily training sessions using simultaneous prompting. During training sessions, the female student was expected to complete the discrete skill and chained task twice. She was provided a folder that which included her worksheet for the chained task (solving linear equations), note cards for the discrete task (identifying shapes), and the task analysis and data sheets for the peer tutor. The tasks were completed during class while other students were doing independent work, and while the teacher was taking attendance or while morning announcements were occurring. The female student was the first to begin instruction in the study, which used a multiple-probe-across-participants design, with concurrent demonstration across two skills per student. When the female student reached 100% correct responses for one day on her discrete task, the next student began intervention.

Though it took the female student four sessions to make progress and eight sessions to reach mastery, her results showed that simultaneous prompting procedure was
effective for teaching STEM content, including algebra and geometry concepts. The other two students made immediate progress and demonstrated the effectiveness of simultaneous prompting on other STEM content areas. Additionally, all three students maintained the skill for at least one month after intervention ended.

Social validity assessed via surveys that were collected before and after the study, and the surveys showed that the study made a direct impact on perceptions of peers and teachers. For instance, the algebra teacher stated prior to the study that he did not think students with SID should be taught core content, but following the study, the same teacher stated that students should be taught grade-level content, just at a modified pace. General education peer perceptions changed in the algebra class as well. After the study, more students expressed opinions that students with SID should attend the class. In summary, though limited research exists on teaching grade-aligned algebra standards to high school students with intellectual disabilities, studies have shown the academic and social benefits of doing so.

d. Geometry.

In addition to the three studies discussed above, the literature review uncovered one other study that focused on geometry. Creech-Galloway, Collins, Knight, and Bausch (2013) used simultaneous prompting procedure to teach the Pythagorean theorem to four high school students with mild to moderate intellectual disabilities within the self-contained classroom setting. The researchers blended grade-level curriculum with personally-relevant activities such as finding the dimensions of a computer or television screen. The researchers found that with the support of an iPad for story context and examples, and using simultaneous prompting procedure, all students
learned to use the formula for the Pythagorean theorem. Three students met criteria within the time constraints, and one did not. Based on visual inspection of the multiple-probe-across-participants design, the study demonstrated that students with SID can learn grade-aligned skills in personally-relevant and meaningful ways.

e. Data analysis

No additional studies beyond those already discussed (Browder, Jimenez, & Trela, 2012; Browder, Trela, Courtade, Jimenez, Knight, & Flowers, 2010) specifically measured data analysis skills, though others informally incorporated graphing of student progress. In addition to content standards, NCTM also identified five process standards: (a) problem solving, (b) reasoning and proof, (c) communication, (d) connections, and (e) representation (NCTM, 2000). Though some studies embedded word problems for teaching problem-solving using addition and subtraction operations, no studies since 2005 demonstrated how students solved problems (Kroesbergen & Van Luit, 2005). None of the other processes were measured in the research.

Much of the limited research base focuses on elementary-aged populations (Waters & Boon, 2011), and research on mathematics and high school students with significant intellectual disabilities is scant (Yakubova & Bouck, 2014). Further, most studies continue to focus on numbers and operations or money management (Browder, Trela, Courtade, Jimenez, Knight, & Flowers, 2012), with only five studies in the last 10 years addressing higher-level content standards for high school students with significant intellectual disabilities (see Table 1).

In summary, the literature review identified 35 research studies on the topic of mathematics instruction for students with significant intellectual disabilities conducted
over the last decade. While this may appear to be a large number of studies, a closer look reveals that only a subset of 13 pertained to high school students with moderate to severe disabilities. Further, despite federal and state mandates in mathematics, a limited scope of research exists that aligns math instruction to the general education curriculum for students with SID. In this literature review, only five studies included teaching grade-level content areas of algebra and geometry to high school students with significant intellectual disabilities. Thus, there is little applicable research for high school special education teachers working with students with SID. As a result of this lack of resources and knowledge, teachers are ill equipped to provide research-based practices to students with the most significant need.

These findings are similar to the meta-analysis on Browder et al.’s (2008) *Teaching Mathematics to Students with Significant Cognitive Disabilities*. The authors selected articles that were peer-reviewed between the years of 1975 and 2005. Of the 68 studies included in the review, the majority focused on numeracy or measurement involving money and time. Only two studies (3%) focused on skills related to algebra, and two targeted geometry standards. When narrowing the research to students with more severe and profound intellectual disabilities, studies focused almost solely on numbers and measurement. There is a limited scope of research that aligns math instruction to the general education curriculum for students with significant intellectual disabilities.
# TABLE I

**LIST OF RESEARCH STUDIES ON MATH INSTRUCTION FOR STUDENTS WITH INTELLECTUAL DISABILITIES**

<table>
<thead>
<tr>
<th>Study</th>
<th>Math skill area</th>
<th>Number of participants</th>
<th>Age/grade level of participants</th>
<th>Significance of intellectual disability</th>
<th>Setting</th>
<th>Instructional method used</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ayres et al., 2006</td>
<td>Purchasing</td>
<td>4</td>
<td>14 Middle school</td>
<td>Mild to moderate intellectual disabilities</td>
<td>Special education classroom</td>
<td>Simultaneous prompting, video technology</td>
</tr>
<tr>
<td>Bouck et al., 2016</td>
<td>Price comparison</td>
<td>3</td>
<td>18 – 21 High school</td>
<td>Mild to moderate intellectual disabilities</td>
<td>Separate classroom, and community</td>
<td>Paper and app-based number lines, audio prompting, system of least prompts, time delay, task analysis</td>
</tr>
<tr>
<td>Browder, Jimenez, et al., 2012</td>
<td>Early numeracy skills</td>
<td>7</td>
<td>8 – 11 Elementary</td>
<td>Moderate intellectual disabilities and autism</td>
<td>Special education and general education classrooms</td>
<td>Literacy-based mathematics, systematic prompting and feedback, manipulatives, and graphic organizers</td>
</tr>
<tr>
<td>Browder, Jimenez, &amp; Trela, 2012</td>
<td>Algebra, geometry, measurement, data analysis</td>
<td>4</td>
<td>11 – 13 Middle school</td>
<td>Moderate to severe intellectual disabilities</td>
<td>Self-contained classroom</td>
<td>Literacy-based mathematics, task analysis, graphic organizers</td>
</tr>
<tr>
<td>Browder, Trela et al., 2012</td>
<td>Geometry, algebra, data analysis/probability, measurement (purchasing)</td>
<td>16 in Math Group</td>
<td>14 – 20 Middle and high school</td>
<td>Moderate to severe intellectual disabilities</td>
<td>Special education classroom</td>
<td>Literacy-based mathematics, task analysis, graphic organizers, manipulatives</td>
</tr>
<tr>
<td>Cihak et al., 2006</td>
<td>Purchasing and banking</td>
<td>6</td>
<td>11 – 15 Middle school</td>
<td>Moderate intellectual disabilities</td>
<td>Special education classroom, and community</td>
<td>Total task chaining, most-to-least hierarchy, video prompting</td>
</tr>
<tr>
<td>Author(s)</td>
<td>Task/Subject</td>
<td>Grade Level</td>
<td>Age Range</td>
<td>Disability Level</td>
<td>Setting</td>
<td>Instructional Strategy/Approach</td>
</tr>
<tr>
<td>-----------------------------------------</td>
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<td>------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Cihak &amp; Foust, 2008</td>
<td>Addition</td>
<td>3</td>
<td>7 – 8</td>
<td>Moderate</td>
<td>Special education classroom</td>
<td>Total task chaining, least-to-most hierarchy</td>
</tr>
<tr>
<td>Collins et al., 2011</td>
<td>Purchasing</td>
<td>3</td>
<td>14 – 15</td>
<td>Moderate</td>
<td>Special education resource classroom</td>
<td>Constant time delay</td>
</tr>
<tr>
<td>Cihak &amp; Grim, 2008</td>
<td>Purchasing</td>
<td>4</td>
<td>15 – 17</td>
<td>Moderate</td>
<td>Resource room, then community</td>
<td>Counting-on/next dollar strategy, least-to-most hierarchy</td>
</tr>
<tr>
<td>Djuric-Zdravkovic et al., 2011</td>
<td>Addition and subtraction</td>
<td>60</td>
<td>12 – 14</td>
<td>Mild to moderate</td>
<td>Special education school</td>
<td>Attention skills</td>
</tr>
<tr>
<td>Everhart et al., 2011</td>
<td>Number identification</td>
<td>2</td>
<td>6, 9</td>
<td>Moderate to severe</td>
<td>Self-contained classroom</td>
<td>Computer-assisted instruction (CAI), flashcards, prompting and feedback</td>
</tr>
<tr>
<td>Falkenstine et al., 2009</td>
<td>Telling time</td>
<td>3</td>
<td>16</td>
<td>Moderate</td>
<td>Special education classroom</td>
<td>Total task chaining</td>
</tr>
<tr>
<td>Fletcher et al., 2010</td>
<td>Addition</td>
<td>3</td>
<td>13 – 14</td>
<td>Moderate</td>
<td>Self-contained classroom</td>
<td>TouchMath versus number line strategy</td>
</tr>
<tr>
<td>Study</td>
<td>Topic</td>
<td>Duration</td>
<td>Age</td>
<td>Disability</td>
<td>Classroom Setting</td>
<td>Instruction Model</td>
</tr>
<tr>
<td>------------------------------</td>
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</tr>
<tr>
<td>Flores et al., 2014</td>
<td>Addition and subtraction</td>
<td>11</td>
<td>5–12</td>
<td>Elementary</td>
<td>Special education classroom in extended school year program</td>
<td>Concrete-representational-abstract and strategic instruction model</td>
</tr>
<tr>
<td>Hansen &amp; Morgan, 2008</td>
<td>Purchasing</td>
<td>3</td>
<td>16–17</td>
<td>High school</td>
<td>Moderate intellectual disabilities</td>
<td>Total task chaining, simultaneous prompting, CAI</td>
</tr>
<tr>
<td>Heinrich et al., 2016</td>
<td>STEM, including linear equations</td>
<td>3 (1 completing math task)</td>
<td>16–17</td>
<td>High school</td>
<td>Mild to moderate intellectual disabilities</td>
<td>Embedded simultaneous prompting, video examples on an iPad</td>
</tr>
<tr>
<td></td>
<td>and geometric shapes</td>
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</tr>
<tr>
<td>Horn et al., 2006</td>
<td>Telling time</td>
<td>3</td>
<td>12–15</td>
<td>Middle school</td>
<td>Moderate to severe intellectual disabilities</td>
<td>Response cards</td>
</tr>
<tr>
<td>Hsu et al., 2016</td>
<td>Purchasing</td>
<td>4</td>
<td>14–15</td>
<td>High school</td>
<td>Moderate intellectual disabilities</td>
<td>Counting-on/one-more-than technique, mobile technology device with purchasing assistance system</td>
</tr>
<tr>
<td>Jimenez et al., 2008</td>
<td>Algebra</td>
<td>3</td>
<td>15–17</td>
<td>High school</td>
<td>Moderate intellectual disabilities</td>
<td>Time delay and task analytic instruction</td>
</tr>
<tr>
<td>Jimenez &amp; Kemmery, 2013</td>
<td>Early numeracy skills</td>
<td>5</td>
<td>(Not specified) Elementary</td>
<td>Moderate intellectual disabilities</td>
<td>Story-based, systematic instruction, manipulatives, graphic organizers, prompting</td>
<td></td>
</tr>
<tr>
<td>Authors</td>
<td>Topic</td>
<td>Grade Distribution</td>
<td>Disability Type</td>
<td>Setting</td>
<td>Instructional Strategies</td>
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<tr>
<td>Jimenez &amp; Staples, 2015</td>
<td>Algebra and geometry</td>
<td>3</td>
<td>10 – 11 Elementary</td>
<td>Moderate intellectual disabilities</td>
<td>Self-contained classroom</td>
<td></td>
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<td></td>
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<td></td>
<td></td>
<td></td>
<td>Theme-based lessons, systematic prompting and feedback, manipulatives, graphic organizers</td>
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</tr>
<tr>
<td>Jolivette et al., 2006</td>
<td>Addition and subtraction</td>
<td>3</td>
<td>7 – 8 Elementary</td>
<td>Significant developmental disabilities</td>
<td>General education and resource</td>
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<td></td>
<td>(no IQ provided) and ADHD</td>
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</tr>
<tr>
<td>Karl et al., 2013</td>
<td>Purchasing</td>
<td>4</td>
<td>15 – 18 High school</td>
<td>Moderate intellectual disabilities</td>
<td>Resource room and community</td>
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<td></td>
<td>Simultaneous prompting and task analysis</td>
<td></td>
</tr>
<tr>
<td>Miller et al., 2008</td>
<td>Subtraction</td>
<td>2</td>
<td>16, 17 High school</td>
<td>Intellectual disabilities</td>
<td>Self-contained classroom</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>(unspecified)</td>
<td>Manipulatives</td>
<td></td>
</tr>
<tr>
<td>Rao &amp; Kane, 2009</td>
<td>Subtraction</td>
<td>2</td>
<td>(Un-specified) Middle school</td>
<td>Mild to moderate intellectual disabilities</td>
<td>Self-contained classroom</td>
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<td></td>
<td></td>
<td></td>
<td>(unspecified)</td>
<td>Simultaneous prompting</td>
<td></td>
</tr>
<tr>
<td>Rao &amp; Mallow, 2009</td>
<td>Multiplication</td>
<td>2</td>
<td>(Un-specified) Middle school</td>
<td>Moderate intellectual disabilities</td>
<td>Special education classroom</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>(7th and 8th grade)</td>
<td>Simultaneous prompting</td>
<td></td>
</tr>
<tr>
<td>Root, Browder, Saunders, &amp; Lo, 2017</td>
<td>Subtraction word problems</td>
<td>3</td>
<td>7, 9, 11 Elementary</td>
<td>Mild to moderate intellectual disabilities and autism</td>
<td>Separate classroom</td>
<td></td>
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<td></td>
<td></td>
<td></td>
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<td></td>
<td>Schema-based instruction, systematic instruction, manipulatives (concrete and virtual using an iPad)</td>
<td></td>
</tr>
<tr>
<td>Root, Saunders, Spooner, &amp; Brosh, 2017</td>
<td>Addition and subtraction word problems</td>
<td>3</td>
<td>14 Middle school</td>
<td>Moderate intellectual disabilities</td>
<td>Self-contained classroom</td>
<td></td>
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<td></td>
<td>Schema-based instruction, systematic instruction, calculator</td>
<td></td>
</tr>
<tr>
<td>Study</td>
<td>Topic</td>
<td>Years</td>
<td>Setting</td>
<td>Disability</td>
<td>Intervention</td>
<td></td>
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<tr>
<td>Saunders et al., 2017</td>
<td>Addition and subtraction word problems</td>
<td>3</td>
<td>13 – 14 Middle school</td>
<td>Moderate intellectual disabilities</td>
<td>Video prompting, finger counting, systematic instruction with error correction and feedback</td>
<td></td>
</tr>
<tr>
<td>Shen, 2006</td>
<td>Numeracy and computation</td>
<td>80</td>
<td>(Un-specified) First Grade</td>
<td>Mild to moderate intellectual disabilities</td>
<td>Abacus and manipulatives</td>
<td></td>
</tr>
<tr>
<td>Skibo et al., 2011</td>
<td>Number identification</td>
<td>3</td>
<td>7 – 10 Elementary</td>
<td>Moderate to profound intellectual disabilities</td>
<td>System of least prompts and use of response cards</td>
<td></td>
</tr>
<tr>
<td>Weng &amp; Bouck, 2014</td>
<td>Price comparison</td>
<td>3</td>
<td>15 – 17 Middle and high school</td>
<td>Mild to moderate autism and intellectual disabilities</td>
<td>Video prompting with iPad, task analysis, most-to-least prompts</td>
<td></td>
</tr>
<tr>
<td>Weng &amp; Bouck, 2016</td>
<td>Number and price comparison</td>
<td>3</td>
<td>14 – 15 Middle and high school</td>
<td>Moderate intellectual disabilities</td>
<td>Paper-based and app-based number lines, task analysis, least-to-most prompts, constant time delay</td>
<td></td>
</tr>
</tbody>
</table>
D. Evidence-Based and Promising Practices

Studies in this review consistently demonstrated that systematic instruction is an evidence-based practice for improving student learning of mathematics (Akmanoglu & Batu, 2004; Browder, Jimenez, Spooner, Saunders, Hudson, & Bethune, 2012; Cihak et al., 2006; Cihak & Foust, 2008; Cihak & Grim, 2008; Courtade, Test, & Cook, 2014; Jimenez, Browder, & Courtade, 2008; Jimenez & Kemmery, 2013; Jimenez & Staples, 2015; Rao & Kane, 2009). The Florida Center for Reading Research defines systematic instruction as:

… a carefully planned sequence for instruction, similar to a builder’s blueprint for a house. A blueprint is carefully thought out and designed before building materials are gathered and construction begins. The plan for systematic instruction is carefully thought out, strategic, and designed before activities and lessons are developed…For systematic instruction, lessons build on previously taught information, from simple to complex, with clear, concise student objectives that are driven by ongoing assessment. Students are provided appropriate practice opportunities, which directly reflect instruction.

Systematic instruction has yielded consistent positive results and, as such, has been deemed an evidence-based practice across all strands of mathematics. Findings from this review are consistent with prior meta-analyses and textbook determinations that systematic instruction is an effective method for teaching mathematics to students with SID (Browder et al., 2008; Brown et al., 2016; Westling et al, 2015). It should also be noted that the National Council of Teachers of Mathematics identifies systematic instruction as an effective strategy (NCTM, 2006).
A second evidence-based practice is the use of in vivo settings or teaching in context (Courtade, Test, & Cook, 2014). The purpose of the common core standards is to prepare students for living and working in the community, and teaching practical mathematics skills through community-based instruction has been shown to prepare students to lead a more independent life (Mazzotti, Test, & Mustian, 2012; NSTTAC, 2010). Students with SID have shown progress in learning mathematics when the common core standards are taught using real-life examples. This may include the teaching of mathematics skills through applied activities such as shopping, cooking, and banking. Three additional studies in this review extended the research that teaching mathematics instruction through purchasing skills in the community setting is an evidence-based practice (Cihak et al., 2006; Cihak & Grim, 2008; Karl et al., 2013).

The use of prompting and fading procedures is another evidence-based practice (Courtade, Test, & Cook, 2014). Response prompting procedures such as time delay, the system of least prompts, most-to-least prompting, and simultaneous prompting have demonstrated repeated effectiveness when teaching discrete and chained tasks to students with disabilities (Morse & Schuster, 2004). Response prompting procedures involve providing extra teacher assistance, or prompts, to students, followed by the removal or fading of that assistance as instruction progresses. Since the prompts are presented before a student responds, the procedure is relatively errorless. In the studies reviewed, simultaneous prompting, or zero second delay, was the most frequently used procedure. Seven studies employed simultaneous prompting, and another 12 used other types of response prompting procedures. All demonstrated that prompting was an effective
strategy to teach mathematics to students with SID (see Table 2 for a brief description of commonly used evidence-based practices).

Task analytic instruction, a “step-by-step teaching procedure for a chain of responses to complete an activity,” had a strong evidence-base in the research literature (Spooner, Knight, Browder, & Smith, 2011, p. 9). In the studies reviewed, task analytic instruction was used to teach mathematics skills including solving an algebra problem, purchasing, and budgeting (Browder, Jimenez, & Trela, 2012; Browder, Trela, Courtade, Jimenez, Knight, & Flowers, 2012; Cihak et al., 2006; Hansen & Morgan, 2008; Jimenez et al., 2008; Karl et al., 2013). All indicated affirmed that task analytic instruction is effective across different mathematics concepts and contexts.

Another strategy that shows promise is visual representation, which uses number lines, manipulative, or pictures to teacher mathematics concepts. One specific method of visual representation is a concrete-to-representational-to-abstract (CRA) model. CRA is a three-part instructional strategy: 1) Concrete- the “doing” stage using concrete objects to model problems, 2) Representational- the “seeing” stage using representations of the objects to model problems, 3) Abstract- the “symbolic” stage using abstract symbols to model problems (Witzel, Mercer, & Miller, 2003) CRA was recognized as an effective method for teaching functional math (Witzel, Mercer, & Miller, 2003; Sandknop, Schuster, Wolery, & Cross, 1992). Five studies in this review applied CRA in their research and found it to be effective.
## TABLE II

A BRIEF DESCRIPTION OF COMMONLY USED, EVIDENCE-BASED PRACTICES

<table>
<thead>
<tr>
<th>Evidence-based practices</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concrete-to-representational-to-abstract (CRA) model</td>
<td>An instructional strategy consisting of three parts: (a) a concrete “doing” stage using concrete objects to model problems, (b) a representational “seeing” stage using representations of the objects to model problems, and (c) an abstract “symbolic” stage using abstract symbols to model problems (Witzel, Mercer, &amp; Miller, 2003)</td>
</tr>
<tr>
<td>Constant time delay</td>
<td>Running the first trial with no delay, then adding fixed delay, usually 3-5 seconds, between the instruction and the prompt (Rao &amp; Kane, 2009)</td>
</tr>
<tr>
<td>Direct/explicit instruction</td>
<td>A teaching sequence that includes a review of prerequisite skills followed by teacher explanation and modeling, then guided and independent student practice with feedback until mastery is achieved (Hua et al., 2012)</td>
</tr>
<tr>
<td>Manipulatives</td>
<td>Materials that are physically handled by students to help them see actual examples of mathematical principles (Miller, Rule, &amp; MacEntee, 2008)</td>
</tr>
<tr>
<td>Next-dollar/counting-on strategy</td>
<td>Teaching students to make purchases using one more dollar than asked for by the salesperson (Test, Howell, Burkhart, &amp; Beroth, 1993). Cents-pile modification—an adaptation of the next-dollar-strategy—puts a dollar aside for the cents</td>
</tr>
<tr>
<td>Progressive time delay</td>
<td>A system of gradually increasing the time between giving the instruction and giving a prompt (Rao &amp; Kane, 2009)</td>
</tr>
<tr>
<td>Response cards</td>
<td>Cards, signs or other conveyances held up simultaneously by all students to display their responses to a teacher-presented question or problem (Cavanaugh, Heward, and Donelson, 1996, p. 403)</td>
</tr>
<tr>
<td>Response prompts</td>
<td>Actions taken by the teacher before a student responds or after he or she makes an error, with the goal of increasing the probability of a correct response and thus minimizing errors during instruction. Constant time delay, progressive time delay, zero-second time delay, a system of least prompts, and simultaneous prompting are different response-prompting strategies (Snell &amp; Brown, 2006)</td>
</tr>
<tr>
<td>Term</td>
<td>Definition</td>
</tr>
<tr>
<td>----------------------------------------------</td>
<td>-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Schema-based instruction</td>
<td>An outline or framework for solving a problem through visual representation such as pictures, diagrams, number sentences or equations (Powell, 2011). The three required components include: identification of the problem structure, use of visual representation, explicit instruction (Jitendra et al., 2015)</td>
</tr>
<tr>
<td>Simultaneous prompting</td>
<td>A system in which the teacher models the answer on every trial (Browder &amp; Spooner, 2006). Control prompts are always used. Probe or test trials can occur at any point in time, but usually occur immediately after training trials in a model-lead-test format (Wolery et al. 1992)</td>
</tr>
<tr>
<td>System of least prompts, or least-to-most hierarchy</td>
<td>A system that involves responding to student errors first with verbal or gestural prompts plus verbal explanation, then with modeling plus verbal explanation, and finally with physical assistance plus verbal explanation (Rao &amp; Kane, 2009)</td>
</tr>
<tr>
<td>Systematic instruction</td>
<td>Teaching focused on specific, measurable responses that may either be discrete or a chained response, and that uses methods of prompting and feedback (Browder &amp; Spooner, 2011)</td>
</tr>
<tr>
<td>Video prompting</td>
<td>A form of video-based instruction in which the student views a skill or chained task in segments and is given the opportunity to perform each sequence in the step before moving on to the next. It is different from video modeling, which typically shows the task in its entirety, not broken down into separate frames (Banda et al, 2011)</td>
</tr>
<tr>
<td>Zero-second time delay</td>
<td>Providing immediate prompting (Rao &amp; Kane, 2009)</td>
</tr>
</tbody>
</table>

Finally, though most studies in this review were conducted in their self-contained classroom, in a separate school, or in a separate testing room, research shows that inclusion general education is an evidence-based practice that provides academic, social, vocational, and independent living benefits (Test, Mazzotti, Mustian, Fowler, Kortering, & Kohler, 2009). It was demonstrated that students could learn grade-level mathematics concepts in the general education classroom (Browder, Jimenez, Spooner, Saunders, Hudson, & Bethune, 2012; Jimenez et al., 2008). Further, research suggests that student
participation in general education is a predictor post-secondary success (McDonnell & Brown, 2010; NSTTAC, 2010).

E. Research in Teacher Preparation

Despite public views that good teaching is something mostly learned through experience, teaching is “unnatural work” (Ball & Forzani, 2009). Teaching the general education curriculum requires understanding of content and pedagogy (Shulman, 1986). Teachers must also have knowledge of evidence-based practices to support students with disabilities in their classrooms. Preparing personnel to teach students with SID is even more complex. To truly understand the best practices and challenges of delivering standards-based instruction to students with SID in secondary general- and special-education classrooms, a broad investigation of special education and general education teacher preparation literature was studied.

This review of research is organized with the assumption that students with SID should first and foremost, have access to and involvement in the general education curriculum in the regular classroom (IDEA, 2004). Thus, general education mathematics teacher preparation will be discussed first. Then, special education teacher mathematics preparation will be reviewed.

1. Secondary education mathematics teacher preparation

One might assume that high school mathematics teachers are the best equipped to teach grade-aligned common core standards to students with SID since they receive significantly more mathematics content and methods courses in college (Maccini & Gagnon, 2002). However, previous research has established that general education teachers rarely focus on individual learning differences and are reluctant to make
curriculum adaptations that are critical when including students with SID (Baker & Zigmond, 1990; McIntosh, Vaughn, Schumm, Haager, & Lee, 1993). Further, they have difficulty differentiating instruction for students with disabilities, especially at the secondary level (Baker & Zigmond, 1995).

Maccini and Gagnon conducted a series of studies between 2002 and 2007 that examined perceptions of general education teachers and special education teachers related to mathematics instruction. The first study investigated secondary teacher familiarity with the NCTM standards, their confidence with implementation, and the barriers to implementation for students with learning disabilities and emotional disabilities (Maccini & Gagnon, 2002). Prior to this study, no studies existed that investigated teacher familiarity with the NCTM standards, nor was there research on the topic of general education teachers working with students with disabilities. The researchers used a survey design to evaluate teacher perceptions. The findings indicated that the greatest barrier perceived by general education teachers was the lack of adequate materials. In later studies, researchers delved into other contributing factors on mathematics instruction for students with learning disabilities and emotional disabilities. Maccini and Gagnon (2006) surveyed the general education and special education teachers to determine the specific instructional strategies the teachers used during instruction on basic computation and problem-solving tasks, the accommodations they made for students, and the factors that predict the number of instructional practices and assessments used. They found that the number of courses taken and the knowledge of course topics correlated to the number of instructional and accommodation practices used. In brief, general education teachers had statistically
greater perceived knowledge in all mathematics topics except basic skills. They used fewer instructional strategies, though the variance in the years of teaching experience between the two groups may have also contributed. The final study addressed teachers’ knowledge, preparation, and beliefs (Gagnon & Maccini, 2007). The methodology and findings from the study were similar to those in previous research. The researchers found statistical differences between general education and special education perceived knowledge of math topics in all areas except basic skills. In all studies, the researchers identified three primary factors that may affect implementation of standards-based curriculum: teacher preparation, content knowledge, and beliefs (Gagnon & Maccini, 2007; Rosas & Campbell, 2010).

Research described in this literature review indicates that secondary education mathematics teachers are confident in their abilities to teach content that is aligned to NCTM standards. Further, general education teachers have greater preparation in content areas, but do not differentiate instruction as frequently. Finally, though teacher beliefs were not a contributing factor in all studies, some teachers still question the relevance of the general education curriculum for students with SID (Agran, Alper, & Wehmeyer, 2002; Wagner et al., 2007). Teacher attitudes may be different when the focus is on students with SID rather than being limited to students with learning and emotional disabilities.

Secondary education instruction is fast-paced, primarily lecture-based, and focused on higher-level, abstract mathematics concepts. As a result, general education classrooms are not as accessible to students with disabilities (Brownell, Sindelar, Kiely, & Danielson, 2010). Though general education teachers at the high school level have the
content-knowledge, they are rarely instructing students with SID, and the few who do indicate that they are unsure about how to adapt the content standards and instruction for students with disabilities. Though the research helps provide a picture of teacher preparation, it does not offer guidance for mathematics instruction for students with significant intellectual disabilities.

2. **Special education teacher attitudes and preparation in mathematics**

   Whether examined from the historical perspective that students with disabilities have been excluded from public education or through the lens that the general education classroom does not offer enough support, most research studies indicated that students with SID received mathematics instruction in special education classrooms (Kleinert, Reeves, Quenemoen, Thurlow, Fluegge, Weseman, & Kerbel, 2015; Kurth, Morningstar, & Kozleski, 2014). This means that special education teachers, not content specialists, are instructing these students in mathematics.

   As previously discussed, Maccini and Gagnon conducted a series of studies between 2002 and 2007 that examined the perceptions of both general education and special education teachers of students with learning disabilities and emotional disabilities in relation to mathematics instruction. As expected, special education teachers reported that they are less familiar than general education teachers in the area of mathematics (Gagnon & Maccini, 2007; Maccini & Gagnon, 2002, 2006). Further, they reported feeling unprepared to teach the content. The number of methods courses taken by this sample of teachers was minimal ($M = 1.92$) (Gagnon & Maccini, 2007).

   Identified barriers that special education teachers faced in including their students in the general education curriculum included a lack of curriculum materials/resources,
limited content knowledge, and the beliefs and attitudes of the general education teachers around them (Klehm, 2014; Lee et al., 2016; Otis-Wilborn, Winn, Griffin, & Kilgore, 2005).

Organizational factors can have an effect on teachers’ access to resources and materials (Greenway et al., 2013). In the first study of special education teachers’ perceptions regarding evidence-based practices for students with intellectual disabilities, Greenway et al. (2013) found that special education teachers operated with relative autonomy, which came along with reduced resources, support, curriculum, and professional development. They had varied beliefs and perceived knowledge of evidence-based practices/instructional strategies. Though the research extended the literature on teacher preparation for students with SID, it did not offer insight into teachers’ attitudes and understanding of mathematics content.

F. Surveys of Special Education Teachers of Students with Significant Intellectual Disabilities.

There is limited research on special education teacher variables on mathematics curriculum and instruction for students with SID (Karvonen, Flowers, et al., 2013; Pennington & Courtade, 2015; Timberlake, 2014). A review of literature on teacher variables for students with SID was broadened to include studies investigating access to the general education curriculum rather than those focusing solely on mathematics content. A series of studies conducted by Karvonen, Flowers, et al. (2013) examined the enacted curriculum for students who participate in alternative assessment. First, Karvonen, Wakeman, Flowers, and Browder (2007) conducted a pilot study of a Curriculum Indicators Survey (CIS) developed to examine the amount of coverage and
cognitive demand across English Language Arts (ELA) and math standards from pre-kindergarten through 12th grade. The mathematics portion consisted of 178 items in five strands of mathematics. The purpose of the study was to validate the instrument. It was pilot tested with 12 teachers of students with SID. As such, while caution was warranted in interpreting the results of the instrument’s content; the survey informed refinements of the instrument for use in future evaluations of alignment of the enacted curriculum to academic content inventories.

Subsequently, Karvonen, Flowers, et al. (2013) used the CIS to evaluate factors associated with access to the general education curriculum for students with disabilities who participate in alternative assessments based on alternative achievement standards. Data in the study was based on short forms of the CIS, which contained 27 content items for ELA, and 16 items for math. For each item, teachers rated the intensity of coverage of the content and the highest performance expectation or cognitive demand. A total of 644 teachers responded, with a subset of 613 teachers completing the responses for math. Survey data was collected between December 2006 and June 2008. Student-level variables were available for 543 students, mostly in grades three through eight. Twenty-three percent were enrolled in high school. The scope and intensity of academic content coverage as well as student and teacher predictor variables associated with access to the general education curriculum were explored. Findings revealed that students across grade levels were exposed to a variety of academic content. A few teacher variables were found to be significant. Teachers with more professional development, with greater general curriculum influences from state and national content standards, alternative assessment requirements and results, content materials, and activities used by general
education teachers, etc.), and who more frequently used performance assessment demonstrated greater access to the general education curriculum. Specific instructional strategies used to deliver the curriculum were outside the scope of the research study. The study did not allow for inferences, including differentiation across grade levels. As such, it was suggested that future research explores how teachers help students access the curriculum at higher grades, where the discrepancy between grade-level expectations and alternative achievement expectations is larger.

The previous study examined teacher and student variables as predictors of access to the general education curriculum. Karvonen, Wakeman, Flowers and Moody (2013) extended the research to assess teachers’ choices of instructional design and delivery. At the time of the study, the researchers noted that no other published study had examined teacher instructional planning for this population on such a large scale. Teachers were recruited from three states participating in a collaborative project, participating in surveys administered during the 2010-2011 school year. A total of 375 teachers completed the survey, though they did not provide demographic information regarding the grade level taught. Data was obtained using the Curriculum Indicators Survey-Revised (CIS-R), which was adapted from the original to include additional information about teacher beliefs and instructional decisions. The results indicated that student variables such as level of communication, as well as teacher beliefs about alternative assessment, had an impact on student achievement. Additionally, data regarding teacher decisions indicated that more than half of respondents (58%) did not consider the state content standards when considering what to teach, and that fewer than 40% of teachers mentioned any type of objective measure being used for determining instruction. Though teacher
instructional decision-making was a component of the research, teacher demographic variables were not a focus of this study. Future research is needed to better understand factors influencing curriculum and instructional decisions.

As previously noted, there is little research available on how special education teachers of students with SID make decisions about academic priorities and on the teacher variables that influence these decisions. Timberlake (2014) conducted phone interviews with 33 special education teachers, 12 of which taught at the high school level, about their academic decision making for students who participated in state-level alternative assessment. Results indicated that teachers perceived themselves to have a high level of discretion over academic choices. The researchers also found that alternative assessments based on alternative achievement standards and local graduation requirements were both perceived boundaries to teachers’ decision-making authority. Compliance with the alternative assessments based on alternative achievement standards defined academic curriculum and instructional decisions. At the middle school and high school levels, participants expressed their sentiment that “the alternate ‘forced’ them to compromise their values by ‘requiring’ them to replace some functional skill instruction with more traditional academics” (Timberlake, 2016, p. 6).

Timberlake (2016) found similarities in comments about curricular decision-making when she conducted phone interviews with 33 special education teachers, 14 of which taught at the elementary level, seven of which taught at the middle school level, and 12 of which taught at the high school level. In the interviews, teachers were asked open-ended questions about the content they selected for students with SID and how they selected that content. Teachers were also asked about the amount of control or discretion
they had over the content taught and how placement decisions were made for including students in the general education classroom for academic instruction. Qualitative analysis was conducted using the ATLAS.ti software package, deductive analysis, matrices and visual mapping to identify patterns, informal ratings, scatterplots for visual analysis, and transcript review again to label emerging patterns.

Results indicated that while teachers felt they had a high level of discretion and autonomy over academic decisions, many reported feeling high degrees of physical and social isolation. While most teachers did not appear bothered by the isolation, one expressed a desire for more collaborative decision-making. There were two identified boundaries on decision-making: local graduation requirements and the state alternative assessment. Without the requirement of alternative assessment, which in this study constituted academic instruction, teachers said they would be able to do what they think is best for their students. At the middle and high school levels, teachers defined functional skills as the best assessment method.

It is not uncommon for teachers to think of academic instruction and alternative assessment as synonymous. Petersen (2016) noted that participants expressed “curriculum access as participation in alternative assessment” (Petersen, 2016, p. 24). The researcher investigated how 21 special educators in one state defined, created, and provided access to the curriculum for students with SID. All provided instruction in self-contained classrooms. Seven were secondary-level teachers, and of those seven, two provided instruction in the content area of mathematics.

The researcher conducted three focus group interviews across three different types of districts – one urban, one suburban, and one rural. Questions were developed based on
a review of literature and in collaboration with the state’s department of education. Responses were analyzed and initially coded through transcription of audiotapes uploaded into Atlas Ti. Coding was then categorized and common phrases were identified. Finally, themes were identified when recurring categories were present across all three groups.

The resulting three themes were: confusion about curriculum access, the logistics of curriculum access, and the need for collaboration and communication. Regarding the first theme, when probed about access to the general education curriculum, teachers referred to alternative assessment. Some teachers were unfamiliar with the CCSS, did not know how to align the standards to the curriculum, and had received no professional development in that area. Most teachers reported that they focused solely on functional/life skills and questioned the appropriateness of the general education curriculum. Regarding the second theme of the logistics of curriculum access, teachers were not sure how to logistically teach across grade levels in their self-contained classrooms. They also pondered how to balance academic and life skills instruction. Contrary to the study by Timberlake (2016), participants in this study expressed a need and desire to collaborate across teachers in special education and general education but noted they had little opportunity to do so. The researchers provided participants with a copy of the Dynamic Learning Map Essential Elements, and teachers expressed appreciation for having a roadmap to link the CCSS to their students. Based on all of the information gleaned from the study, the researchers identified the following supports as being necessary for ensuring access to the general education curriculum: (a) collaboration with general education teachers, (b) leadership supports for creating structures for
communication and collaboration, and (c) professional development on CCSS and access to the general education curriculum for students with SID.

Olson et al. (2016) focused on a middle school identified as an exemplar of inclusive education, explored how its support personnel—including school administrators, general education teachers, and special education staff—define and provide access to the general education curriculum for students with SID. The researchers used a case study design to study a middle school team that received an Inclusive Education Award from the nonprofit advocacy group TASH. Twelve of 42 people recruited for the study agreed to participate in the study, including two administrators, two learning specialists, one inclusion support teacher, one educational assistant, and six general education teachers in the subject areas of physical education, language arts, science, business, and music. Researchers collected data using a questionnaire, interviews, a reflection form to describe decision making, document review, and observations of staff during instruction or administrative meetings or during professional development conversations among staff regarding access to the general education curriculum. The software program NVIVO was used to code data from all sources. The research team used peer debriefing to reach consensus on coding in all phases from priori coding to sub-coding to categorization.

Results revealed that students were consistently accessing the general education content and materials in all classes observed. Several research participants expressed the importance of “opportunities” for students with SID to learn and make progress academically and socially (Olson et al., 2016, p. 149). Instructional decisions were based on the individual needs of the students and on grade-level expectations. A variety of instructional arrangements were used, including cooperative groups and peer supports, to
meet the individual needs of the student. Collaboration across stakeholders was defined as a critical component in providing access, and the collaboration took many forms—in leadership teams, in problem-solving teams, through team teaching, during co-planning, and during time specifically allocated for teaming. Access to the general education curriculum was identified as a priority and shared responsibility of all.

There were some limitations to this study that are important to consider. First, only a subsample of staff at the school participated in the study, so the study does not provide the perspective of any math teachers or of the other content specialists who did not participate. Second, the school only served three students with SID, thus access may look different in a school with larger numbers of students with disabilities. Finally, data on student performance and progress was not collected.

Ruppar et al. (2017) also used a selected group of practitioners who were deemed to be exemplars, but in this study, the research team was evaluating the skills and qualities demonstrated by “expert” teachers of students with SID. The researchers used reputational sampling to recruit the 11 teacher participants from various states across the United States. Teachers were nominated through administrators and university faculty who had participated in previous studies or had conducted research on instruction for students with SID. The teaching experience of participants ranged from three to 25 years, and their grade level experience covered early-childhood education through high school. Ten of the participants taught in self-contained classrooms.

The teachers were interviewed using a structured teacher interview protocol. Audio-recorded interviews lasted approximately 45-60 minutes and were transcribed for data analysis. Each researcher interviewed between three and five teachers, but all three
researchers coded the entire data set. The findings were very similar from one participant to another, resulting in eight well-defined categories, four skill indicators and four quality indicators of expertise in instructing students with SID. Skills included: advocacy, systematic instruction and academics, individualization and adaptation, and collegial relationships. Participants emphasized the importance of access to age-appropriate academic instruction. Though all voiced a belief in inclusion, few worked in the general education environment. Despite the lack of access to general education, the participants aligned curriculum to grade level standards. Some teachers used commercially available materials, specifically referencing Teaching to the Standards: Math (Trela, Jimenez, & Browder, 2008). Others adapted materials from the general education textbook or developed their own adapted materials. The study identified the qualities of “expert” teachers for students with SID as flexibility and creativity, a tendency to set high expectations, positivity, and continual efforts toward improvement. The findings demonstrate the dichotomy teachers of students with SID face. Though teacher skills and qualities are focused on advocacy and equity for students in the general education curriculum, most teachers develop and implement instruction in self-contained classrooms.

The final study included in this review surveyed special education teachers of students with SID in the state of Wisconsin. Ruppar et al. (2016) obtained a list of licensed teachers from the Department of Public Instruction and filtered the list to identify teachers working with the target population. From the list of 5,998 teachers who met the criteria, the researchers randomly selected 10% of teachers from each of the 12 regional cooperative districts in the state. Using email addresses found through Internet
search, they invited 515 teachers to participate in the study. Twenty percent \( (n = 104) \) of respondents participated. Participating teachers taught students ranging in age from early childhood through high school and transition age. The percentage of teachers at the high school level was 27\% or \( (n = 28) \).

The vignette-style survey first solicited demographic information, then presented three brief vignettes. Each vignette briefly described a student with SID. Following each vignette was a list of 10 competencies that were specific to the student. The study participants were then asked to rate how prepared they felt to complete the competency or practice. For example, one of the vignettes described a student with the pseudonym of Leo who was “a determined young man who experiences significant behavior challenges at school . . . He communicates using a few picture symbols and gestures” (Ruppar et al., 2016, p. 277). Given that scenario and the respondents’ experiences and education, they were asked how prepared they would feel to create a behavior intervention plan for Leo.

In addition to probing teachers’ competencies related to functional assessments and behavior intervention plans, the research explored topics including: collaboration, effective instruction, inclusion, curriculum content identification processes, advocacy, transition planning, physical and sensory needs, Individualized Education Program, and medical needs. The curriculum-based competencies probed in this study were: (a) “determine the most important general education content for Leo to learn;” (b) “explain Caroline’s performance on state standardized assessments;” (c) “align Abigail’s goals with state standards;” and (d) “teach Caroline skills that will lead to lifelong involvement outside of school.” Competencies about prompting strategies and universal design were also probed.
Descriptive statistics were used to analyze the data, and means and standard deviations were calculated for individual responses. Independent sample t tests were also conducted to compare responses of participants to licensure, level of education, and years of experience. Results indicated that teachers were most prepared for completing IEPs and collaborating with team members, but less prepared for planning curriculum and supporting students’ physical and medical needs and assistive technology. Licensure type, level of education, and years of experience were all found to be significant. Teachers with specific licensure in cognitive disabilities felt more prepared than those with general certification. Teachers with master’s degrees and more than 10 years of experience also reported being more prepared than teachers with bachelor’s degrees and less than 10 years of experience. The information gleaned from this study can be used as a foundation for future research in other geographic areas.

1. **Teacher education intervention studies**

Little research attention has been paid to developing the mathematics knowledge of special education teachers (Faulkner & Cain, 2013). Only a handful of studies were found that evaluated the effectiveness of professional development on mathematics knowledge for special education teacher of students with SID (Faulkner & Cain, 2013; Browder, Jimenez, Mims, Knight, Spooner, Lee, & Flowers, 2012; Browder, Trela, Courtade, Jimenez, Knight, & Flowers, 2010).

Browder et al. (2010) evaluated professional development training they provided to special education teachers in teaching mathematics and science interventions that were aligned to general education standards. The researchers selected a literacy-based approach that placed math problems into the context of a story, and conducted the study
in self-contained classrooms in a large, urban school system in the southeastern United States. Ten middle and high school teachers were recruited and randomly assigned to the math or science intervention. Teachers were considered “highly qualified” to teach students with moderate to severe intellectual disabilities, but none were licensed to teach math, nor had they taken any specific coursework in math prior to this study. The participating teachers nominated student participants. After meeting inclusionary criteria for IQ, among other prerequisites, sixteen students participated in the math group. All had an IQ less below 55, with a mean IQ of 44.85 for the group. Five were also classified on the autism spectrum. The students ranged in age from 14 to 20 years old.

The researchers identified four mathematics standards to target for instruction, and used a quasi-experimental design to evaluate the effectiveness of the math intervention through a pretest and posttest. Research-based interventions included story-based problems, graphic organizers, manipulatives, and step-by-step task analyses. The content included a nine-step geometry task, a 10-step algebra task, a 10-step task for the data analysis and probability standard, and 10 purchasing problems to solve for the measurement competency.

Student participants were administered a math achievement test. Statistical differences were noted between the intervention groups on mathematics gain scores. There was a significant interaction effect \[ F(1, 35) = 42.88, p<.001 \]. Overall, teacher training to use literacy-based mathematics instruction increased students’ acquisition of mathematics skills. Literacy-based or story-based instruction emerged as an evidence-based practice in mathematics for students with SID.
In a second study, Browder, Jimenez et al. (2012) evaluated the effectiveness of a method of professional development called *Tell, Show, Try, and Apply* (TSTA) to train teachers in teaching grade-level academic standards in English, mathematics, and science to students with SID. They also investigated the effects of TSTA professional development on generalization of systematic instruction to new content with the teachers’ own students in the three content areas.

The design of the professional development was based on effective practices in research synthesized by Yoon, Duncan, Lee, Scarloss, and Shapley (2007). Yoon et al. systematically reviewed 1,300 studies related to professional development for teachers. They concluded that only nine studies met *What Works Clearinghouse* evidence standards, and none targeted teachers of students with SID. All teacher participants taught in self-contained classrooms. Each teacher recruited one or two of their students to participate in the training, with participants totaling 49 students with moderate, severe or profound intellectual disabilities or autism. Students were in grades 3-11.

Presenters applied the *Tell, Show, Try and Apply* process as follows: (a) they provided information on a professional development strategy from the research (tell); (b) they provided a model through video or other tools (show); (c) they had teachers role play using the strategy (try); and (d) they gave teachers ways to apply strategies to their classroom (apply). Teachers were instructed to use systematic instruction within “work it across” to extend state standards, literacy-based lessons, mathematics graphic organizers, and task analytic instruction. To assess application of task analysis with fidelity, participants were asked to submit videotapes of applications in their classroom. Teachers
were also asked to submit evidence of their ability to generalize applications to new content standards. The results revealed that the professional development package was effective in increasing teachers’ knowledge of alignment. Of note was the fact that pretest scores for the formula and skill domains were extremely low, indicating that very few teachers knew how to plan for teaching grade-level content.

G. Summary of Research

In summary, few guidelines exist for teaching mathematics skills that are linked to grade-level content for students with SID (Browder, et al., 2007). There is even less to draw on when examining the factors associated mathematics curriculum and instruction for special education teachers of students with SID. However, some themes did emerge from the literature review. First, that general education high school math teachers need more knowledge on how to differentiate and remediate instruction for students with disabilities (Gagnon & Maccini, 2007; Klehm, 2014; Maccini & Gagnon, 2006). Second, that most special education teachers lack the content knowledge to teach general education mathematics curriculum (Browder et al., 2010; Browder et al., 2012; Faulkner & Cain, 2013; Gagnon & Maccini, 2007; Maccini & Gagnon, 2002, 2006; Otis-Wilborn et al., 2005). For example, special education teachers are unfamiliar with the goals of NCTM (Maccini & Gagnon, 2002), reported less confidence and preparedness to teach content (Gagnon & Maccini, 2007; Maccini & Gagnon, 2002, 2006), were at least five times more likely to teach basic mathematics skills (Maccini & Gagnon, 2002, 2006), and were unable to link students’ goals to the general education curriculum (Otis-Wilborn et al., 2005). Further, general education and special education teacher groups reported that a common barrier is a lack of instructional tools and resources (Otis-Wilborn et al., 2005;
Maccini & Gagnon, 2002). They have few models for teaching students with SID content that links to common core standards in mathematics (Browder, Courtade, Jimenez, Knight, & Flowers, 2012). As a result, in practice, teachers typically continue to focus mathematics instruction on functional life skills and repeated instruction of numbers and numeric operations. While students with significant intellectual disabilities can learn higher-level mathematics skills, their access to those standards is limited. Maccini and Gagnon (2002), Petersen (2016), and Karvonen, Flowers, et al. (2013) offered some insight into the barriers for special education teachers of students with disabilities, and Greenway et al. (2013) described special education teacher’s decision-making about instruction in evidence-based practices for students with intellectual disabilities. But the research does not illuminate the attitudes, preparation and factors affecting instructional decision-making in the area of mathematics at the secondary-level for students with significant intellectual disabilities.

The following chapter will discuss the methods used to address the gap in available research on how special education teachers make decisions about mathematics curriculum and instruction for students with SID at the high school level and on the teacher variables that influence these decisions. Gagnon and Maccini (2007), and Maccini and Gagnon (2002, 2006) offer some insight into the factors contributing to high school teachers’ mathematics instruction for students with mild disabilities and into the barriers of teacher beliefs, preparation and content knowledge, but it is uncertain whether the same demographic attributes and barriers exist for students with SID. Two small-scale studies involving interviews with 12 or fewer high school teachers discussed decision making about academic access (Timberlake, 2014) and the use of evidence-
based practices (Greenway et al., 2013) for students with significant intellectual disabilities. Those findings revealed that teacher autonomy is a contributing factor. However, no other published study has made a larger-scale examination of factors influencing special education teachers’ math curriculum, instruction, and design for high school students with SID.
III. METHODS

A. Research Design

This study uses survey methodology to explore the nature of mathematics instruction for students with significant intellectual disabilities, to determine the relationship between teacher characteristics and special education teachers’ math instruction and design at the high school level, and to identify barriers that may interfere with the delivery of standards-based math instruction (e.g. perceptions, resources, competency, knowledge, and training) and the use of evidence-based practices. Surveys are often the best means of collecting information from or about people in order to describe, compare, or explain their knowledge, attitudes, and behavior (Fink, 2002). “Frequently our understanding of educational phenomena is enhanced greatly by the process of careful description” (Suter, 2012, p. 331). As such, the use of a survey is the best method for answering the research questions in this study.

B. Participants and Setting

Census and snowball sampling techniques were employed for obtaining a sample for the study. First, a census was taken to identify all qualified participants for the study. The researcher contacted all public districts and state-approved, private therapeutic schools in Illinois that serve high-school aged students with significant intellectual disabilities. The researcher used the Illinois State Board of Education (ISBE) Directory of Educational Entities to identify all public districts and state-approved private therapeutic schools in Illinois that served high-school aged students with significant intellectual disabilities. The search yielded a total of 574 districts and private therapeutic schools in Illinois.
Then snowball sampling technique was employed to obtain referrals from initial contacts. The researcher emailed high school special education directors or the district administrators overseeing special education programs from the 574 districts. The email to the administrators introduced the research and requested contact information for eligible teacher participants. Special education administrators were informed of the criteria for inclusion so that they could determine whether any of their special education teachers were eligible to participate in the study. Eligible participants included teachers licensed in special education in Illinois, who had taught for at least two years, and who were teaching mathematics at the high school level to students with significant intellectual disabilities (defined as at least one student participating in the state alternative assessment) during the time of the study. Teachers with less than two years of experience and who were not currently teaching high school students with SID were excluded.

Of the 574 districts, 217 (38%) of them responded to the researcher’s email. Responses varied across districts. Some district administrators commented that they did not hire teachers and relied on a special education cooperative to support their students with SID, while some said they had no teachers who met the criteria. Some would not provide consent, some had no students with SID, some had no teachers who were interested, and some provided the emails for teachers they believed qualified for the study. Altogether, 117 districts provided emails for teachers, yielding 352 high school special education teachers’ emails.

Next, an email was sent to all potential teacher participants. The email included an overview of the study and eligibility criteria, along with an online consent form that registered informed consent when the teacher read the online form and clicked the submit
button to enter the survey. The email also included a link to the survey that was hosted by Qualtrics. A copy of the IRB-approved letters, consent form, and survey are provided in Appendix B. A total of 145 teachers (41%) completed the online survey. Though a survey return rate of 50% is common (Weisberg, Krosnick, & Bowen, 1989), the researcher reached a saturation point in data collection. To accomplish this, the researcher sent out biweekly reminders from January 2017 through July 2017 to try to increase response rate. However, in July, all of those who had already responded requested to be taken off of the email distribution list. At that time, the researcher consulted with the dissertation committee members, who agreed that a saturation rate had been met.

Finally, the researcher reviewed survey results to determine eligibility through additional screening mechanisms that were embedded in the survey. If the teacher answered “no” to questions 11, 13, or 14, the survey directed the participant to the end of the survey. Nineteen respondents did not complete the survey. After all completed surveys were submitted, the researcher again reviewed the survey to determine whether the teachers met the study criteria based on how they answered the following survey questions: (#3) endorsements held; (#9) years of teaching experience; (#11, #13, #14) teaching assignment. Fifty-one were removed due to exclusionary factors. A total of 75 teachers were determined to be eligible to participate in the study.

Table 3 describes the demographic information of the participants. Special education teachers were employed at K – 12 school districts ($n = 27$), high school districts ($n = 28$), special education cooperatives ($n = 16$), and private facilities ($n = 4$) across northern, central, and southern Illinois. Few teachers who participated in the study
taught in an urban setting ($n=6$). The majority of participants were split between suburban locations ($n=35$) and rural locations ($n=34$). Most educators taught in special education instructional classrooms ($n=43$) or self-contained programs in a general education building ($n=32$). Thirteen ($n=13$) teachers taught in separate schools. Eight taught in a resource room ($n=8$), and only one ($n=1$) teacher taught in the general education classroom. Most teachers were female (89%) and white (97%). Teachers ranged in age from 24 to 66, with a mean age of 40 years.

**TABLE III**

SPECIAL EDUCATION TEACHER DEMOGRAPHICS

<table>
<thead>
<tr>
<th>Variable</th>
<th>Sample (N = 75)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>School type</strong></td>
<td>N (%)</td>
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<tr>
<td>K-12 school district</td>
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<tr>
<td>High school district</td>
<td>28 (37)</td>
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<tr>
<td>Special education cooperative</td>
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<td>Private facility</td>
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<td>Suburban</td>
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<td>34 (45)</td>
</tr>
<tr>
<td><strong>Special education setting</strong></td>
<td></td>
</tr>
<tr>
<td>General education classroom</td>
<td>1 (1)</td>
</tr>
<tr>
<td>Resource room</td>
<td>8 (11)</td>
</tr>
<tr>
<td>Special education instructional classroom</td>
<td>43 (57)</td>
</tr>
<tr>
<td>Self-contained class in general education building</td>
<td>32 (43)</td>
</tr>
<tr>
<td>Separate school</td>
<td>13 (17)</td>
</tr>
<tr>
<td><strong>Gender</strong></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>67 (89)</td>
</tr>
<tr>
<td>Male</td>
<td>8 (11)</td>
</tr>
<tr>
<td><strong>Teaching experience</strong></td>
<td></td>
</tr>
<tr>
<td>2-5 years</td>
<td>20 (27)</td>
</tr>
<tr>
<td>6-10 years</td>
<td>15 (20)</td>
</tr>
<tr>
<td>11-15 years</td>
<td>13 (17)</td>
</tr>
<tr>
<td>16-20 years</td>
<td>11 (15)</td>
</tr>
<tr>
<td>21-25 years</td>
<td>6 (8)</td>
</tr>
<tr>
<td>&gt;25 years</td>
<td>10 (13)</td>
</tr>
<tr>
<td><strong>Ethnicity</strong></td>
<td></td>
</tr>
<tr>
<td>Hispanic or Latino</td>
<td>2 (3)</td>
</tr>
<tr>
<td>Non-Hispanic or Latino</td>
<td>71 (95)</td>
</tr>
<tr>
<td><strong>Race</strong></td>
<td></td>
</tr>
<tr>
<td>White</td>
<td>73 (97)</td>
</tr>
<tr>
<td>Black or African-American</td>
<td>2 (3)</td>
</tr>
</tbody>
</table>
Table 4 describes teacher variables including degree type, licensure, and mathematics background for students with disabilities to provide a descriptive picture of the special education teachers participating in the study as well as for use as predictor variables for later hierarchical linear modeling. The majority of teachers (60%) held undergraduate degrees in special education. Of those, 10 also earned graduate degrees in special education. Twenty-five teachers (47%) exclusively held graduate degrees in special education. Though 88% of teachers had at least some coursework in mathematics, a noteworthy proportion of teachers (12%) reported having none.

**TABLE IV**

**EDUCATIONAL BACKGROUND OF SPECIAL EDUCATION TEACHERS**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Sample (N = 75)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Degree type</strong></td>
<td></td>
</tr>
<tr>
<td>Undergraduate in special education</td>
<td>45 (60)</td>
</tr>
<tr>
<td>Undergraduate in elementary education</td>
<td>3 (4)</td>
</tr>
<tr>
<td>Undergraduate in secondary education</td>
<td>3 (4)</td>
</tr>
<tr>
<td>Undergraduate in non-education field</td>
<td>3 (4)</td>
</tr>
<tr>
<td>Dual undergraduate degree in special education and elementary education</td>
<td>5 (7)</td>
</tr>
<tr>
<td>Graduate degree in special education</td>
<td>35 (47)</td>
</tr>
<tr>
<td><strong>License</strong></td>
<td></td>
</tr>
<tr>
<td>Special education (LBS1)</td>
<td>74 (99)</td>
</tr>
<tr>
<td>Elementary education</td>
<td>11 (15)</td>
</tr>
<tr>
<td>Secondary education</td>
<td>10 (13)</td>
</tr>
<tr>
<td>Math subject area (9th-12th grade)</td>
<td>2 (3)</td>
</tr>
<tr>
<td>Provisional</td>
<td>0 (0)</td>
</tr>
<tr>
<td><strong>Math background</strong></td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>9 (12)</td>
</tr>
<tr>
<td>Some coursework in mathematics</td>
<td>35 (47)</td>
</tr>
<tr>
<td>Previously deemed “highly qualified” in math</td>
<td>31 (41)</td>
</tr>
<tr>
<td>Endorsement in secondary-level math</td>
<td>0 (0)</td>
</tr>
</tbody>
</table>
Table 5 delineates the frequencies, means, and standard deviations of college-level mathematics courses and general education math methods courses taken. The number of college-level mathematics courses and general education math methods courses taken by teachers varied significantly from 0-15 courses. Ninety-two percent of educators completed four or fewer, with an average of two classes ($M = 2.4, SD = 2.30$).

**TABLE V**

<table>
<thead>
<tr>
<th>Courses</th>
<th>N (%)</th>
<th>None</th>
<th>1-2</th>
<th>3-4</th>
<th>5-6</th>
<th>7 or &gt;</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>College level math courses</td>
<td>9 (12)</td>
<td>42 (56)</td>
<td>18 (24)</td>
<td>2 (3)</td>
<td>4 (5)</td>
<td>2.45</td>
<td>2.30</td>
<td></td>
</tr>
<tr>
<td>General education math methods</td>
<td>20 (27)</td>
<td>38 (51)</td>
<td>13 (17)</td>
<td>3 (4)</td>
<td>1 (1)</td>
<td>1.71</td>
<td>1.67</td>
<td></td>
</tr>
</tbody>
</table>

Teachers also reported whether they had taken any mathematics method courses that addressed teaching math to students with disabilities. Some ($n = 29$) indicated “yes.” Most ($n = 35$) indicated “maybe.” Eleven did not indicate either way. The number of math methods courses taken and other teacher-level characteristics were used during the examination of the research questions. This will be discussed further in the data analysis section of this chapter.
C. Instrumentation

Participants completed an online survey consisting of 36 core items across five domains that included: personal confidence; familiarity and knowledge of mathematics; attitudes toward students with intellectual disabilities; enacted curriculum and instruction; and teacher preparation. The instrument incorporated literature from teacher education in special education, mathematics teacher education research, and effective strategies for students with SID. Appendix A provides a full description of the item development process, survey structure, and response scale format. It also describes the pilot study that was conducted using Survey Monkey to collect data on the effectiveness, dimensionality, reliability, and validity of the survey instrument. Based on the pilot study, the dimensionality analysis supported a multidimensional structure of the instrument; thus, in the current study, the analysis was reported for the subscales.

1. Reliability

Internal consistency estimates using Cronbach’s Alpha were calculated for each individual subscale. Reliability estimates for Preparation, Confidence, and Knowledge, Type and Frequency of Math Content subscales were .72, .88, and .87, .84 and .81 respectively. Additionally, within the HLM model, the reliability estimate was reported for the HLM data analysis conducted to determine the amount of variation in math content accounted for by the predictor variables. A reliability of person content ability estimates of 0.818 resulted.

2. Validity.

Validity was assessed for content, structural, and factorial validity. First, content validity was assessed during the pilot study of the survey instrument using a
content validity rating form. Operational definitions were developed for each category. Then, experts in the field were commissioned to evaluate agreement of the operational definitions for the domains of the test. Statements not fitting any domain were re-evaluated for wording. Second, structural validity—the extent to which a test’s scoring structure is consistent with the structure of the content domain of the test—was measured by comparing the item-difficulty hierarchies with the expected response. Responses to items that are expected to be harder for the respondent to endorse should be higher on the continuum than items that are considered easier to endorse. For instance, based on research that special education teachers have more knowledge of strategies than academic content, it would be expected that special education teachers would find it easier to endorse an item such as “I know research-based, effective math instructional strategies for students with disabilities” than it would be for them to endorse an item such as “I know the NCTM standards for the grade level I teach.” Structural validity was assessed in the pilot study using variable maps for each subscale from Winsteps (Linacre, 2012). Easier to endorse items were listed near the bottom of the map, while harder to endorse items were near the top. The variable map offered structural validity of the instrument. The continuum of item difficulty on the variable map mirrored the theoretical underpinnings. Third, a factor analysis was conducted for the current study. The number of factors was determined using the Kaiser-Guttman rule with eigenvalues greater than 1.0 suggested there were five factors. However, factors fourth and fifth eigenvalues were less than 2.0 and each explained 6.19% and 4.73% of variance, respectively. A visual inspection of the elbow of the scree plot suggested that three factors should be extracted.
Performance of people on this survey was consistent with the pilot and consistent with the assumptions that there are clusters of knowledge, confidence, and preparation.

D. Data Analysis

The survey was administered using an online survey program, Qualtrics. Respondent demographics were examined descriptively using SPSS 24.0. Participant responses to the survey were analyzed to determine the math curriculum and instruction for high school students with significant intellectual disabilities and how it was chosen. The data analysis method varied based on the research question and is described below.

1. Research question: The Content

What is the content being taught to students with significant disabilities (e.g. functional skills, secondary course content areas)? This question was examined descriptively through analysis of data obtained in response to the content areas taught across settings (survey question 17) and the frequency of the content area taught (survey question 20) using SPSS. Frequencies, means, and standard deviations were calculated.

2. Research question: Evidence-based practices

What evidence-based practices do special education teachers reportedly use during mathematics instruction for students with significant intellectual disabilities? Teachers were questioned on the frequency of their use of evidence-based practices (survey question 23). The mean number of evidence-based practices is reported.

3. Research question: How the curriculum was determined

How was the mathematics curriculum and instruction determined? Was it based on the individual (attributes, assessments, and/or goals), on teacher variables, and/or on organizational influences? Teachers were queried regarding how mathematics
curriculum and instruction were determined (survey question 18) and what forms of assessment they found most useful for instructional planning (survey question 24). A descriptive statistics process was used to calculate means and standard deviations from survey questions. Level of autonomy (survey question 19) and level of accountability (questions 25, 26) was also reported using descriptive statistics.

4. **Research question: Special education teacher knowledge**

How reportedly knowledgeable are secondary special education teachers of mathematics content and instruction? Is there a relationship between the perceived knowledge teachers possess and their curriculum and instruction? Where do high school special education teachers learn about curriculum and instructional strategies for teaching mathematics to students with significant disabilities (e.g. college courses, professional development activities, consultation with general education teachers)? What are the perceived barriers to teaching standards-based math content for high school students with significant intellectual disabilities and what are the possible resolutions?

Since the instrument followed a multidimensional framework, the teacher perceived knowledge subscale was analyzed through descriptive statistics. Further, a brief performance assessment (based on the work of Ball & Forzani, 2009; Hill et al., 2008) was conducted whereby teachers were asked to solve a simple multiplication problem followed by questions about how they were taught to solve the problem, what other answers students may have given to the problem and why, and what similar problem the teacher could give to confirm the student’s misconception. Responses were coded using a rating of 0 (representing an absence of knowledge), 1 (representing a basic level of knowledge), or 2 (representing more in-depth knowledge). The researcher and
faculty sponsor independently coded 100% of all participants scores. After all scores were coded, the researcher and faculty sponsor discussed them, and if there was a disagreement, scores were revised based on consensus. The formula used for interrater reliability was dividing the number of agreements by the total number of agreements plus disagreements and multiplying by 100 (Miles & Huberman, 1994). An interrater agreement of 93% was obtained. After consensus, means and standard deviations were calculated for scores on the performance assessment.

Finally, a correlation analysis was used to analyze the relationship between reported knowledge and their curriculum and instruction. The null hypothesis is that there is no relationship between teachers’ knowledge and their curriculum and instruction.

5. Research question: Predictor variables

How much variation in mathematics content (e.g. algebra, life skills) is accounted for by teacher-level characteristics (licensure, coursework, attitudes, perceived preparation and knowledge, location, and classroom setting) above and beyond years of teaching experience? Hierarchical linear modeling (HLM) was used to analyze predictor teacher variables. The final variance components table was used and $p$-values for final estimations of fixed effects were analyzed. The final variance components table is used to inform researchers of whether the intercept of the outcome variable is significantly affected by its predictors. The null hypothesis is that there is no predictive relationship between teacher characteristics and implementation of curriculum and instruction.

A Likert-type coding scheme was developed to code the open-ended question pertaining to the special education teacher characteristic of attitudes. Specifically,
question #8 asked, “Are there students in your class for whom the general education mathematics standards would not be reflected in the curriculum you are teaching? If so, in what instance?” Evaluating teacher’s beliefs/attitudes about the appropriateness of general education standards for students with intellectual disabilities, a “0” was assigned if the teacher noted that the curriculum is not appropriate because of the student’s disability. A “1” was assigned if they made a conditional statement (such as indicating that the standards are appropriate with accommodations/modifications), and a “2” was assigned if the teacher did not differentiate by disability. The researcher and faculty sponsor independently coded all scores. After scores were coded, the coders discussed them, and if there was a disagreement, codes were revised based on consensus. Interrater agreement was calculated by dividing the number of agreements by the total number of agreements plus disagreements and multiplying by 100 (Miles & Huberman, 1994). Interrater agreement was calculated at 89%.
IV. RESULTS

This chapter describes the results of the study. The following five research questions guided this study.

A. **What is the content being taught to students with significant intellectual disabilities (e.g. functional skills, secondary course topics)?**

Special education teachers detailed the type of mathematics content (e.g. life skills, algebra, geometry, etc.) they taught in different educational settings. The responses were too limited to report the type of content being taught for students with SID in the general education setting. Almost all special education teachers (93%) taught students with SID in special education instructional classrooms or self-contained settings. In those settings, approximately 80% of teachers indicated they primarily taught “money, time, and calendar,” “other math-related life skills,” and “numbers and operations” type math problems. In addition to the type of content taught, teachers designated the frequency of teaching the content.

Table 6 describes *how often* the various types of math content are being taught. The majority of teachers (56%) taught life skills daily, but rarely instructed students with SID in algebra and geometry. Approximately one third of teachers (29%) specified that they had never taught algebra to their students. However, only 2.8% had never taught numbers and operation and none of the teachers indicated that they had never taught life skills.
### TABLE VI

**FREQUENCY OF MATH CONTENT TAUGHT**

<table>
<thead>
<tr>
<th>Type of math content</th>
<th>Never</th>
<th>Less than once a month</th>
<th>Once a month</th>
<th>Frequently</th>
<th>Always</th>
<th>2-3 Times per week</th>
<th>Daily</th>
</tr>
</thead>
<tbody>
<tr>
<td>Numbers &amp; operations</td>
<td>2 (3)</td>
<td>0 (0)</td>
<td>2 (3)</td>
<td>17 (23)</td>
<td>7 (9)</td>
<td>19 (25)</td>
<td>25 (33)</td>
</tr>
<tr>
<td>Algebra</td>
<td>22 (29)</td>
<td>13 (17)</td>
<td>9 (12)</td>
<td>11 (15)</td>
<td>0 (0)</td>
<td>8 (11)</td>
<td>5 (7)</td>
</tr>
<tr>
<td>Geometry</td>
<td>17 (23)</td>
<td>17 (23)</td>
<td>10 (13)</td>
<td>11 (15)</td>
<td>1 (1)</td>
<td>8 (11)</td>
<td>3 (4)</td>
</tr>
<tr>
<td>Measurement</td>
<td>5 (7)</td>
<td>6 (8)</td>
<td>14 (19)</td>
<td>20 (27)</td>
<td>3 (4)</td>
<td>16 (21)</td>
<td>5 (7)</td>
</tr>
<tr>
<td>Data analysis &amp; prob</td>
<td>24 (32)</td>
<td>8 (11)</td>
<td>10 (13)</td>
<td>12 (16)</td>
<td>1 (1)</td>
<td>6 (8)</td>
<td>3 (4)</td>
</tr>
<tr>
<td>Money, time, calendar</td>
<td>0 (0)</td>
<td>3 (4)</td>
<td>1 (1)</td>
<td>11 (15)</td>
<td>9 (12)</td>
<td>15 (20)</td>
<td>35 (47)</td>
</tr>
<tr>
<td>Other life skills</td>
<td>0 (0)</td>
<td>1 (1)</td>
<td>0 (0)</td>
<td>11 (15)</td>
<td>7 (9)</td>
<td>10 (13)</td>
<td>42 (56)</td>
</tr>
<tr>
<td>Strategic instruction</td>
<td>8 (11)</td>
<td>3 (4)</td>
<td>6 (8)</td>
<td>18 (24)</td>
<td>3 (4)</td>
<td>10 (13)</td>
<td>18 (24)</td>
</tr>
</tbody>
</table>

B. What evidence-based practices do special education teachers reportedly use during mathematics instruction for students with significant intellectual disabilities?

Overall, special education teachers were familiar with and implemented many EBPs in mathematics for students with SID. Table 7 delineates the frequency of the most commonly used instructional practices. Direct instruction was frequently used EBPs ($M = 5.39$). Visual supports, the use of manipulatives and real-world applications were also commonly applied during mathematics instruction.
<table>
<thead>
<tr>
<th>Type of instructional practice</th>
<th>Not familiar (0)</th>
<th>Never (1)</th>
<th>&lt;Once/month (2)</th>
<th>2-3 times/month (3)</th>
<th>Once/week (4)</th>
<th>2-3 times/week (5)</th>
<th>Daily (6)</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manipulatives</td>
<td>0 (0)</td>
<td>1 (1)</td>
<td>1 (1)</td>
<td>2 (3)</td>
<td>2 (3)</td>
<td>22 (29)</td>
<td>45 (60)</td>
<td>5.44</td>
</tr>
<tr>
<td>Real world applications</td>
<td>3 (4)</td>
<td>0 (0)</td>
<td>0 (0)</td>
<td>1 (1)</td>
<td>2 (3)</td>
<td>16 (21)</td>
<td>51 (68)</td>
<td>5.44</td>
</tr>
<tr>
<td>Visuals and graphics</td>
<td>1 (1)</td>
<td>0 (0)</td>
<td>1 (1)</td>
<td>1 (1)</td>
<td>4 (5)</td>
<td>22 (29)</td>
<td>44 (59)</td>
<td>5.41</td>
</tr>
<tr>
<td>Direct instruction</td>
<td>1 (1)</td>
<td>1 (1)</td>
<td>0 (0)</td>
<td>4 (5)</td>
<td>4 (5)</td>
<td>13 (17)</td>
<td>49 (65)</td>
<td>5.39</td>
</tr>
<tr>
<td>Multiple models</td>
<td>1 (1)</td>
<td>1 (1)</td>
<td>1 (1)</td>
<td>2 (3)</td>
<td>5 (7)</td>
<td>28 (37)</td>
<td>34 (45)</td>
<td>5.18</td>
</tr>
<tr>
<td>Prompting and fading</td>
<td>2 (3)</td>
<td>2 (3)</td>
<td>2 (3)</td>
<td>3 (4)</td>
<td>12 (16)</td>
<td>11 (15)</td>
<td>41 (55)</td>
<td>4.99</td>
</tr>
<tr>
<td>Assistive technology</td>
<td>2 (3)</td>
<td>0 (0)</td>
<td>2 (3)</td>
<td>1 (1)</td>
<td>18 (24)</td>
<td>21 (28)</td>
<td>29 (39)</td>
<td>4.90</td>
</tr>
<tr>
<td>Next-dollar/Counting on</td>
<td>5 (7)</td>
<td>6 (8)</td>
<td>4 (5)</td>
<td>3 (4)</td>
<td>3 (4)</td>
<td>16 (21)</td>
<td>36 (48)</td>
<td>4.53</td>
</tr>
<tr>
<td>Interpret and respond to student ideas</td>
<td>7 (9)</td>
<td>4 (5)</td>
<td>1 (1)</td>
<td>2 (3)</td>
<td>9 (12)</td>
<td>16 (21)</td>
<td>33 (44)</td>
<td>4.53</td>
</tr>
<tr>
<td>Self-monitoring</td>
<td>2 (3)</td>
<td>8 (11)</td>
<td>2 (3)</td>
<td>3 (4)</td>
<td>15 (20)</td>
<td>21 (28)</td>
<td>21 (28)</td>
<td>4.33</td>
</tr>
<tr>
<td>Peer-assisted learning</td>
<td>1 (1)</td>
<td>8 (11)</td>
<td>5 (7)</td>
<td>5 (7)</td>
<td>9 (12)</td>
<td>21 (28)</td>
<td>22 (29)</td>
<td>4.31</td>
</tr>
<tr>
<td>Use natural environment</td>
<td>1 (1)</td>
<td>1 (1)</td>
<td>8 (11)</td>
<td>9 (12)</td>
<td>19 (25)</td>
<td>18 (24)</td>
<td>17 (23)</td>
<td>4.27</td>
</tr>
</tbody>
</table>
Table 8 provides the frequency of the least used instructional practices. Response prompting strategies such as time delay was less frequently employed as a strategy. Concrete-Representational-Abstract (CRA) was the least familiar strategy utilized by teachers.

<table>
<thead>
<tr>
<th>Type of instructional practice</th>
<th>Not familiar (0)</th>
<th>Never (1)</th>
<th>&lt;Once/month (2)</th>
<th>2-3 times/month (3)</th>
<th>Once/week (4)</th>
<th>2-3 times/week (5)</th>
<th>Daily (6)</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Least Frequently Used Strategies</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Concrete-representational-abstract (CRA)</td>
<td>31 (41)</td>
<td>6 (8)</td>
<td>4 (5)</td>
<td>3 (4)</td>
<td>9 (12)</td>
<td>9 (12)</td>
<td>9 (12)</td>
<td>2.23</td>
</tr>
<tr>
<td>Progressive time delay</td>
<td>22 (29)</td>
<td>9 (12)</td>
<td>3 (4)</td>
<td>6 (8)</td>
<td>10 (13)</td>
<td>12 (16)</td>
<td>8 (11)</td>
<td>2.59</td>
</tr>
<tr>
<td>Response cards</td>
<td>2 (3)</td>
<td>21 (28)</td>
<td>10 (13)</td>
<td>15 (20)</td>
<td>14 (19)</td>
<td>6 (8)</td>
<td>5 (7)</td>
<td>2.77</td>
</tr>
<tr>
<td>Constant time delay</td>
<td>9 (25)</td>
<td>8 (11)</td>
<td>2 (3)</td>
<td>8 (11)</td>
<td>10 (13)</td>
<td>15 (20)</td>
<td>8 (11)</td>
<td>2.84</td>
</tr>
<tr>
<td>Simultaneous prompting</td>
<td>18 (24)</td>
<td>7 (9)</td>
<td>4 (5)</td>
<td>1 (1)</td>
<td>10 (13)</td>
<td>12 (16)</td>
<td>15 (20)</td>
<td>3.1</td>
</tr>
<tr>
<td>Strategies (e.g. mnemonics)</td>
<td>6 (8)</td>
<td>14 (19)</td>
<td>9 (12)</td>
<td>9 (12)</td>
<td>12 (16)</td>
<td>12 (16)</td>
<td>10 (13)</td>
<td>3.15</td>
</tr>
<tr>
<td>Task analytic</td>
<td>10 (13)</td>
<td>4 (5)</td>
<td>7 (9)</td>
<td>10 (13)</td>
<td>17 (23)</td>
<td>13 (17)</td>
<td>10 (13)</td>
<td>3.39</td>
</tr>
<tr>
<td>Most-to-least prompts</td>
<td>10 (13)</td>
<td>7 (9)</td>
<td>8 (11)</td>
<td>4 (5)</td>
<td>16 (21)</td>
<td>7 (9)</td>
<td>18 (24)</td>
<td>3.46</td>
</tr>
<tr>
<td>System of least prompts</td>
<td>12 (16)</td>
<td>5 (7)</td>
<td>5 (7)</td>
<td>4 (5)</td>
<td>9 (12)</td>
<td>12 (16)</td>
<td>26 (35)</td>
<td>3.82</td>
</tr>
<tr>
<td>Systematic instruction</td>
<td>10 (13)</td>
<td>5 (7)</td>
<td>3 (4)</td>
<td>3 (4)</td>
<td>9 (12)</td>
<td>18 (24)</td>
<td>20 (27)</td>
<td>3.91</td>
</tr>
</tbody>
</table>
C. **How was the mathematics curriculum and instruction determined? Was it based on the individual (attributes, assessments, and/or goals), on teacher variables, and/or on organizational influences?**

Table 9 describes how teachers determined math curriculum and instruction. The majority of teachers (81%) designed the curriculum around students’ IEPs. In addition, special educators commonly used teacher-created materials and/or various published, supplementary materials. Math curriculum and instruction rarely involved collaboration with a general education teacher(s) (7%) or math committee (7%). Moreover, little evidence showed that special educators referenced general education curriculum or standards, including alternative assessment standards. Only 23% of teachers referred to high school level learning standards.
Table 10 lists the type of assessments teachers found to be most useful for instructional planning. Using a response scale from 0 (not at all useful) to 3 (very useful), educators reported that teacher-created assessments, data collection forms, student observations, and professional judgment to be most useful in instructional planning. Teachers indicated that state and district/school assessments were the least useful in their practices.

1. **Autonomy and accountability.**

   Teachers believed that they maintained high levels of autonomy in determining what to teach to their students with SID. Responses were scored using a rating scale from 0 (no autonomy) to 3 (full autonomy). The vast majority of teachers described having “a lot of autonomy” (40%) or “full autonomy” (another 40%) in determining what to teach their students with SID ($M = 2.19$, $SD = .80$). A total of 80% of teachers
believed they had either a lot or full autonomy with respect to deciding what math curriculum to teach their students with SID.

When asked about the degree to which alternative achievement standards and accountability influenced their math curriculum and instruction, teachers reported that standardized assessments impacted their teaching very little. However, teachers felt some accountability for achievement outcomes on state alternative assessments.
TABLE X
ASSESSMENTS TEACHERS FOUND MOST USEFUL FOR INSTRUCTIONAL PLANNING BY RANK

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>Standard deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Observations of students</td>
<td>2.85</td>
<td>0.39</td>
</tr>
<tr>
<td>Teacher-created classroom assessments</td>
<td>2.77</td>
<td>0.42</td>
</tr>
<tr>
<td>Teacher-created data-collection forms</td>
<td>2.66</td>
<td>0.63</td>
</tr>
<tr>
<td>Professional judgment</td>
<td>2.55</td>
<td>0.71</td>
</tr>
<tr>
<td>Performance tasks</td>
<td>2.45</td>
<td>0.71</td>
</tr>
<tr>
<td>Portfolio or work products</td>
<td>2.2</td>
<td>0.88</td>
</tr>
<tr>
<td>Transition assessments</td>
<td>2.01</td>
<td>0.87</td>
</tr>
<tr>
<td>Curriculum-based measures</td>
<td>1.80</td>
<td>0.99</td>
</tr>
<tr>
<td>Student self-evaluations</td>
<td>1.77</td>
<td>0.93</td>
</tr>
<tr>
<td>Adaptive behavior assessments</td>
<td>1.73</td>
<td>1.01</td>
</tr>
<tr>
<td>Publisher-created assessments</td>
<td>1.58</td>
<td>0.98</td>
</tr>
<tr>
<td>Achievement tests</td>
<td>1.48</td>
<td>1.02</td>
</tr>
<tr>
<td>State standardized assessments</td>
<td>0.88</td>
<td>1.05</td>
</tr>
<tr>
<td>District-wide and/or school-wide assessments</td>
<td>0.83</td>
<td>1.01</td>
</tr>
</tbody>
</table>

D. How reportedly knowledgeable are secondary special education teachers of mathematics content and instruction?

This question explored the relationship between teachers’ knowledge and their curriculum, the source and amount of coursework, training, or professional development educators felt they received, and the perceived barriers to teaching standards-based math content.

1. The relationship between teachers’ knowledge and curriculum

Table 11 denotes the responses and average rating that teachers endorsed for perceived knowledge. Overall, special educators felt that they were most adept at adjusting their lessons and using various strategies for developing students’
understanding of math. In contrast, teachers reported less ability about the general
education indicators, including NCTM and CCSS.

In addition to self-report, teachers completed a brief performance assessment
where they were asked to solve a simple multiplication. Then, there were follow-up
questions asking how they were taught to solve the problem, what other answers students
may have given to the problem and why, and what similar problem the teacher could give
to confirm the student’s misconception. Teachers’ total scores on the assessment ranged
from 0 to 8, with an average score of 4.27.
<table>
<thead>
<tr>
<th>Variable</th>
<th>Not at all (0)</th>
<th>A little (1)</th>
<th>A moderate amount (2)</th>
<th>A lot (3)</th>
<th>A great deal (4)</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>I can adjust my lesson based on student level of understandings and misconceptions</td>
<td>0 (0)</td>
<td>4 (5)</td>
<td>12 (16)</td>
<td>30 (40)</td>
<td>28 (37)</td>
<td>3.11</td>
<td>0.87</td>
</tr>
<tr>
<td>I have various strategies for developing student understanding of concepts</td>
<td>0 (0)</td>
<td>3 (4)</td>
<td>22 (29)</td>
<td>37 (49)</td>
<td>12 (16)</td>
<td>2.78</td>
<td>0.76</td>
</tr>
<tr>
<td>I can select and administer assessments to determine students' math knowledge and errors</td>
<td>2 (3)</td>
<td>4 (5)</td>
<td>26 (35)</td>
<td>22 (29)</td>
<td>20 (27)</td>
<td>2.73</td>
<td>1.01</td>
</tr>
<tr>
<td>I can explain connections/relationship between different math ideas</td>
<td>2 (3)</td>
<td>4 (5)</td>
<td>31 (41)</td>
<td>23 (31)</td>
<td>14 (19)</td>
<td>2.58</td>
<td>0.95</td>
</tr>
<tr>
<td>I can design math lessons incorporating the common core standards and individual learners' needs</td>
<td>3 (4)</td>
<td>11 (15)</td>
<td>19 (25)</td>
<td>24 (32)</td>
<td>17 (23)</td>
<td>2.55</td>
<td>1.12</td>
</tr>
<tr>
<td>I know research-based, effective math instructional strategies for students with significant intellectual disabilities</td>
<td>3 (4)</td>
<td>8 (11)</td>
<td>31 (41)</td>
<td>25 (33)</td>
<td>7 (9)</td>
<td>2.34</td>
<td>0.94</td>
</tr>
<tr>
<td>I can use technical mathematical language and terminology precisely</td>
<td>7 (9)</td>
<td>8 (11)</td>
<td>31 (41)</td>
<td>21 (28)</td>
<td>7 (9)</td>
<td>2.18</td>
<td>1.06</td>
</tr>
<tr>
<td>I know the Common Core State Standards (CCSS) for the grade level I teach</td>
<td>11 (15)</td>
<td>15 (20)</td>
<td>29 (39)</td>
<td>13 (17)</td>
<td>6 (8)</td>
<td>1.84</td>
<td>1.14</td>
</tr>
<tr>
<td>I know the NCTM Standards for the grade level I teach</td>
<td>29 (39)</td>
<td>22 (29)</td>
<td>13 (17)</td>
<td>8 (11)</td>
<td>1 (1)</td>
<td>1.04</td>
<td>1.07</td>
</tr>
</tbody>
</table>
A Spearman’s correlation was computed to determine whether a relationship existed between teachers’ perceived knowledge and their curriculum and instruction. Correlation analysis revealed no relationship between reported knowledge and the curriculum and instruction being taught ($r(73) = .028, p = .83$).

2. **The source for learning about math curriculum and instruction**

Table 12 denotes the amount of coursework, training, or professional development educators felt they received by ranking. Teachers received most of their training from undergraduate studies, reading professional literature, and taking workshops. Teachers rarely received coaching from a specialist, co-taught with a math expert, or consulted with their general education counterpart.
## Table XII

### Rating of How Much Coursework Teachers Received

<table>
<thead>
<tr>
<th>Variable</th>
<th>None (0)</th>
<th>A little (1)</th>
<th>A moderate amount (2)</th>
<th>A lot (3)</th>
<th>A great deal (4)</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Received specific instructional strategies for teaching mathematics during undergraduate studies</td>
<td>8 (11)</td>
<td>27 (36)</td>
<td>31 (41)</td>
<td>6 (8)</td>
<td>3 (4)</td>
<td>1.59</td>
<td>0.93</td>
</tr>
<tr>
<td>Read professional literature on effective mathematics instruction</td>
<td>21 (28)</td>
<td>25 (33)</td>
<td>18 (24)</td>
<td>9 (12)</td>
<td>2 (3)</td>
<td>1.28</td>
<td>1.09</td>
</tr>
<tr>
<td>Taken workshops on mathematics content and instructional strategies</td>
<td>15 (20)</td>
<td>33 (44)</td>
<td>21 (28)</td>
<td>5 (7)</td>
<td>1 (1)</td>
<td>1.25</td>
<td>0.90</td>
</tr>
<tr>
<td>Consulted with a general education mathematics teacher when planning lessons</td>
<td>32 (43)</td>
<td>21 (28)</td>
<td>12 (16)</td>
<td>9 (12)</td>
<td>1 (1)</td>
<td>1.01</td>
<td>1.10</td>
</tr>
<tr>
<td>Received specific instructional strategies for teaching mathematics during graduate studies</td>
<td>40 (53)</td>
<td>17 (23)</td>
<td>8 (11)</td>
<td>8 (11)</td>
<td>1 (1)</td>
<td>0.82</td>
<td>1.09</td>
</tr>
<tr>
<td>Co-taught with a certified mathematics teacher</td>
<td>44 (59)</td>
<td>12 (16)</td>
<td>11 (15)</td>
<td>5 (7)</td>
<td>3 (4)</td>
<td>0.82</td>
<td>1.16</td>
</tr>
<tr>
<td>Received coaching from a mathematics specialist</td>
<td>45 (60)</td>
<td>22 (29)</td>
<td>4 (5)</td>
<td>4 (5)</td>
<td>1 (0)</td>
<td>0.56</td>
<td>0.83</td>
</tr>
</tbody>
</table>

Table 13 displays the types of training venues teachers felt best prepared them to teach math. They believed that undergraduate or graduate studies and attendance at workshops most effectively prepared them to teach math. Research studies and professional literature were deemed least effective at supporting math instruction for students with SID.
### TABLE XIII

TEACHER REPORTED MOST EFFECTIVE PREPARATION
FOR TEACHING MATH BY RANK

<table>
<thead>
<tr>
<th>Variable</th>
<th>Sample (N = 75)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coursework during undergraduate or graduate studies</td>
<td>24 (32)</td>
</tr>
<tr>
<td>Workshops on mathematics content and instructional strategies</td>
<td>22 (29)</td>
</tr>
<tr>
<td>Co-teaching with a certified mathematics teacher</td>
<td>8 (11)</td>
</tr>
<tr>
<td>Professional literature on effective mathematics instructions</td>
<td>7 (9)</td>
</tr>
<tr>
<td>Consultation from a general education mathematics teacher when planning lessons</td>
<td>6 (8)</td>
</tr>
<tr>
<td>Coaching from a mathematics specialist</td>
<td>4 (5)</td>
</tr>
<tr>
<td>Research studies on effective mathematics instruction</td>
<td>4 (5)</td>
</tr>
</tbody>
</table>

3. **Perceived barriers to teaching standards-based math content.**

Table 14 ranks the perceived barriers to teaching standards-based math content to students with SID at the high school level from highest to lowest. Though lack of planning time continues to be ranked highest, teachers identified the lack of supplemental curriculum materials to be equally challenging. They also believed professional development and networking to be barriers to teaching standards-based math. In an open-ended response opportunity, teachers repeated statements that having a scope and sequence and curriculum to follow – one that meets the needs of all students – would help them to feel more equipped to teach math. They also stated that more professional development opportunities and more time to collaborate with others who teach a similar population would be beneficial for teaching math.
TABLE XIV

PERCEIVED BARRIERS TO TEACHING STANDARDS-BASED MATH CONTENT

<table>
<thead>
<tr>
<th>Barrier</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>Std. deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lack of planning time</td>
<td>1</td>
<td>4</td>
<td>2.65</td>
<td>1.020</td>
</tr>
<tr>
<td>Lack of supplemental curriculum materials</td>
<td>1</td>
<td>4</td>
<td>2.64</td>
<td>0.995</td>
</tr>
<tr>
<td>Lack of professional development opportunities</td>
<td>1</td>
<td>4</td>
<td>2.59</td>
<td>0.960</td>
</tr>
<tr>
<td>Lack of professional network/peers with similar assignment</td>
<td>1</td>
<td>4</td>
<td>2.55</td>
<td>0.934</td>
</tr>
<tr>
<td>Lack of assessment tools</td>
<td>1</td>
<td>4</td>
<td>2.51</td>
<td>0.964</td>
</tr>
<tr>
<td>Lack of a math scope and sequence for students with significant intellectual disabilities</td>
<td>1</td>
<td>4</td>
<td>2.51</td>
<td>0.964</td>
</tr>
<tr>
<td>Lack of a core curriculum</td>
<td>1</td>
<td>4</td>
<td>2.49</td>
<td>1.005</td>
</tr>
<tr>
<td>Lack of coaching support</td>
<td>1</td>
<td>4</td>
<td>2.47</td>
<td>0.963</td>
</tr>
<tr>
<td>Lack of preparation you received in college</td>
<td>1</td>
<td>4</td>
<td>2.40</td>
<td>0.900</td>
</tr>
<tr>
<td>Lack of knowledge in math instructional/evidence-based practices for students with significant intellectual disabilities</td>
<td>1</td>
<td>4</td>
<td>2.32</td>
<td>0.918</td>
</tr>
<tr>
<td>Lack of access to research in the field</td>
<td>1</td>
<td>4</td>
<td>2.16</td>
<td>0.777</td>
</tr>
<tr>
<td>Lack of staffing (e.g. paraprofessionals)</td>
<td>1</td>
<td>4</td>
<td>2.16</td>
<td>1.079</td>
</tr>
<tr>
<td>Lack of knowledge of mathematics principles and standards</td>
<td>1</td>
<td>4</td>
<td>2.07</td>
<td>0.782</td>
</tr>
<tr>
<td>Lack of administrative support</td>
<td>1</td>
<td>4</td>
<td>1.79</td>
<td>0.905</td>
</tr>
<tr>
<td>Lack of confidence</td>
<td>1</td>
<td>4</td>
<td>1.69</td>
<td>0.920</td>
</tr>
</tbody>
</table>
E. **How much variation in mathematics content (e.g. algebra, life skills) is accounted for by teacher-level characteristics (licensure, coursework, attitudes, perceived preparation and knowledge, location, and classroom setting) above and beyond years of teaching experience?**

HLM was used to run and report predictor variables. The Level 2 predictors assessed included:

- gender;
- type of college degree;
- math background;
- number of college-level math courses;
- number of special education math methods courses;
- whether teachers had a special education methods course(s);
- overall preparedness;
- attitude score; and
- instructional setting

Prior to evaluating the predictor variables, the factors of overall preparedness and attitudes were initially analyzed. In order to analyze overall preparedness, teachers were asked to report their overall rating on preparedness to teach math. On average, teachers reported feeling moderately to very prepared ($M = 2.30, SD = .61$) to teach mathematics to their students. Their individual ratings of overall preparedness were used for making predictions.

Second, teacher attitudes related to the general education mathematics curriculum for students with SID was scored as follows. Specifically, question #8 inquired, “Are there students in your class for whom the general education mathematics standards would not be reflected in the curriculum you are teaching? If so, in what instance.” A rating of 0 to 2 was used to evaluate teachers’ attitudes about the appropriateness for students with significant intellectual disabilities. A “0” was assigned if the teacher felt the curriculum
was not appropriate because of the student’s disability. A “1” was recorded if teachers made conditional statements, such as “the standards are appropriate with accommodations/modifications.” Finally, a score of “2” was assigned to teachers who did not differentiate by disability. Within this sample, approximately half of special educators (48%) believed that the general education standards were not appropriate for students with significant intellectual disabilities. Another 23% of educators said that the standards were appropriate with modifications. Moreover, 13% of teachers did not think standards-based teaching was appropriate given the nature of the students’ disabilities. Each teacher’s score was used as a predictor variable for attitudes.

HLM was used to run and report all predictor variables. Table 15 displays the descriptive statistics within the hierarchical linear model. For the three missing Level 2 (L2) data points, a single imputation based on fitting a multivariate student’s t-model to the data on the L2 predictor variables was employed.
TABLE XV

HLM DESCRIPTIVE STATISTICS OF THE CONTENT SUBSCALE SCORES

<table>
<thead>
<tr>
<th>Variable name</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level-1 descriptive statistics</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Index1</td>
<td>600</td>
<td>4.50</td>
<td>2.29</td>
<td>1.00</td>
<td>8.00</td>
</tr>
<tr>
<td>Trans1</td>
<td>600</td>
<td>0.55</td>
<td>0.50</td>
<td>0.00</td>
<td>1.00</td>
</tr>
<tr>
<td>I33</td>
<td>600</td>
<td>-0.13</td>
<td>0.33</td>
<td>-1.00</td>
<td>0.00</td>
</tr>
<tr>
<td>I34</td>
<td>600</td>
<td>-0.13</td>
<td>0.33</td>
<td>-1.00</td>
<td>0.00</td>
</tr>
<tr>
<td>I35</td>
<td>600</td>
<td>-0.13</td>
<td>0.33</td>
<td>-1.00</td>
<td>0.00</td>
</tr>
<tr>
<td>I36</td>
<td>600</td>
<td>-0.13</td>
<td>0.33</td>
<td>-1.00</td>
<td>0.00</td>
</tr>
<tr>
<td>I37</td>
<td>600</td>
<td>-0.13</td>
<td>0.33</td>
<td>-1.00</td>
<td>0.00</td>
</tr>
<tr>
<td>I38</td>
<td>600</td>
<td>-0.13</td>
<td>0.33</td>
<td>-1.00</td>
<td>0.00</td>
</tr>
<tr>
<td>I39</td>
<td>600</td>
<td>-0.13</td>
<td>0.33</td>
<td>-1.00</td>
<td>0.00</td>
</tr>
<tr>
<td>I40</td>
<td>600</td>
<td>-0.13</td>
<td>0.33</td>
<td>-1.00</td>
<td>0.00</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Variable name</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level-2 descriptive statistics</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gender</td>
<td>75</td>
<td>1.89</td>
<td>0.31</td>
<td>1.00</td>
<td>2.00</td>
</tr>
<tr>
<td>Degree</td>
<td>75</td>
<td>3.87</td>
<td>2.94</td>
<td>0.00</td>
<td>9.00</td>
</tr>
<tr>
<td>Mathback</td>
<td>75</td>
<td>2.29</td>
<td>0.67</td>
<td>1.00</td>
<td>3.00</td>
</tr>
<tr>
<td>Colcours</td>
<td>75</td>
<td>2.45</td>
<td>2.30</td>
<td>0.00</td>
<td>15.00</td>
</tr>
<tr>
<td>Methcour</td>
<td>75</td>
<td>1.71</td>
<td>1.67</td>
<td>0.00</td>
<td>9.00</td>
</tr>
<tr>
<td>Spedmeth</td>
<td>75</td>
<td>0.39</td>
<td>0.49</td>
<td>0.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Overallp</td>
<td>75</td>
<td>3.30</td>
<td>0.61</td>
<td>2.00</td>
<td>4.00</td>
</tr>
<tr>
<td>Attitude</td>
<td>75</td>
<td>0.49</td>
<td>0.72</td>
<td>0.00</td>
<td>2.00</td>
</tr>
<tr>
<td>Setting</td>
<td>75</td>
<td>1.78</td>
<td>0.72</td>
<td>1.00</td>
<td>3.00</td>
</tr>
</tbody>
</table>

The final estimation of variance components displayed that the component for the intercept was 4.85, \( df = 66, p < 0.001 \), meaning that the intercept was significantly affected by its predictors. The model with predictors was created. Table 16 summarizes the effects (slope coefficients) of the Level 2 predictors on person content ability. The data showed no significant predictors of variables tested (gender, degree, math
background, preparation, attitude, setting) for the overall model. Final estimations of fixed effects had p-values greater than 0.05.

**TABLE XVI**

**FINAL ESTIMATION OF FIXED EFFECTS**
(UNIT-SPECIFIC MODEL WITH ROBUST STANDARD ERROR)

<table>
<thead>
<tr>
<th>Fixed Effect</th>
<th>Coefficient</th>
<th>Error</th>
<th>T-ratio</th>
<th>df.</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td>G01</td>
<td>-0.020626</td>
<td>1.085100</td>
<td>-0.019</td>
<td>66</td>
</tr>
<tr>
<td>Degree</td>
<td>G02</td>
<td>0.102127</td>
<td>0.094392</td>
<td>1.082</td>
<td>66</td>
</tr>
<tr>
<td>Mathback</td>
<td>G03</td>
<td>-0.331227</td>
<td>0.462246</td>
<td>-0.717</td>
<td>66</td>
</tr>
<tr>
<td>Colcours</td>
<td>G04</td>
<td>-0.038703</td>
<td>0.103314</td>
<td>-0.375</td>
<td>66</td>
</tr>
<tr>
<td>Methcour</td>
<td>G05</td>
<td>-0.006518</td>
<td>0.178458</td>
<td>-0.037</td>
<td>66</td>
</tr>
<tr>
<td>Spedmeth</td>
<td>G06</td>
<td>0.279718</td>
<td>0.591546</td>
<td>0.473</td>
<td>66</td>
</tr>
<tr>
<td>Overallp</td>
<td>G07</td>
<td>0.476370</td>
<td>0.354788</td>
<td>1.343</td>
<td>66</td>
</tr>
<tr>
<td>Attitude</td>
<td>G08</td>
<td>0.066140</td>
<td>0.466735</td>
<td>0.142</td>
<td>66</td>
</tr>
<tr>
<td>Setting</td>
<td>G09</td>
<td>0.008148</td>
<td>0.425265</td>
<td>0.019</td>
<td>66</td>
</tr>
</tbody>
</table>

1. **Level of Importance.**

Though no teacher variables were found to be predictors for the mathematics content taught during HLM analysis, level of importance was found to be significantly correlated to the content taught. Special education teachers indicated how important it was to follow mathematics content (e.g. numbers and operations, algebra, geometry, etc.) for students with SID. The response scale format was labeled on a scale from 0 (not at all important) to 4 (extremely important). Teachers rated “other life skills” as most important ($M = 3.78, SD = .51$), followed by “money, time, calendar” ($M = 3.69,"
Least important was “Algebra” (\(M = .95, SD = .95\)) then “Geometry” (\(M = 1.03, SD = .84\)).

A Spearman’s correlation was conducted to determine the relationship between how often each content area was taught and how important teachers rated the content area for their students with SID. There was a significant positive correlation between the importance of algebra and how often it was taught, which was statistically significant (\(r = .755, p < .001\)).
V. DISCUSSION

The study explored the nature of mathematics curriculum and instruction, influences on instruction and curriculum design, and obstacles that may interfere with the delivery of grade-aligned, standards-based math curriculum and instruction for high school students with significant intellectual disabilities. Few studies currently exist that examine preparedness to teach the general education curriculum to students with SID (Olson, Leko, & Roberts, 2016; Petersen, 2016; Ruppar et al., 2016; Ruppar, Roberts, & Olson, 2017; Timberlake, 2016). While these studies offer insight regarding access to academic instruction across grade levels, they did not specifically target math nor did they disaggregate data by grade level. This study extended the limited research by specifically exploring special education teachers’ preparedness in mathematics at the secondary level for students with SID. Furthermore, the current study examined special educator perspectives in new geographic locations (Petersen, 2016). Findings from this study note the following themes: life skills curriculum, individualized instruction, student placement, teacher isolation and math knowledge, skill values, organizational factors, and available resources. This chapter discusses each theme from a survey of 75 Illinois secondary special educators who serve students with significant intellectual disabilities (SID). The discourse focuses on results that were supported by previous literature. The chapter also presents the limitations of the study and potential implications for practice. Based on the results, suggestions are made for future research.

A. Life Skills Instruction is Still the Standard

While NCLB, IDEA, and ESSA have placed increased emphasis on teaching to the grade-level standards for all students, teaching functional life skills to students with
SID remains a predominant practice. The absence of mathematics instruction aligned to the general education standards, especially at the high school grade level, is attributed to a myriad of factors. Those attributes are organized by Greenway et al. (2013) theoretical construct of people (students and teachers), organizations (district, state, and federal levels of government), and tools (curriculum, resources, training) and their influences on teacher decision-making of mathematics curriculum and instruction for students with significant intellectual disabilities.

B. Student Factors

Similar to the findings from Soukup et al. (2007), the current study found that curriculum design is not driven by grade level standards, but rather by IEP goals of each student (Soukup, Wehmeyer, Bashinski, & Bovaird, 2007). The significance of the student’s disability may have also contributed to curricular decisions. For example, in an open-ended section on the survey, one teacher responded, “the students have significant disabilities so the curriculum is adapted to meet their IEP goals.” Another stated, “I teach in a life skills classroom of students with significant disabilities. They are not able to complete the coursework for grade level standards, as they are learning at a much lower level.”

Further, the placement of the student as determined in his or her IEP may be a contributing factor to the type of instruction the student receives. This finding aligns with the majority of research studies that signify that students with SID receive mathematics instruction in special education classrooms (Kleinert et al., 2015; Kurth, Morningstar, & Kozleski, 2014). However, research continues to support a significant positive correlation between inclusive class settings and math achievement (Kleinert et
al., 2015). The setting of the student in a “life skills classroom” was often a self-fulfilling prophecy. For instance, one teacher reported, “all of my students are considered ‘life skills’ and are working on money, time, and very basic math, far below the high school level.” Another special education educator who teaches in both a special education classroom and co-taught classroom responded, “All curriculum is referenced to a math standard, directly or indirectly, in my classroom with students with significant needs. In a co-taught section of pre-algebra, the coursework is directly aligned to the standards.”

In summary, student factors, including the nature of the student’s disability and placement, impacts access to the general education math curriculum.

C. Teacher Factors

1. Isolation

   Self-contained classrooms produce environments of seclusion. Overwhelmingly, study findings showed that math curriculum and instructional design occurs in isolation. Similarly, Timberlake (2016) identified that teachers felt high degrees of physical and social isolation and possess a high level of discretion and autonomy over academic decisions. On the survey, one teacher described her isolation by stating, “I am the only life skills teacher in my building, and I have very little support from others who understand my students’ needs.” With respect to deciding what math curriculum to teach their students with SID, the vast majority of teachers believed they held either a great degree or full autonomy. They believed that they were able to use their professional judgment to make instructional decisions and write their own curriculum and did not have much oversight or involvement from administration.

2. Pedagogical knowledge.
Special education teacher competencies emphasize knowledge of the individual over content knowledge (Council for Exceptional Children, 2014). This study found that teachers are more comfortable with pedagogy than subject-matter content. In other words, they are learning strategists more focused on adapting to the individual than to the standards. Teacher familiarity and knowledge of instructional strategies support the findings of similar research in the field. It revealed that special education teachers endorsed stronger knowledge of pedagogy than of mathematics content (Maccini & Gagnon, 2002). For example, respondents were less familiar with the standards for the grade level they taught, but could adjust their lessons based on student level of understanding and misconceptions.

Special education teachers reported lack of familiarity with strategies such as C-R-A, task analytic instruction, and prompting strategies. This may be attributed to the fact that teachers are unfamiliar with the strategy by name and do not regularly reference research studies where these methods are defined and described. Further information should be obtained to determine whether teachers used this methodology but were unfamiliar with the technical label, or if teachers were truly unfamiliar with the instructional methodology.
3. **Teachers’ math knowledge**

Teachers’ math content knowledge and what teachers identify as important has an effect on curricular choices. Although teachers know how to deliver instruction, they are not teaching with the general education curriculum in mind. This study found that the math curriculum for students with intellectual disabilities is focused on life skills. Findings relating to teacher knowledge presented interesting and contradictory results. First, teachers believed that they were highly prepared to teach math despite having limited math training. Additionally, teachers perceived that they had the math content knowledge for what they taught; however, several teachers did not have the correct answers to the mathematics performance assessment, nor did many teachers possess awareness of the NCTM standards for their grade level. These results are similar to earlier research of teachers of students with learning disabilities that found teachers did not possess knowledge of the standards (Maccini & Gagnon, 2002). One potential explanation for this incongruity may be that given the core content in the classroom is practical life skills, teacher reports of their knowledge for teaching the content may be accurate. In other words, this could be attributed to the fact that they are teaching functional math skills and thus feel qualified to teach them. In fact, one teacher commented, “I am not equipped to teach secondary math, but I know my students and know life skills math.” If the measure for ability is based on teaching money, time, and calendar, then given the lower expectations, it is reasonable to infer that teachers can be confident that they are meeting student’s educational needs despite a lack of training in math.
4. Level of importance

The importance teachers place on life skills over the general education math curriculum appears to be the most significant variable that influences the continued emphasis on life skills instruction for students with SID. Similar to the findings of Agran et al. (2016), this study found that more than half of the teachers questioned the relevance of the general education curriculum for students with significant intellectual disabilities (Agran, Alper, & Wehmeyer, 2002; Petersen, 2016). Further, teachers typically do not implement what they do not see as beneficial to students (Nolen, Horn, Ward, & Childers, 2011). This study established that the level of importance teachers assigned to the different types of curriculum (algebra, measurement, life skills) was strongly correlated to how often it was taught. This commitment to what is meaningful and relevant is consistent with research, generally, on access to academic instruction (Timberlake, 2014). This study, however, applies that knowledge specifically to the subject area of mathematics.

The importance of life skill instruction should not preclude access to the general education math curriculum (Courtade et al., 2012). In contrast to previous research (Agran et al., 2002), more teachers in this study endorsed the importance of teaching standards-based mathematics curriculum to students with SID. At least 40% of teachers stated that the standards are reflected in the curriculum that they teach to their students with SID, even though it might not be at grade-level standards or to the same depth as would be taught to their same age peers. If special education teachers realize the importance of math topics such as algebra and are able to adapt the general education curriculum to make it meaningful and relevant, then perhaps teachers would be better
able to determine how to involve students within the general education curriculum and the general education classroom setting.

D. Organizational Factors

In districts across Illinois, general education and special education still occupy disparate worlds. Organization structures perpetuate silos of teaching. While teachers have a desire to access their colleagues, most do not actually do so. One possible reason may be that most teachers expressed an interest in collaboration with peers in similar positions, and in most districts, there was only one special education teacher serving students with SID. It was also evident that teachers did not have access to the knowledge their general education colleagues had to offer. Few special education teachers saw the importance of consulting with verified math experts or consulting with a general education teacher, yet collaboration and shared responsibility is essential for providing access (Olson et al, 2016). Restructuring teaming opportunities to foster greater collaboration between general education and special education would increase teacher knowledge and student instruction aligned with the general education curriculum in math.

1. State and federal policy

While federal policies such as NCLB, IDEA, and ESSA have placed increased emphasis on states to deliver instruction aligned to the grade-level standards for all students, data regarding teacher decisions revealed that fewer than one-fifth of the teachers considered the state content standards when determining what to teach. Further, performance on state alternative assessments was not found to be useful for teachers’ instructional planning.
Studies of special educators have consistently indicated teacher uncertainty about the Common Core State Standards and how to provide instruction that is aligned to the standards (Petersen 2016; Ruppar, Neeper, & Dalsen, 2016; Timberlake, 2016). In this study, teachers expressed confusion about how to align the content standards for students with SID. Further comments revealed that teachers may not understand the relationships among general education standards, essential elements, and the Dynamic Learning Maps (DLM) alternative assessment. For example, one teacher shared that the general education standards are not appropriate and further explained, “I teach students in the life skills program. They are being assessed with the DLM.”

Furthermore, while some of the teachers tried to adapt the CCSS for their students, the majority were uncertain about how to address common core standards and functional skills. There is some evidence to suggest that compliance with alternative assessment or other policies may impact curricular and instructional decisions (Karvonen, Flowers, et al. 2013; Timberlake, 2014). Accountability played a role in access to the general education math curriculum for some teachers. For example, one teacher explained, “the curriculum that we are teaching aligns to general education standards, however it is still too difficult for my students. We were told to teach the curriculum for exposure, and not mastery of concepts.”

E. **Tools**

Greenway et al. (2013) found that because special education teachers operated with relative autonomy, they also had reduced access to resources, supports, curricula, and professional development. A lack of age-appropriate general education curriculum and materials, lack of easy access to research in the field, and the need for relevant
professional development were found to be barriers to teaching the general education curriculum in the limited studies pertaining to students with significant intellectual disabilities (Greenway et al., 2013; Lee, Browder, Flowers, & Wakeman, 2016; Restorff & Abery, 2013). This analysis closely mirrored the findings, except in relation to teachers’ accessing published research.

Aside from lack of time, which is commonly cited as a barrier to instructional planning (Klehm, 2014), teachers repeatedly referenced missing a clear scope and sequence and adapted curriculum in mathematics for students with SID. Teachers described other barriers including the need for, “a highly adapted curriculum as well as manipulatives and materials,” or “a clear scope and sequence designed specifically for this population of students along with supplemental materials.” Though some published materials exist such as the Equals Mathematics Curriculum (Ablenet, n.d.), many teachers appeared unaware of their availability or were unable to access them.

The exception was one teacher who referenced having a curriculum, but expressed difficulty integrating it with competing priorities. “I feel a disconnect between the standards, the curriculum I have access to (EQUALS math) and making math functional (i.e. time, money) for IEP goals . . . It is very difficult to teach two math curriculums (one for time/money/life skills, and the other for whatever the curriculum or standards say), so I often just pick and choose to meet my students’ IEP goals. I wish I had more direction to know what to do and/or how to balance this dilemma.”

In addition to challenges with curricular resources, teachers identified a strong interest in having more training and professional development. They reported that undergraduate or graduate studies most effectively prepared them to teach math, followed
by attendance at workshops. Thus, it is not surprising that the solution teachers most often made reference to was both training during pre-service teaching while still in their undergraduate studies, and in-service professional development. While professional development in special education has focused on teaching evidence-based practices, the teachers in this study sought training that was focused on the math conceptual knowledge. To illuminate this point, an educator declared, “More professional development directly related to mathematics for students with significant disabilities . . . not just direct instruction programs.” Teachers also heavily preferred attending workshops to reading professional literature. Also notable was the fact that only one teacher requested better assessment tools that measure core math concepts. Karvonen, Flowers, et al. (2013) found that teachers with more professional development, greater general curriculum influences (state and national content standards, alternative assessment requirements and results, content materials, activities used by general education teacher, etc.), and who use performance assessments more frequently demonstrated greater access to the general education curriculum. The results of this survey identified several gaps for teaching standards-based mathematics instruction for this population of students.

F. Limitations

While this study extends the research on access to the general education curriculum and fills a gap in the research by more specifically addressing mathematics education for students with SID, it also has a few limitations. Given the small sample of participants, caution should be taken when interpreting the results. Recruitment for the study proved difficult. Although multiple outreach attempts were made for recruitment,
the researcher reached a saturation point in enrollment. Challenges included low response rates, a limited number of teachers in Illinois who met the criteria, and a low-incidence student population that some districts did not serve.

Another limitation was the inability to determine how responses may have differed from those individuals who either declined or did not reply at all. Biases can result when the characteristics of the respondents differ from those of non-respondents. If that were the case, the sample may not be representative of the population.

Thirdly, though surveys can and should be used as one method for analyzing teacher perspectives, a survey is limited by its reliance on teacher self-reporting. Teachers may not have provided responses that were as candid as they might have been if they had any concerns about confidentiality. Additionally, teachers may perceive their practices differently than other observers might. Multiple data sources could have been used to enhance the trustworthiness of the data.

Lastly, it is important to note that two predictor variables were one-item scales (attitude and overall preparation). Psychometrically, single-item measures may be viewed as questionable since they are more vulnerable to measurement error and unknown biases in meaning and interpretation. Additionally, internal consistency reliability statistics cannot be calculated on a single-item measure.

G. **Implications for Practice**

The purpose of this study was to acquire a better picture of the curriculum and instruction occurring at the high school level, and of the dynamics that may be interfering with implementation of standards-based mathematics for students with SID. Specifically, the researcher wanted to understand how students, teachers, tools, and organizations
played a role in decision-making and implications for practice. The following are recommendations for practice and future research.

First, it was clear from this study that special education teachers made decisions in isolation based on students’ IEP goals and educational contexts. Student instructional targets and classroom placements were repeatedly described as “life skills” and therefore most students were working on money, time, and number identification rather than algebraic thinking and problem-solving. The perpetuation of life skills classrooms needs to be redefined to emphasize a focus on academic skills. Further, IEP goals should be developed to align with common core state standards, formal and informal assessment data, and the skills taught. One model, *Aligning IEPs to the Common Core State Standards for Students with Moderate to Severe Disabilities* (Courtade & Browder, 2011) could be used as a reference.

Second, the results from this study revealed that special education teachers need more training and professional development in secondary math content and standards, in how to blend the general education curriculum into meaningful and relevant contexts for student with SID, and in comprehending the relationship between common core state standards, essential elements, and DLM. The focus should not only be building the content knowledge of the teacher, but also on providing a rationale for changing practice. “When are we ever going to use this?” is a common question in an algebra classroom. Additionally, an emphasis should be placed on post-school outcomes, especially at the high school level. If teachers realized that access to the general education curriculum is a significant predictor of post-secondary success, they may be more likely to teach it in conjunction with the life skills that they feel are vital for post-school independence.
Though the recommendations above focus on building the capability of the special education teacher, curricular decision-making should not be the sole responsibility of one individual. Collaboration and shared responsibility between team members, including general education teachers, could increase access to general education curriculum. In order to achieve a culture of collaboration, leadership supports are important for creating structures for communication and teamwork. Additionally, the support of a content expert or coach is an untapped resource that could be made available to special education teachers and teams.

Fourth, teachers in this study responded that coursework during undergraduate or graduate studies most effectively prepared them to teach math, yet most teacher preparation programs did not adequately prepare special educators to teach standards-based academics content, including mathematics, to students who have severe disabilities (Flowers, Ahlgrim-Delzell, Browder, & Spooner, 2005; Murphy & Marshall, 2015; Spooner, Dymond, Smith & Kennedy, 2006). Faculty in higher education should also be equipped with the training and resources to prepare pre-service teachers to teach CCSS, and subsequently offer more methods courses for teaching math content to students with SID.

Fifth, special education teachers echoed the need for a scope and sequence, for curriculum, and for supplementary materials to implement standards-based math instruction. Teachers reported lacking the tools to teach, and as a result, were creating teacher-made materials at their own discretion. While there are a few comprehensive, research-based programs that exist for students with SID, additional accessible and cost-effective materials are needed.
Lastly, state- and federal-level departments of education and professional organizations should continue efforts to foster collaboration between general education and special education divisions. For example, the NCTM, in collaboration with the Council on Exceptional Children, hosted a conference on strategies in teaching and assessment in mathematics. Though the focus was on Response to Intervention, opportunities may exist to extend this partnership of researchers and practitioners to mathematics education and special education for students with SID.

In summary, Karvonen, Flowers, et al. (2013) suggested that teachers with more professional development, greater general curriculum influences (state and national content standards, alternative assessment requirements and results, content materials, activities used by general education teacher, etc.), and who use performance assessment more frequently demonstrated greater access to the general education curriculum.

H. Future Research

One key finding revealed that the level of importance teachers place on the curriculum is strongly correlated to how often the content is taught. This topic is worthy of further exploration. Future researchers could conduct in-depth interviews with the teachers that highly valued algebra instruction to understand why they held this belief and what may have had an influence on them. Further, teachers of students with SID want their students to be successful. They feel like life skills are the most important and best preparation for students after they leave high school. More research is needed to look at post-school outcomes and the impact of participation in the general education math curriculum on students with SID. A longitudinal study monitoring the effects of the standards-based mathematics curriculum on the in-school and post-school outcomes of
students with SID could address this gap. The research also needs to be disseminated to practitioners in the field.

Second, though studies exist that have examined access to the general education curriculum for students with SID, it is difficult to decipher to what degree the findings pertained to teachers of elementary students versus high school students. Future analysis should take measures to disaggregate the data by content area and grade level. For example, Karvonen (2013) evaluated the enacted curriculum; however, conclusions could not be drawn specifically for high schools. Future research could explore how teachers help students access the curriculum at the secondary level, where the discrepancy between grade-level expectations and alternative achievement is much greater.

Third, the teachers in this study primarily taught in self-contained classes. As such, there was insufficient data to determine whether the setting in which a teacher instructs could predict the content taught. Future research could explore the degree to which differences exist between teachers of students with SID in the general education setting versus teachers of students with SID in the special education setting in order to determine the extent to which the curriculum aligns.

Finally, Lee, Browder, Flowers, and Wakeman (2016) provided teachers with needed resources to develop special education teachers’ content knowledge in mathematics and to aid in their design of mathematics instruction aligned to grade-level standards for to students with SID. The dissemination and evaluation of these types of resources should be extended to other geographic regions. Additionally, new evidence-based resources should be created and evaluated by teachers in the field.
This chapter described the problem of the paucity of research relating to mathematics instruction at the high school level for students with SID. The research revealed that the curriculum is almost exclusively centered on life skills and that IEPs drive curricular decisions. Further, special education teachers are determining the curriculum in isolation, with limited collegial support or administrative oversight. Special educators feel highly qualified to teach in mathematics, yet they have minimal training and content knowledge for grade-level content standards. Teachers are confident that they are teaching their students what they need to learn, although it has been determined that the general education curriculum is a predictor of improved outcomes for all students. A number of opportunities exist for research and practice to evaluate student outcomes and improve teacher knowledge, collaborative partnerships, and shared resources.
Survey Development and Pilot Study

Surveys use a systematic process from design to analysis. According to Fink (2002), there are seven activities in survey research. These include: setting objectives, designing the study, preparing a reliable and valid survey instrct, administering the survey, managing and analyzing survey data, and reporting results. The instrument was designed based on the literature on teacher education in special education, mathematics teacher education research, and effective strategies for students with SID.

The survey included questions pertaining to special education teachers – specifically to those who teach students with significant intellectual disabilities. The focus of research is mathematics instruction for students with intellectual disabilities; however, teachers in the state where this study took place are licensed to teach special education students in 14 different categories (e.g. learning disabilities, emotional disabilities, autism, intellectual disabilities, etc.) and may currently teach or have previously taught in more than one category. As such, respondents were asked to provide background information including educational background, teaching experiences, populations of students they have taught and currently teach, as well as, demographic information (e.g. age, gender, race, ethnicity).

Next, teachers were asked to rate their use of effective instructional strategies for mathematics. Items were based on research of effective mathematics instruction for students with SID as outlined in Table 2 (Browder et al., 2008; Browder & Spooner, 2006; Karvonen et al, 2007) and adapted from previous research by Gagnon and Maccini
APPENDIX A (continued)

(2007). Permission was granted to use and/or adapt information and questions in the published articles. Other items such as frequency and importance of mathematics content were developed based on the NCTM standards (National Council of Teachers of Mathematics, 2000). Teachers were asked to rate their level of preparedness and identify how much coursework, training, or professional development they received. Teacher confidence scales were adapted from previous research (Maccini & Gagnon, 2002). To assess teachers’ perceived mathematical knowledge, the researcher drew upon the extensive pool of research in general education to identify math content knowledge indicators (Ball & Forzani, 2009; Hill et al., 2008). Teacher attitudes were collected using two formats. First, teachers were asked to rate the frequency and importance of math topics aligned to the NCTM standards for their students with intellectual disabilities. Second, participants were asked to respond to the open-ended question, “Are there students in your class for whom the general education standards would not be reflected in the curriculum you are teaching them?” This question was originally asked in a research study by Karvonen, Wakeman, Flowers and Browder (2007) in a different context regarding the enacted curriculum, and stood out as a unique way to implicitly get at teacher attitudes (p.35). Finally, perceived barriers to teaching effective mathematics instruction were probed. Stimulus variables were duplicated or adapted from earlier research on teacher perceptions of barriers to implementation of the NCTM standards with students identified as emotionally disturbed or learning disabled (Maccini & Gagnon, 2002).
APPENDIX A (continued)

The Survey Structure. The survey (shown in Appendix B) used a self-report technique primarily employing a forced-choice format. It consisted of 36 items in five domains: personal confidence, familiarity and knowledge of mathematics, attitudes toward students with significant intellectual disabilities, enacted curriculum, evidence-based practices and instruction, and teacher preparation. The scale was administered using the online survey program, Qualtrics. Participants first read an online consent form explaining the purpose of the scale and informing them that participation was voluntary and that results would remain confidential. The survey was anticipated to take approximately 20-30 minutes to complete, including time for completing demographic information. Demographics included questions regarding: gender, years of teaching experience, level of education, and number of courses taken in teaching math methods.

Response Scale Format. The rating scale used for responses varied depending on the domain (Thorndike, 2005). For teacher perceived competencies and attitudes toward students with disabilities, an agreement scale was used and an open-ended question was asked. For the knowledge domain, the rating scale was changed to a level of knowledge. Lastly, the teacher preparation used a frequency scale. All scales had anchors and labels. This was done to reduce misinterpretation. The disadvantage of this method was that a person might have inflated his rating and given a false impression, but the researcher attempted to mitigate this disadvantage by ensuring that participants’ responses were anonymous.
Pilot Study

A pilot study of 34 teachers was conducted to collect data on the model and on the effectiveness, reliability, and validity of the survey instrument.

Unidimensionality. Rasch rating scale model and factor analysis were used to investigate the unidimensionality of the test by means of Winsteps (Linacre, 2012). Winsteps Table 13 displayed item fit. Three items were misfit (greater than +2.0) and two items over-fit the model (greater than -2.0). These will be discussed further in the next section. Further Winsteps Table 23 was used to assess standardized residual loading. There appears to be a contrast between the items. Further, the eigenvalue of the 1st contrast equals 5.6. Guidelines indicate that if the first contrast has units less than 3, then the test is probably unidimensional.

The number of factors was determined using the Kaiser-Guttman rule with eigenvalues greater than 1.0 suggested there were five factors. However, factors fourth and fifth eigenvalues were less than 2.0 and each explained 6.19% and 4.73% of variance, respectively. A visual inspection of the elbow of the scree plot suggested that three factors should be extracted. Results affirmed that a multidimensional model would be more appropriate.

Model Fit. Through the Rasch model, the item and person Outfit ZSTD statistics were used to check whether the data fit the model. For this data set, the person Outfit ZSTD had a mean of 0.0 and a standard deviation of 1.7, implying that there was more variability in the fit of these teachers than expected; the expected standard deviation was 1.0. The mean fit was at expected levels of 0.0. The mean item Outfit ZSTD was -0.2
with a standard deviation of 1.6. The mean was slightly below the expected value of 0.0, suggesting that these responses were more consistent than the model expects. The standard deviation was higher than the expected value of 1.0, suggesting that there were some items that were misfit. Identification of item misfit was investigated using Winsteps Output Table 13.1. Inspection of the Outfit ZSTD indicated that there were three items above the expected range of 2.0—items one (2.6), item two (2.6), and item five (2.1). Further there were two items that overfit the model (values less than 2.0), item 15 (-3.2) and item 20 (-3.3).

Person fit was also evaluated by examining Winsteps Output Table 17.1. Similar to item fit, misfitting persons were identified by Outfit ZSTD values greater than +2.0. There were two people with larger than expected Outfit ZSTD values,—person 27 with a value of 2.9, and person 3 with a value of 4.4. None had values less than -2.0 (which would have indicated responses too consistent with the model). Winsteps Table 7.1 was used to examine the residuals for the person. The person responses showed that two people caused the majority of misfit and these persons exhibit misfit in four items or less to which they responded.

Interclass correlation coefficient, ICC, was calculated using data from the HLM output. ICC = 7.72/(.91 + 7.72) = .89. When ICC approaches 0 or is negative, hierarchical modeling is not appropriate. In this study, given the significance of the intercept component and the ICC (.89), a hierarchical model was appropriate and needed.

The results of item bias (DIF) analysis were obtained using an HLM model. Some items were biased. Items three (taken workshops), four (received...
coaching), and seven (reviewed research-based strategies) were biased by overall preparedness (a self-rated scale). Items eight (read professional literature), 10 (strong background in math), 11 (feel comfortable teaching secondary math), 15 (have the pedagogical knowledge), and 19 (can explain relationships) were biased toward degree-type. Finally, item 18 (have various strategies) was biased by the number of methods courses the person had taken. Using an HLM model corrects for DIF.

Psychometric Models Used. Two models were used – first Rasch rating scale model. The Rasch model is a specific case of Item Response Theory (Linacre, 1989). Rasch analysis is the process of formally testing data against a measurement model developed by Georg Rasch (1960) and assessing the degree to which data fit the model expectations for measurement construction (Smith & Smith, 2004). By identifying misfitting persons and items that do not contribute to the construct being measured, the Rasch model can assist the researcher in detecting item bias and determining revisions to the instrument in order to provide a more accurate estimation of the construct (Wolfe & Smith, 2007a). In a Rasch model, observed item responses can estimate the difficulties of the items on a test, regardless of the abilities of the particular examinees who have taken the test. Similarly, item responses can be used to estimate the abilities of the examinees, regardless of the difficulties of the particular set of items on the instrument. In other words, parameter estimates are neither sample- nor test-dependent; the item difficulty estimates are freed from the distribution of examinee ability, and the examinee ability estimates are freed from the distribution of item difficulty when data fit model requirements (Wolfe & Smith, 2007a). Rasch also provides more comprehensive
APPENDIX A (continued)

reliability estimates, including reliability estimates for person and questionnaire item responses. In summary, a Rasch model addresses limitations of a true-score model (e.g. sample dependency, comparable scores), provided that the data satisfy the assumptions of unidimensionality and local independence (Smith & Smith, 2004). Based on responses to the pilot survey, most open-ended questions were changed to a “check all that apply” format, as teachers did not indicate an “other” response. Further, given the identification of item misfit (there were three items above the expected range of 2.0, and two items that over-fit the model, values less than 2.0), these items were reviewed and rewritten (Smith & Smith, 2004).

Second, hierarchical linear modeling (HLM) was used. HLM, a multi-level Rasch model, is valuable for understanding relationships in hierarchical data structures, such as teachers within school districts (Raudenbush & Bryk, 2002). HLM allows for the study of relationships at any level in a single analysis, while not ignoring the variability associated with each level of the hierarchy. For this study, hierarchical linear modeling was selected as the most appropriate technique. This is based on the idea that special education teachers’ knowledge of mathematics instruction is likely to be influenced by a teachers’ background experience and preparation as well as district and state-level influences. HLM allows the researcher to integrate characteristics of the teachers (Raudenbush & Bryk, 2002).

Reliability. Within the HLM model, a reliability estimate of 0.995 resulted. Results from real-person and real-item separation in a Rasch model were also reported for reliability. The real-person separation was 3.48; person reliability, approximately
APPENDIX A (continued)

equivalent to Coefficient Alpha, was 0.93, suggesting that the scale discriminates between the persons well. The real item separation was 3.54, and reliability was 0.94, indicating that the items create a well-defined variable.

Examining Pt-Measure Correlations from Winsteps Output Table 10.1 assessed item technical quality. Typically, the cut value is 0.4 for polytomous data; non-negative statistics can also be an acceptable criterion. The measures ranged from .27 to .83. All were non-negative; however, many items exceeded 0.4.

Validity. First, content validity was assessed using a content validity rating form (a form used to evaluate the domain that best fits the survey statements). This method is applicable to affective instruments that measure feelings and perceptions. Operational definitions were developed for each category. Then, experts in the field of special education and math education were commissioned to evaluate agreement of the operational definitions for the domains of the test using the content validity rating form. One statement not fitting any domain was re-evaluated for wording.

Content validity was also assessed through consultation regarding issues of clarity of instructions and language issues with an English content specialist who held a master’s degree in English and had a number of years of English teaching experience at the secondary level. A math content specialist who held a master’s degree and had a number of years of mathematics teaching experience at the secondary level also responded to issues of survey content and questions. Piloting and feedback from special education teachers was conducted to evaluate the overall format and clarity of questions. The researcher also compared survey questions to guidelines to improve attitude scale
construction (Edwards, 1957; Thorndike, 2005). Finally, staff from the survey research laboratory reviewed the survey to address validity. Based on feedback, the researcher made revisions to wording of stimulus variables, revised questions and directions, and modified response categories.

Structural validity—the extent to which a test’s scoring structure is consistent with the structure of the content domain of the test—was assessed by comparing the item difficulty hierarchies with the expected response. Responses to items that are expected to be harder for the respondent to endorse should be higher on the continuum than items that are considered easier to endorse. For instance, based on research that special education teachers have more knowledge of strategies than academic content, it would be expected that special education teachers would find it easier to endorse an item such as “I know research-based, effective math instructional strategies for students with disabilities” than to endorse an item such as “I know the NCTM standards for the grade level I teach.” In the pilot study, the variable map offered structural validity of each domain. The continuum of item difficulty on the variable map mirrored the theoretical underpinnings.
APPENDIX B

IRB Forms

UNIVERSITY OF ILLINOIS
AT CHICAGO

Office for the Protection of Research Subjects (OPRS)
Office of the Vice Chancellor for Research (MC 672)
203 Administrative Office Building
1737 West Polk Street
Chicago, Illinois 60612-7227

Approval Notice
Initial Review (Response to Modifications)

November 28, 2016

Jennifer Pearson
Special Education

RE: Protocol # 2016-0919
“Factors Influencing Special Education Teachers' Math Instruction for High School Students with Significant Intellectual Disabilities”

Dear Ms. Pearson:

Your Initial Review application (Response to Modifications) was reviewed and approved by the Expedited review process on November 19, 2016. You may now begin your research.

Please note the following information about your approved research protocol:

Please note that stamped and approved .pdfs of all recruitment and consent documents will be forwarded as an attachment to a separate email. OPRS/IRB no longer issues paper letters and stamped/approved documents, so it will be necessary to retain these emailed documents for your files for auditing purposes.

Protocol Approval Period: November 19, 2016 - November 19, 2017
Approved Subject Enrollment #: 800
APPENDIX B (continued)

Additional Determinations for Research Involving Minors: These determinations have not been made for this study since it has not been approved for enrollment of minors.

Performance Site: UIC
Sponsor: None
Research Protocol:
  a) Factors Influencing Special Ed Teachers' Math Instruction for H.S. Students with Significant Intellectual Disabilities; Version 2; 11/07/2016
Recruitment Materials:
  a) Letter to Directors; Version 1; 09/07/2016
  b) Research Project Recruitment Email; Version 2; 11/07/2016

Informed Consents:
  a) A waiver of consent has been granted for initial identification and recruitment purposes only for the identification and release of contact information of potential teacher subjects under 45 CFR 46.116(d) (minimal risk)
  b) "Dear High School Special Education Teachers" first four pages of online survey (no footer)
  c) A waiver of documentation of consent (electronic consent/no written signature obtained) has been granted for this online survey research under 45 CFR 46.117(c)(2) (minimal risk; subjects will be presented with an information sheet containing all of the elements of consent which they may print out for their records)

Your research meets the criteria for expedited review as defined in 45 CFR 46.110(b)(1) under the following specific category:

(7) Research on individual or group characteristics or behavior (including but not limited to research on perception, cognition, motivation, identity, language, communication, cultural beliefs or practices and social behavior) or research employing survey, interview, oral history, focus group, program evaluation, human factors evaluation, or quality assurance methodologies.

Please note the Review History of this submission:

<table>
<thead>
<tr>
<th>Receipt Date</th>
<th>Submission Type</th>
<th>Review Process</th>
<th>Review Date</th>
<th>Review Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>09/12/2016</td>
<td>Initial Review</td>
<td>Expedited</td>
<td>10/04/2016</td>
<td>Modifications Required</td>
</tr>
<tr>
<td>11/10/2016</td>
<td>Response To Modifications</td>
<td>Expedited</td>
<td>11/19/2016</td>
<td>Approved</td>
</tr>
</tbody>
</table>
APPENDIX B (continued)

Please remember to:

→ Use your research protocol number (2016-0919) on any documents or correspondence with the IRB concerning your research protocol.

→ Review and comply with all requirements on the OPRS website under: "UIC Investigator Responsibilities, Protection of Human Research Subjects" (http://tigger.uic.edu/depts/ovcr/research/protocolreview/irb/policies/0924.pdf)

Please note that the UIC IRB has the prerogative and authority to ask further questions, seek additional information, require further modifications, or monitor the conduct of your research and the consent process.

Please be aware that if the scope of work in the grant/project changes, the protocol must be amended and approved by the UIC IRB before the initiation of the change.

We wish you the best as you conduct your research. If you have any questions or need further help, please contact OPRS at (312) 996-1711 or me at (312) 996-2014.

Sincerely,

Sandra Costello
Assistant Director, IRB # 2
Office for the Protection of Research Subjects

Please note that stamped and approved .pdfs of all recruitment and consent documents listed below will be forwarded as an attachment to a separate email. OPRS/IRB no longer issues paper letters and stamped/approved documents, so it will be necessary to retain these emailed documents for your files for auditing purposes.

Enclosures:

1. Informed Consent Document:
   a) "Dear High School Special Education Teachers" first four pages of online survey (no footer)

2. Recruiting Materials:
3. Appendix B (continued)

a) Letter to Directors; Version 1; 09/07/2016
b) Research Project Recruitment Email; Version 2; 11/07/2016

cce: Norma Lopez-Reyna, Special Education, M/C 147
     Lisa Cushing (faculty advisor), Special Education, M/C 147
     The survey.
I am contacting you to receive your permission to recruit special education teachers in your district for a research study. As a doctoral student majoring in special education at the University of Illinois, Chicago, I am conducting a research study to determine the current nature of mathematics instruction for students with significant intellectual disabilities.

Special education teachers who are currently in certified special education teaching positions at the high school level in Illinois will be eligible to participate. Candidates could have received special education endorsement through regular or alternative paths. They can be teaching in general education classrooms, special education classrooms, or separate special education programs/schools. Further participants will meet inclusion criteria if they were (a) teaching for at least two years, (b) currently teaching mathematics to students with significant intellectual disabilities (defined as at least one student participating in the state alternative assessment), (c) currently teaching in grades 9-12. Teachers who have less than 2 years of experience and are not currently teaching high school students with significant disabilities will be excluded.

The study will involve the completion of a short survey. If you allow me to recruit teachers, please send me the email addresses for special education teachers who you believe to meet the criteria above.

An individual email would be sent from me to the teacher's district email address. The email will include an overview of the study along with an online consent form and a link to the survey. It will be emphasized that their participation is completely voluntary. The survey is 42 questions in length and should take approximately 30 minutes to complete. All data is confidential and any identifying information in the participants' responses will be deleted before dissemination of findings.

If you have any questions about this survey or the study being conducted, please contact me via phone 847-975-3473 or email (jpearson@glenbrook225.org) or my Doctoral Chair, Dr. Lisa Cushing via email (lcushing@uic.edu).

Thank you for assisting in my research interests.

Warm regards,

Jennifer Pearson
APPENDIX B (continued)

I am contacting you as a doctoral student majoring in special education at the University of Illinois, Chicago. In partial fulfillment of the requirements for my program, I am conducting a research study to determine the current nature of mathematics instruction for students with disabilities.

You have been asked to participate in the research because you are a special education teacher who is (a) currently in certified special education teaching positions at the high school level in Illinois, (b) teaching for at least two years, (c) currently teaching mathematics to students with significant intellectual disabilities (defined as at least one student participating in the state alternative assessment), (d) currently teaching in grades 9-12. Your participation in this research is voluntary.

The study will involve the completion of a survey. The survey is 42 questions in length and should take approximately 30 minutes to complete. Your decision whether you choose to participate or not will in no way affect your relationship with UIC or the school you work at. Your responses are voluntary and if you decide to participate, you are free to withdraw your consent and discontinue participation at any time. Your individual answers will not be shared with anyone except the two researchers (Dr. Cushing and me). All data is confidential and any identifying information in the participants’ responses will be deleted before dissemination of findings.

There is a risk of a breach of privacy (others may find out the subject is participating in the research) and/or confidentiality (others may find out identifiable information collected or disclosed during research) even though the data will be protected to the extent technologically possible. Further, UIC IRB and State of Illinois auditors may have access to identifiable information for the purposes of monitoring the research. Subject identifiers and contact information will be destroyed at the end of the study.

There are no direct benefits to the participants, but the information may help to improve special education teacher preparation in mathematics instruction. You may choose not to answer every question, or discontinue your participation at any time without prejudice.

If you have any questions about this survey or the study being conducted, please contact me via phone 847-975-3473 or email (jpearson@glenbrook225.org) or my Doctoral Chair, Dr. Lisa Cushing via email (l cushing@uic.edu). If you have questions about your rights as a research subject or concerns, complaints, or to offer input you may call the Office of Protection of Research Subjects (OPRS) at 312-996-1711 or 1-866-789-6215 (toll-free) or email OPRS at uicirb@uic.edu.

Thank you for assisting in my research interests.
APPENDIX B (continued)

To begin the survey, click on the link below:
Dear High School Special Education Teachers,

My name is Jennifer Pearson, I am a doctoral student in special education at the University of Illinois, Chicago. In partial fulfillment of the requirements for my program, I am conducting research to determine the current nature of mathematics instruction for students with disabilities in Illinois.

I invite you to participate in this study. You have been asked to participate in the research because you are a special education teacher who is (a) currently in certified special education teaching positions at the high school level in Illinois, (b) teaching for at least two years, (c) currently teaching mathematics to students with significant intellectual disabilities (defined as at least one student participating in the state alternative assessment), (d) currently teaching in grades 9-12.

The survey is 42 questions in length and should take approximately 30 minutes to complete. You are encouraged to answer the survey questions however, your responses are voluntary and if you elect to participate, you are free to withdraw your consent and discontinue participation at any time. Your decision whether to participate will not impact your relationship with either UIC or the school in which you are employed. Your individual answers will not be shared with anyone except members of the research team. All data is confidential and any subject identifier and contact information will be deleted before dissemination of findings.

There is a risk of a breach of privacy (others may find out the subject is participating in the research) and/or confidentiality (others may find out identifiable information collected or disclosed during research) even though the data will be protected to the extent technologically possible. Further, UIC IRB and State of Illinois auditors may have access to identifiable information for the purposes of monitoring the research. There are no direct benefits to the participants, but the information may help to improve special education teacher preparation in mathematics instruction. You may choose not to answer every question, or discontinue your participation at any time without prejudice.

If you have any questions about this survey or the study being conducted, please contact me via phone 647-971-3473 or email (jpearson@glenbrook225.org) or my Doctoral Chair, Dr. Lisa Cushing via email (lcushing@uic.edu). If you have questions about your rights as a research subject or concerns, complaints, or to offer input you may call the Office for the Protection of Research Subjects (OPRS) at 312-996-1711 or 1-888-789-9215 (toll-free) or email OPRS at UICIRB@uic.edu.

Thank you for assisting in my research interests.

Sincerely,

Jennifer Pearson

I have read and understand the above consent form. I certify that I am 18 years old or older.

By clicking the ">> " button to enter the survey, I indicate my willingness voluntarily take part in the study.
APPENDIX B (continued)

Q2 Describe your education background: (Check all that apply)
- Undergraduate degree in special education
- Undergraduate degree in elementary education
- Undergraduate degree in secondary education
- Undergraduate degree in non-education related field
- Dual undergraduate degree in elementary education and special education
- Graduate degree in special education

Q3 What endorsements do you hold on your professional educator license?
- Special education endorsement (LBST)
- Elementary education
- Secondary education
- Math content/subject area (9th-12th grade)
- Provisional educator

Q4 Describe your educational background in the subject area of mathematics:
- None
- Some coursework in mathematics
- Previously deemed “Highly Qualified” in math
- Endorsement in secondary level mathematics

Q5 How many college-level mathematics courses have you taken, not including mathematics teaching methods courses?
- Number of College Math Courses: 0
- Total: 0

Q6 How many general education mathematics methods courses have you taken?
- Number of General Education Math Methods Courses: 0
- Total: 0

Q7 Did you take a mathematics methods course that addressed teaching math to students with disabilities?
- Yes
- Maybe
- If yes, please describe the content of the course.

https://uic.qualtrics.com/ControlPanel/?ClientActions=EditSurvey&Sections=SV_SzRzliWuQufL0ut&SubSections=&SubSubSections=&PageActionOptions=&Transact...
APPENDIX B (continued)

Q8 Are there students in your class for whom the general education mathematics standards would not be reflected in the curriculum you are teaching them? If so, in what instances?

Q9 How many years of teaching experience do you have?

Number of Years of Teaching Experience

Total

Q10 What population of students have you taught? (Check all that apply)

- Students without disabilities
- Students with learning disabilities (LD)
- Students with emotional disabilities (ED)
- Students with autism (high-functioning/mild)
- Students with autism (moderate to severe/profound impairment)
- Students with intellectual disabilities (previously referred to as cognitive disability or mental retardation)

Q11 Have you taught students with significant intellectual disabilities (defined as unable to participate in regular state assessments, requiring alternative assessment)?

- Yes
- No

If No is Selected, Then Skip To End of Survey

Q12 How many years have you taught students with significant intellectual disabilities (defined as unable to participate in regular state assessments, requiring alternative assessment)?

Number of Years Teaching Students with Significant Disabilities

Total

Q13 Are you currently teaching high school (grades 9-12) students with significant intellectual disabilities (defined as unable to participate in regular state assessments, requiring alternative assessment)?

- Yes
- No

If No is Selected, Then Skip To End of Survey
APPENDIX B (continued)

Q14
If yes, in what environment(s) are you currently teaching mathematics to students with significant intellectual disabilities?

☐ General education classroom
☐ Resource room
☐ Special education instructional classroom
☐ Self-contained program in general education building
☐ Separate school for students with disabilities
☐ I am not currently teaching math to students with significant intellectual disabilities

If I am not currently teaching... Is Selected, Then Skip To End of Survey

Q15
Who are you employed by? (Choose the one that best fits)

☐ K-12 School District
☐ High School District
☐ Special Education Cooperative District
☐ Private Facility

Q16
How would you describe the setting where your school is located?

☐ Urban
☐ Suburban
☐ Rural
In this question, the rows are a list of classroom settings and the columns are areas of mathematics. For each classroom setting listed, please indicate the type of mathematics content you have taught (choose all boxes that apply). If you have not taught in a setting, you may indicate so by checking (N/A).

<table>
<thead>
<tr>
<th>Setting</th>
<th>Location Operations</th>
<th>Algebra</th>
<th>Geometry</th>
<th>Measurement</th>
<th>Probability</th>
<th>Calendar</th>
<th>Skills</th>
<th>Other Mathematics</th>
</tr>
</thead>
<tbody>
<tr>
<td>A) General education classroom (co-teaching)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B) Instructional classroom for math interventions for students with and without disabilities</td>
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<td></td>
<td></td>
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<tr>
<td>C) Special education resource room (math tutoring)</td>
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<tr>
<td>D) Instructional special education classroom for students with learning disabilities (primarily)</td>
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<tr>
<td>E) Instructional special education classroom for students with emotional disabilities (primarily)</td>
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<tr>
<td>F) Instructional special education classroom for students with intellectual disabilities (primarily)</td>
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<tr>
<td>G) Instructional special education cross-categorical classroom</td>
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</tr>
</tbody>
</table>
APPENDIX B (continued)

1/9/2016

For students with significant intellectual disabilities in the class you are teaching, how was the mathematics curriculum and instruction determined? (Check all that apply)

- It was determined by a district or building-level curriculum committee
- It was determined by a math committee
- It was a pre-existing curriculum from another teacher
- It was a pre-existing published curriculum
- The general education teacher and I adapted it from the high school's general education curriculum
- I adapted it from the general education curriculum
- I designed the curriculum from the high school level learning standards
- I designed the curriculum using state alternate assessment standards
- I designed the curriculum using various published, supplemental curriculum
- I designed the curriculum using teacher-made materials
- I designed it based on student performance on curriculum-based assessments
- I designed the curriculum based on my current students' IEPs

How much autonomy do you have in determining what to teach your students with significant disabilities?

<table>
<thead>
<tr>
<th>Amount of autonomy</th>
<th>No autonomy</th>
<th>Some autonomy</th>
<th>A lot of autonomy</th>
<th>Full Autonomy</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

How often do you teach the following mathematics content to your students with significant intellectual disabilities?

<table>
<thead>
<tr>
<th></th>
<th>Less than Once a Month</th>
<th>Once a Month</th>
<th>Frequently</th>
<th>Always</th>
<th>2-3 Times a Week</th>
<th>Daily</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number and operations</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Algebra</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Geometry</td>
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<td></td>
</tr>
<tr>
<td>Measurement</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Data Analysis &amp; Probability</td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Money, Time, Calendar</td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td>Other Life Skills</td>
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<td></td>
</tr>
<tr>
<td>Strategic Instruction</td>
<td></td>
<td></td>
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<td></td>
<td></td>
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</tr>
</tbody>
</table>

designing strategies
## APPENDIX B (continued)

### Q21

How **important** are the following mathematics content for your students with significant intellectual disabilities?

<table>
<thead>
<tr>
<th>Topic</th>
<th>Not at all important</th>
<th>Slightly important</th>
<th>Moderately important</th>
<th>Very important</th>
<th>Extremely important</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number and operations</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Algebra</td>
<td></td>
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<tr>
<td>Geometry</td>
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</tr>
<tr>
<td>Measurement</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Data Analysis &amp; Probability</td>
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<tr>
<td>Money, Time, Calendar</td>
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<td></td>
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<tr>
<td>Other Life Skills</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Strategic Instruction (learning strategies)</td>
<td></td>
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<tr>
<td>Common core content standards for math (e.g., reasoning, problem-solving)</td>
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</tr>
<tr>
<td>Process standards for math (e.g., reasoning, problem-solving)</td>
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<td></td>
</tr>
</tbody>
</table>

### Q22

How often do you use the following instructional formats during mathematics instruction for students with significant intellectual disabilities?

<table>
<thead>
<tr>
<th>Instruction Format</th>
<th>Less than 2-3 Times a Month</th>
<th>2-3 Times a Month</th>
<th>Once a Week</th>
<th>2-3 Times a Week</th>
<th>Daily</th>
</tr>
</thead>
<tbody>
<tr>
<td>Whole group instruction</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Small group instruction</td>
<td></td>
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<tr>
<td>One-to-one instruction</td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

### Q23

How often do you use the following instructional practices/strategies during mathematics instruction for students with significant intellectual disabilities?

<table>
<thead>
<tr>
<th>Practice</th>
<th>Less than 2-3 Times a Month</th>
<th>2-3 Times a Month</th>
<th>Once a Week</th>
<th>2-3 Times a Week</th>
<th>Daily</th>
<th>I am not familiar with this practice</th>
</tr>
</thead>
<tbody>
<tr>
<td>Use Direct/explicit instruction</td>
<td></td>
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<tr>
<td>Use Systematic instruction</td>
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<tr>
<td>Illustrate concepts via multiple models</td>
<td></td>
<td></td>
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<tr>
<td>Incorporate visuals and graphic depictions of problems</td>
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<tr>
<td>Use manipulatives</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Use concrete-representational-abstract (C-R-A) approach</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Encourage peer-assisted</td>
<td></td>
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</tbody>
</table>

https://nic.qualtrics.com/ControlPanel/?ClientAction=EditSurvey&Section=SV_8erUWQhL0zat&SubSection=&SubSubSection=&PageActionOptions=&Transact...
| Use strategies (e.g. mnemonics) |   |   |   |   |   |   |   |
| Embed real world applications |   |   |   |   |   |   |   |
| Use natural environments (e.g. grocery store in community) to teach math concepts |   |   |   |   |   |   |   |
| Use task analytic instruction |   |   |   |   |   |   |   |
| Use of general prompting and fading techniques |   |   |   |   |   |   |   |
| Use of constant time delay |   |   |   |   |   |   |   |
| Use of progressive time delay |   |   |   |   |   |   |   |
| Use of simultaneous prompting |   |   |   |   |   |   |   |
| Use of system of least prompts |   |   |   |   |   |   |   |
| Use system of most-to-least prompts |   |   |   |   |   |   |   |
| Demonstrate use of assistive or other technologies |   |   |   |   |   |   |   |
| Interpret and respond accordingly to students' math ideas |   |   |   |   |   |   |   |
| Teach self-monitoring strategies to help students with problem-solving activities |   |   |   |   |   |   |   |
| Use next-dollar/counting-on strategy |   |   |   |   |   |   |   |
| Use response cards (signs held up by students to display their response) |   |   |   |   |   |   |   |
### APPENDIX B (continued)

**Q24**

What forms of assessment do you find most useful for instructional planning?

<table>
<thead>
<tr>
<th>Assessment Type</th>
<th>Not at all useful</th>
<th>A little useful</th>
<th>Moderately useful</th>
<th>Very useful</th>
<th>N/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>State Standardized Assessments (e.g., DLM, IAA)</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>District-Wide and/or School-Wide Assessments</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Publisher-Created Assessments</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Teacher-Created Classroom Assessments</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Achievement Tests (e.g., WIAT, WJ, Brigance, PPVT)</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Curriculum-Based Measures (e.g., aimsweb, STAR, DIBELS)</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Adaptive Behavior Assessments</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Transition Assessments (e.g., JOS, TPI, LCCE, Self-Determination Scales)</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Teacher Created Data Collection Forms</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Observations of Students</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Student Self-Evaluations</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Portfolio or Work Products</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Performance Tasks</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Professional Judgment</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
</tbody>
</table>

**Q25**

To what degree do you have accountability for helping your students with significant disabilities achieve annual yearly progress (AYP) on state alternative assessments?

- ○ Not at all
- ○ A little
- ○ A moderate amount
- ○ A lot
- ○ A great deal

**Q26**

How much does alternative achievement standards and accountability influence your mathematics curriculum and instruction?

- ○ Not at all
- ○ A little
- ○ A moderate amount
- ○ A lot
- ○ A great deal
### Q27
Using the scale below, rate how much coursework, training, or professional development you received for each of the following statements.

<table>
<thead>
<tr>
<th>Received specific instructional strategies for teaching mathematics during undergraduate studies</th>
<th>None</th>
<th>A little</th>
<th>A moderate amount</th>
<th>A lot</th>
<th>A great deal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Received specific instructional strategies for teaching mathematics during graduate studies</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Taken workshops on mathematics content and instructional strategies</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Received coaching from a mathematics specialist</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Co-taught with a certified mathematics teacher</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Consulted with a general education mathematics teacher when planning lessons</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reviewed research studies on effective mathematics instruction</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Read professional literature on effective mathematics instruction</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Q28
Which, in your opinion, most effectively prepared you to teach mathematics to students with significant disabilities?

<table>
<thead>
<tr>
<th>Coursework during undergraduate or graduate studies</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Workshops on mathematics content and instructional strategies</td>
<td></td>
</tr>
<tr>
<td>Coaching from a mathematics specialist</td>
<td></td>
</tr>
<tr>
<td>Co-teaching with a certified mathematics teacher</td>
<td></td>
</tr>
<tr>
<td>Consultation from a general education mathematics teacher when planning lessons</td>
<td></td>
</tr>
<tr>
<td>Research studies on effective mathematics instruction</td>
<td></td>
</tr>
<tr>
<td>Professional literature on effective mathematics instruction</td>
<td></td>
</tr>
</tbody>
</table>

### Q29
Overall, how well prepared do you feel you are to teach mathematics to your students?

<table>
<thead>
<tr>
<th>Not at all</th>
<th>Slightly</th>
<th>Moderately</th>
<th>Very</th>
</tr>
</thead>
</table>
### Q30

How much do each of the following statements describe you?

<table>
<thead>
<tr>
<th>Statement</th>
<th>Not at all</th>
<th>A little</th>
<th>A moderate amount</th>
<th>A lot</th>
<th>A great deal</th>
</tr>
</thead>
<tbody>
<tr>
<td>I enjoy teaching math</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I have a strong background in mathematics</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I feel comfortable teaching beginning level secondary-level mathematics concepts</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I feel comfortable teaching higher-level math content, such as Algebra II/Trigonometry</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I feel comfortable in my ability to adapt high school level Common Core math standards for students with intellectual disabilities</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I have the subject-matter knowledge to teach secondary-level mathematics</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I have the pedagogical knowledge to teach secondary-level mathematics</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### APPENDIX B (continued)

**Q31** How much do each of the following statements describe you?

<table>
<thead>
<tr>
<th>Statement</th>
<th>Not at all</th>
<th>A little</th>
<th>A moderate amount</th>
<th>A lot</th>
<th>A great deal</th>
</tr>
</thead>
<tbody>
<tr>
<td>I know the NCTM Standards for the grade level I teach</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I know the Common Core State Standards (CCSS) for the grade level I teach</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I know research-based, effective math instructional strategies for</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>students with significant intellectual disabilities</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I have various strategies for developing student understanding of</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>concepts</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I can explain connections/relationship between different math ideas</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I can use technical mathematical language and terminology precisely</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I can adjust my lesson based on student level of understandings and</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>misconceptions</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I can design math lessons incorporating the common core standards and</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>individual learners’ needs</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I can select and administer assessments to determine students’</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>math knowledge and errors</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

**Q32** Solve to find the answer to this problem: (point 2 times point 4)

\[ 2 \times 4 = \]

**Q33** How were you taught to solve this problem?
APPENDIX B (continued)

misconception?

firm the student's
### APPENDIX B (continued)

**Q36**

As a special education teacher, what do you believe to be the greatest barriers to teaching effective mathematics instruction to students with significant intellectual disabilities?

<table>
<thead>
<tr>
<th>Lack of preparation you received in college</th>
<th>Not at all a barrier</th>
<th>A slight barrier</th>
<th>A moderate barrier</th>
<th>Very much a barrier</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lack of professional development opportunities</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Lack of access to research in the field</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Lack of professional network/peers with similar assignment</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Lack of coaching support</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Lack of knowledge of mathematics principles and standards</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Lack of knowledge in math instructional/evidence-based practices for students with significant intellectual disabilities</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Lack of a math scope and sequence for students with significant intellectual disabilities</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Lack of a core curriculum</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Lack of supplemental curriculum materials</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Lack of assessment tools</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Lack of staffing (e.g. paraprofessionals)</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Lack of planning time</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Lack of confidence</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Lack of administrative support</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Other</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Other</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
</tbody>
</table>

**Q37**

What would help you feel more equipped to teach mathematics?

---

s://aic.qualtrics.com/ControlPanel/?ClientAction=EditSurvey&Section=SV_SerzjWiWnQhL0zat&SubSection=&SubSubSection=&PageActionOptions=&Transa...
APPENDIX B (continued)

Q38  Please complete the following demographic information. This information will be kept confidential and accessible only to the researchers of this study.

- Name
- Organization/School District
- School Name
- City where school is located

Q39  What is your gender?
- Male
- Female

Q40  What is your ethnicity?
- Hispanic or latino
- Not hispanic or latino

Q41  Please select the racial category or categories with which you most closely identify.
- White
- Black or African-American
- American Indian or Alaskan Native
- Asian
- Native Hawaiian or other Pacific Islander

Q42  What is your current age?
APPENDIX B (continued)

Approval Notice
Continuing Review

October 24, 2017
Jennifer Pearson
Special Education

RE:   Protocol # 2016-0919
  “Factors Influencing Special Education Teachers' Math Instruction for High
School Students with Significant Intellectual Disabilities”

Dear Dr. Pearson:

Your Continuing Review was reviewed and approved by the Expedited review process on
October 24, 2017. You may now continue your research.

Please note the following information about your approved research protocol:

Please note that it appears the research may qualify for study closure as the
following has been met: enrollment has been completed, there will be no further
contacts or interactions with the subjects (including long term follow-up), data
collection is complete, the only remaining activity is analysis of de-identified (no
identifying links or codes) data (including video/audio files), and there is no
additional research beyond the original intent planned for these data. If the
aforementioned criteria has been met, submit a Final Report.

Protocol Approval Period:   November 19, 2017 - November 19, 2018
Approved Subject Enrollment #:  800 (75 subjects enrolled – limited to data
analysis
Additional Determinations for Research Involving Minors: These determinations
have not been made for this study since it has not been approved for enrollment of
minors.
Performance Sites:       UIC
Sponsor:                    None

Research Protocol(s):
   b) Factors Influencing Special Ed Teachers' Math Instruction for H.S. Students with
      Significant Intellectual Disabilities; Version 2; 11/07/2016

Recruitment Material(s):
APPENDIX B (continued)

N/A – limited to data analysis

Informed Consent(s):
N/A – limited to data analysis

Your research meets the criteria for expedited review as defined in 45 CFR 46.110(b)(1) under the following specific category:

(7) Research on individual or group characteristics or behavior (including but not limited to research on perception, cognition, motivation, identity, language, communication, cultural beliefs or practices and social behavior) or research employing survey, interview, oral history, focus group, program evaluation, human factors evaluation, or quality assurance methodologies.

Please note the Review History of this submission:

<table>
<thead>
<tr>
<th>Receipt Date</th>
<th>Submission Type</th>
<th>Review Process</th>
<th>Review Date</th>
<th>Review Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>10/16/2017</td>
<td>Continuing Review</td>
<td>Expedited</td>
<td>10/24/2017</td>
<td>Approved</td>
</tr>
</tbody>
</table>

Please remember to:

➔ Use your research protocol number (2016-0919) on any documents or correspondence with the IRB concerning your research protocol.

➔ Review and comply with all requirements on the enclosure, "UIC Investigator Responsibilities, Protection of Human Research Subjects" ([http://tigger.uic.edu/depts/ovcr/research/protocolreview/irb/policies/0924.pdf](http://tigger.uic.edu/depts/ovcr/research/protocolreview/irb/policies/0924.pdf))

Please note that the UIC IRB has the prerogative and authority to ask further questions, seek additional information, require further modifications, or monitor the conduct of your research and the consent process.

Please be aware that if the scope of work in the grant/project changes, the protocol must be amended and approved by the UIC IRB before the initiation of the change.

We wish you the best as you conduct your research. If you have any questions or need further help, please contact OPRS at (312) 996-1711 or me at (312) 996-0548. Please send any correspondence about this protocol to OPRS at 203 AOB, M/C 672.

Sincerely,

Brandi L. Drumgole, B.S.
Assistant Director
Office for the Protection of Research Subjects
Enclosure(s): none

cc: Norma Lopez-Renya, Special Education, M/C 147
    Lisa Cushing, Faculty Sponsor, M/C 147
February 22, 2018

Meaghan McCollow, PhD, BCBA-D
Assistant Professor
Department of Educational Psychology
California State University, East Bay

I am writing to request permission to use the conceptual framework figure from your publication (Greenway, McCollow, Hudson, Peck, & Davis, 2013) in my thesis. This material will appear as originally published (or with changes noted below). Unless you request otherwise, I will use the conventional style of the Graduate College of the University of Illinois at Chicago as acknowledgment.

Thank you for your kind consideration of this request.

Sincerely,

Jennifer Pearson
Doctoral Student
University of Illinois, Chicago

The above request is approved.

Approved by: [Signature]

Date: 2/26/18
CITED LITERATURE


CITED LITERATURE (continued)


CITED LITERATURE (continued)


CITED LITERATURE (continued)


CITED LITERATURE (continued)


CITED LITERATURE (continued)


CITED LITERATURE (continued)


CITED LITERATURE (continued)


CITED LITERATURE (continued)


CITED LITERATURE (continued)


National Secondary Transition Technical Assistance Center (2010). Evidence-Based Practices and Predictors in Secondary Transition: What We Know and What We Still Need to Know, Charlotte, NC, NSTTAC.

CITED LITERATURE (continued)


CITED LITERATURE (continued)


CITED LITERATURE (continued)


CITED LITERATURE (continued)


CITED LITERATURE (continued)


Timberlake, M. T. (2014). The path to academic access for students with significant cognitive disabilities. The Journal of Special Education, 0022466914554296.


U.S. Department of Education. Title I-Improving the Academic Achievement of the disadvantaged; Final Rule, 68 Fed. Reg. 236 (December 9, 2003).


Wolfe, E. W. and Smith, Jr., E. V. (2007), Instrument development tools and activities for measure validation using Rasch models: Part II—Validation activities, in E. V. Smith, Jr., & R. M. Smith (Eds.), Rasch measurement: advanced and specialized application (pp. 243-290), Maple Grove, MN: JAM Press.


VITA

NAME: Jennifer Pearson

EDUCATION: B.A., Special Education, Northeastern Illinois University, 1992

M.S. Ed., Educational Administration, Northern Illinois University 1997


Ph.D., Special Education University of Illinois at Chicago 2018

PROFESSIONAL EXPERIENCE

**Director of Special Education**
Glenbrook High School District #225
Glenview, IL

**Program Administrator**
Educational and Life Skills Program
Northern Suburban Special Education District (NSSED)
Highland Park, IL

**Assistant Director of Special Education**
Township High School District #211
Palatine, IL

**Special Education Teacher/504 and IEP Coordinator**
Lake Forest High School
Lake Forest, IL

UNIVERSITY TEACHING

**Graduate Teaching Assistant**
College of Education, Department of Special Education
University of Illinois at Chicago
Course Taught: SPED 471 – Curricular Adaptations for Learners with Significant Disabilities.

**Graduate Teaching Assistant**
College of Education, Department of Special Education
University of Illinois at Chicago
Course Taught: SPED 473 – Teaching Math and Science with Adaptations

**Graduate Teaching Assistant**
College of Education, Department of Special Education
University of Illinois at Chicago
Course Taught: SPED 471 – Curricular Adaptations for Learners with Significant Disabilities.

**Graduate Teaching Assistant**
College of Education, Department of Special Education
University of Illinois at Chicago
Course Taught: SPED 473 – Teaching Math and Science with Adaptations

Fall 2015

Spring 2016, Summer 2016, Spring 2018
VITA (continued)

GRANTS


PRESENTATIONS AND PUBLICATIONS


VITA (continued)


PROFESSIONAL SERVICE

Advisory Board, Enriched Lifestyles for Adults (ELA) 2006-Present
Advisory Board, Project SEARCH Collaborates for Autism at Northwestern University 2013-Present
Member, IAASE Federal Committee 2013-Present
Co-Founder, Glenview Northbrook Coalition for Youth 2013-Present
Chairman, Transition Action Network for Mental Health 2014-Present
Member, NSSED Finance Committee Meeting 2010-Present

PROFESSIONAL MEMBERSHIPS

• Illinois Alliance of Administrators of Special Education
• National Alliance on Mental Illness
• Council for Exceptional Children
  - Division on Autism and Developmental Disabilities (DADD)
  - Council of Administrators of Special Education (CASE)
  - Division on Career Development and Transition (DCDT)
  - Teacher Education Division (TED)
VITA (continued)

RESEARCH INTERESTS

- Research is focused on improving outcomes for students with disabilities through access to the general education curriculum and development of teacher skills.

- Current scholarly interests include: the inclusion of students in high school and community settings, transition planning, content-area curriculum development for individuals with extensive support needs, professional development and mentoring for new and veteran staff.

- Administrative leadership to UIC’s Project SET Advisory and Evaluation Committee. Project SET is a five-year grant funded project from the U.S. Department of Education, Office of Special Education Programs. The project’s goal is to prepare 56 highly qualified special educators with knowledge and skills to become Transition Specialists in Illinois in order to improve transition services for high-need youth with disabilities and their families.