

Special Education Teacher Preparation in Mathematics Instruction and Intervention

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Special education teacher training programs are increasingly addressing pedagogy for academic subjects, but little is known about how we are preparing teacher candidates to provide mathematics instruction and intervention to students with or at-risk for learning disabilities. The present study surveyed recent graduates (n = 48) on (1) types of coursework that prepared them in mathematics instruction, (2) evidence-based practices addressed in those courses, (3) the amount of time allocated to each evidence-based practice, and (4) the types of instructional activities students engaged in for each practice. Most respondents indicated that they enrolled in at least one course that facilitated their preparation in mathematics teaching, but evidence-based practices were inconsistently addressed. These trends indicate increased attention to mathematics pedagogy at the pre-service level while also revealing areas that warrant improvement in order to more consistently and comprehensively prepare special educators.

***Keywords:* special education, teacher preparation, mathematics, evidence-based practices, learning disabilities**

Introduction

Trends in Academic Expectations for Special Educators

Special education teacher training programs, historically, have not emphasized content-area pedagogy (Brownell et al., 2005). Rather, they focused on generic instructional methods or professional practices unique to special education such as developing an Individualized Education Program and the evaluation process for special education services. More recently, as co-teaching and intervention programming have become more common (Berkeley et al., 2020; Iacono et al., 2023), the field is promoting training in evidence-based instructional and assessment practices for students with learning disabilities in academic subjects (Brownell et al., 2023). However, little is known about how special education teacher training programs are addressing this trend in the area of mathematics.

Teaching Responsibilities

Gimour and colleagues (2023) evaluated the roles, responsibilities, preparation, and supports for special educators in the United States over 16 years

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(1999/2000 to 2015/2016) using the National Teacher Principal Survey data. Two pivotal findings in regards to the roles special education teachers reported working in were (a) self-contained settings remained constant across time and (b) there was a 44% increase in co-teaching assignments. Similarly, Vannest and Burke (2010) and Vannest et al. (2011) evaluated how special educators working in four different types of settings (i.e., content mastery, co-teaching, resource, adaptive behavior) spent their time during the day. Despite the time varying by teaching responsibility, teachers reported allocating time towards academic instruction as the highest (resource, content mastery) or second highest (self-contained, coteaching) compared to 11 other job-related responsibilities. These data highlight two points: (a) academic instruction is one of the elements special educators spend most of their time engaging in and (b) the amount of time special educators have to provide academic instruction is insufficient. Pre-service educators must be equipped to provide high-quality academic intervention using evidence-based practices (EBPs) to ensure students with disabilities can obtain meaningful academic learning outcomes in the limited time available.

Teacher Preparation

In light of the responsibilities and challenges that special educators currently face, literature on the preparation of special educators to teach mathematics has identified essential components of quality teacher training programs. Foundationally, programs should provide opportunities for improving special education teacher candidates' own content knowledge and skills in mathematics (e.g., Griffin et al., 2014; van Garderen et al., 2013). Extant literature and related resources—such as the Institute for Education Sciences Practice Guides (IES, n.d.) as well as the Council for Exceptional Children's initial preparation standards (CEC, 2015)—also note the importance of pre-service teachers learning key practices for mathematics teaching such as explicit instruction (e.g., Gersten et al., 2009), the concrete-representational-abstract model (Bouck et al., 2018), schema-based instruction for word problem solving (Cook et al., 2020), using technology to support mathematics learning (e.g., van Garderen et al., 2013), and other EBPs for mathematics instruction and intervention. Similarly, teacher candidates must be prepared to use assessment practices effectively in mathematics (e.g., Allsopp et al., 2008; Powell, 2015). Through preparation programs, pre-service special educators should develop an understanding of mathematics difficulty, including learner characteristics and the challenges that students with mathematics difficulties may experience, like limitations in attentive behavior (e.g., Fuchs et al., 2006), memory and monitoring processes (e.g., Swanson & Jerman, 2006), and gaps in background and foundational knowledge (e.g., Geary, 2004). Furthermore, based on this knowledge, pre-service teachers need to learn to adapt reform mathematics curriculum materials to make them more effective for students with learning disabilities (e.g., Doabler et al., 2018; Sayeski & Paulsen, 2010; Woodward & Montague, 2002). Finally, this body of literature emphasizes the importance of teacher candidates participating in field experiences related to their mathematics coursework (e.g., Brownell et al., 2019; Powell, 2015).

Impact of Teacher Preparation

Students with learning disabilities largely demonstrate lower achievement in mathematics than their peers (Mattison et al., 2023). Their learning may be impacted by difficulty with computation, limited conceptual understanding of mathematics, insufficient problem-solving strategies, challenges with long-term and working memory, and poor self-monitoring and self-regulation skills (Wei et al., 2012). Students with non-verbal learning disabilities often experience challenges with the visuospatial processing requirements of mathematics such written calculations, graphic representations, and tabular data (Mammarella et al., 2023).

Teacher preparation coursework that builds both content and pedagogical content knowledge in mathematics is critical as research consistently demonstrates that teachers with strong knowledge in both areas have the greatest impact on student achievement. Further, as students with learning disabilities are increasingly taught and expected to master grade-level academic standards, they not only need teachers familiar with subject-area content but also those who can provide effective individualized instruction (Childre, 2014; Gilmour & Henry, 2018; Kirksey & Lloydhauser, 2022). Dually-certified teachers seem to be most capable of meeting the comprehensive needs of students with disabilities in mathematics as demonstrated by higher student achievement compared to general or special educators (Gilmour, 2020; Kirksey & Lloydhauser, 2022). However, students are rarely assigned to dual licensed teachers for mathematics (Gilmour & Henry, 2018; Gilmour, 2020). Comparisons of the mathematics achievement of students with disabilities between general education teachers and special educators have yielded mixed results. Feng and Sass (2013) found that special education certification was associated with a significant positive impact on students' mathematics achievement. Gilmour (2020), in contrast, reports that the mathematics achievement of students with learning disabilities was not significantly different whether they were taught by general or special education teachers. In both cases, these students performed well below their peers.

The Current Study

The literature offers preliminary guidance on the preparation of special educators to provide mathematics instruction and support to students with or at-risk for learning disabilities as well as evidence on the importance of teacher qualifications for improving student achievement. However, little is known about actual preparation practices. Through this study, we sought to better understand the learning experiences of pre-service special education teachers regarding current recommended practices for effective mathematics instruction and intervention for this population of students. Aligned with this goal, we addressed these research questions:

1. What types of coursework are available to prepare pre-service teachers in mathematics instruction for students with or at-risk for learning disabilities?
2. How does preparation in mathematics instruction align with EBPs for these students?
3. How does preparation in mathematics instruction vary by type of coursework?

Methods

Participants

Study participants included recent graduates (within 1 year after program completion) from undergraduate special education and dual licensure programs in the United States. Two approaches were utilized to recruit participants who graduated in the 2021-2022 and 2022-2023 academic years. First, we directly emailed faculty at 36 colleges and universities who are in our professional network requesting that they forward a recruitment email including the survey link to recent graduates of their institution's undergraduate special education or dual licensure program. Seven contacts responded that they would share our email, while 4 indicated that their institutions either did not have an undergraduate program or that their program was too new to have graduates. The remaining faculty contacts did not respond to our initial request or follow-up communication. In addition to these direct contacts, we posted the recruitment information and survey link to the newsfeed of a closed Facebook group for faculty associated with teacher education programs, asking members to share the information with recent graduates. Neither approach required faculty to directly respond to the researchers in order to share study information with recent graduates; therefore, we do not know how many prospective participants were contacted.

Forty-eight respondents completed the survey. Participant characteristics are presented in Table 1. The majority of participants identified as female, age 20-29, and White. There was more variation in the region of the country where they completed their preparation programs with the southeast having the highest representation and the west having the lowest.

Research Design

This study utilized a survey research design as a mechanism to understand pre-service special educators' learning experiences. Surveys allow for the efficient collection of data on a variety of topics from a representative sample of the population (Check & Schutt, 2011). Through survey, we were able to target specific aspects of preparation regarding mathematics instruction and intervention (described in the next section), providing operational definitions of each for shared understanding. This approach also allowed us to engage recent graduates from a variety of regions and institutions, increasing the representativeness of our findings beyond what we would expect to learn from participants with whom we might have direct contact. Furthermore, by surveying pre-service teachers, we attempted to mitigate the risk of social desirability bias (Check & Schutt, 2011) from course instructors, who may have been inclined to respond with ideal rather than actual preparation practices.

Table 1. ***Participant Characteristics***

		n	%
Gender	Female	34	70.8
	Male	8	16.7
	Non-binary	2	4.2
	Trans man	1	2.1
	Declined to answer	3	6.3
Age	20-29	34	70.8
	30-39	7	14.6
	40-49	2	4.2
	50-59	3	6.3
	Declined to answer	2	4.2
Race/Ethnicity	White	32	66.7
	Latinx	7	14.6
	Multiracial	3	6.3
	Asian	3	6.3
	African American	1	2.1
	Declined to answer	2	4.2
Region of College/ University	Southeast	21	43.8
	Midwest	13	27.1
	Northeast	7	14.6
	Southwest	4	8.3
	West	3	6.3

Instrument

Respondents completed an electronic survey addressing (1) types of coursework that prepared them in mathematics instruction and intervention, (2) EBPs addressed in those courses, (3) the amount of time allocated to each EBP, and (4) the types of instructional activities students engaged in for each practice. Types of coursework included general education math methods, special education math methods, comprehensive methods, practicum or field experience, and none. Methods courses were operationalized in the survey as those that "focus on teaching you how to teach." EBPs were derived from the IES Practice Guides *Assisting Students Struggling with Mathematics: Intervention in the Elementary Grades* (Fuchs et al., 2021) and *Assisting Students Struggling with Mathematics: Response to Intervention (RtI) for Elementary and Middle Schools* (Gersten et al., 2009). Fourteen practices were included: feedback, fluency, interventions in rational numbers, interventions in whole numbers and operations, mathematical language, modeling and think-aloud, motivational strategies, progress monitoring, purposeful practice, schema-based instruction, segmenting, supports and prompts, universal screening, and visual representations. Time allocations were approximated as none, partial class session, whole class session, or multiple class sessions. Response options for how each practice was taught/learned were reading, lecture, discussion, in-class activity/practice, field experience assigned by the course, and assignment. For practicum/field experience, the options included observing the practice, discussing the practice with cooperating teacher, implementing the practice, or practice not addressed. The survey also included consent and demographic items. It took approximately 15 minutes to complete. The survey instrument is available from the authors upon request.

Procedures

We disseminated information about the study to faculty associated with undergraduate special education and dual licensure preparation programs via closed Facebook groups for teacher educators and direct contacts to colleagues in our respective professional networks. Faculty were asked to forward a recruitment email, including the survey link, to recent graduates after the 2021-2022 and 2022-2023 academic years. All study procedures were approved by a university Institutional Review Board.

Data Analysis

Results were prepared for analysis by grouping responses according to course types in line with our research questions. Data were analyzed using descriptive statistics, namely frequencies and rates. When analyzing the evidence-based practices by course type, rates were calculated relative to the number of respondents for that course type and the total number of respondents. Descriptive statistics were then analyzed for trends relevant to our research questions. One approach to identifying trends involved clustering response rates (i.e., 0-20%, 20.1-40%, 40.1-60%, 60.1-80%) to identify similarities and differences across the practices within each course type. We then considered similarities and difference across course types.

Results

Overview of Coursework Completed by Pre-Service Teachers

Aligned with our first research question, participants indicated the types of coursework that they completed contributing to their preparation to provide mathematics instruction to students with or at-risk for learning disabilities. Table 2 presents the number and percentage of respondents who indicated each type of coursework.

Table 2. ***Types of Coursework***

	n	%
General education math methods course	17	35.4
Special education math methods course	28	58.3
Comprehensive methods course not specific to, but including, math methods	10	20.8
Field placement/practicum	30	62.5
None	5	10.4

The most common course type reported by participants was field experience/practicum (n = 30; 62.5%); the least common was comprehensive methods (n = 10; 20.8%). More than half of respondents indicated completion of math methods course specific to special education (n = 28; 58.3%), and approximately 35% (n=17) expressed that a general education math methods course addressed working with students who struggle with mathematics. While many recent graduates reported engagement in multiple course types, 5 of the 48 respondents (10.4%) indicated that they did not participate in any courses to prepare for the provision of mathematics instruction.

For each course type that a participant reported completing, they were asked about the EBPs addressed in that course, including how much time was allocated to each practice and how each practice was taught/learned. The following sections detail responses for each EBP by type of coursework.

General Education Mathematics Methods Courses

Of the 48 survey respondents, 17 (35.4%) reported that completing a general education math methods course contributed to their preparation for teaching mathematics to students with or at-risk for learning disabilities. Table 3 provides results about time allocations and teaching/learning methods for each of the 14 EBPs in question, including the number of participants who reported each option, the percentage of respondents for this course type, and the percentage of total respondents in parentheses.

Participants indicated that visual representations and supports and prompts received the most attention in general education mathematics courses relative to the other EBPs. Approximately 50% of recent graduates who completed this course type reported that these practices were addressed for a whole class session or multiple class sessions. In contrast, the practices that received limited attention—as indicated by at least two-thirds of participants reporting no coverage or a partial class session—were universal screening, interventions in whole numbers and operations, interventions in rational numbers, progress monitoring, and modeling and think aloud. Progress monitoring, in particular, received the least attention with just over 40% of recent graduates indicating that it was not addressed in their general education course. Results demonstrate that lecture, discussion, and in-class activities were the most frequently used teaching/learning approaches. Readings were reported with moderate frequency, while class-related field experiences and assignments were not implemented often.

Special Education Mathematics Methods Courses

Twenty-eight recent graduates (58.3% of survey respondents) indicated enrollment in a special education mathematics methods course. Table 4 presents their reports of time allocations and teaching/learning techniques for each evidence-based practice. The frequency of each response is noted as well as the percentage of respondents for this course type and the percentage of total participants in parentheses.

According to participants who completed a special education mathematics methods course, interventions in rational numbers, schema-based instruction, visual representations, and purposeful practice were the EBPs with the greatest time allocations. A majority of respondents (60-70%) reported that these practices were covered for a whole or multiple class sessions. Conversely, building arithmetic fluency and motivational strategies were reported to have the least time allocated with approximately two-thirds of recent graduates indicating that they were not addressed or only addressed for a portion of a class session. Lecture, discussion, and in-class activities were reported as highly common teaching/learning approaches in special education mathematics methods courses; readings were reasonably common as well. Course-related field experiences and assignments were noted with less frequency but, on the whole, were not rare.

Comprehensive Methods Courses

Ten participants (20.8%) responded that a comprehensive methods course helped prepare them to provide mathematics instruction to students with or at-risk for learning disabilities. See Table 5 for their reports of time allocations and teaching/learning strategies for each of the EBPs.

Largely, the EBPs addressed in this study did not receive much attention in this type of course. With one exception, most respondents indicated that these EBPs received no attention or partial session allocation, which may be more reasonable given that mathematics is not the sole focus in a comprehensive methods course. The exception was mathematical language; an equal number of recent graduates for this course type reported no or partial session allocation as did whole or multiple sessions. The practices receiving the least attention with 80-90% of participants indicating that it was not addressed or only for a partial session were progress monitoring, motivational strategies, modeling and think aloud, and providing feedback. Results indicate that discussion and in-class activities were the most common teaching/learning approaches, and readings and lecture were used with moderate frequency. Field experiences associated with the course and assignments were far less common.

Field Experience/Practicum

Of the 48 participants, 30 (62.5%) reported that a field experience or practicum helped prepare them to provide mathematics instruction to struggling students. Given that field experience/practicum does not follow a traditional course structure, we did not inquire about time allocation for each evidence-based practice. Additionally, the options for how each practice was addressed differed from the traditional course types to include not addressed, observation of the cooperating teacher using the practice, discussion of the practice with the cooperating teacher, and implementation of the practice by the teacher candidate. These responses are presented in Table 6.

Of the 14 EBPs, interventions in rational numbers and building arithmetic fluency had slightly more reports of not being addressed (26-30%) during field experience/practicum than other practices. Universal screening, interventions in whole numbers and operations, and motivational strategies had higher reports (greater than 60% of respondents for this course type) of being observed, discussed, and implemented. While observation, discussion, and implementation were all reported to be fairly common, implementation was the most common way that practices were addressed during field experience/practicum on the whole.

Comparison Across Course Types

There was little consistency across course types in the amount of attention that each evidence-based practice received. Only one practice, visual representations, was reported to receive greater time allocations in more than one course type (general education math methods and special education math methods). Five practices were reported to receive relatively little attention in more than one course type: interventions in rational numbers (general education math methods, field experience/practicum); progress monitoring (general education math methods, comprehensive methods); modeling and think aloud (general education math methods, comprehensive methods); motivational strategies (special education math methods, comprehensive methods); and building arithmetic fluency (special education math methods, field experience/practicum). Some practices received different amounts of attention depending on course type. Interventions in rational numbers were noted as frequently addressed in special education math methods courses but received little attention in general education math methods courses and field experience/practicum. Universal screening, interventions in whole numbers and operations, and motivational strategies were thoroughly address in field experience/practicum but receive low time allocations in at least one of the other course types. Teaching and learning approaches were far more consistent across the three types of methods courses. Participants indicated that, across course types, discussions and in-class activities were frequently used, readings were moderately common, and class-related field experiences and assignments were not often utilized. Lectures were frequently reported for general and special education mathematics methods courses and moderately reported for comprehensive methods courses.

Table 3. ***EBPs in General Education Math Methods Courses***

	Session Allocation				Ways Addressed					
Evidence-Based Practice	None	Partial	Whole	Multiple	Reading	Lecture	Discussion	In-Class Activity	Field Experience	Assignment
Universal Screening	4 23.5 (8.3)	9 52.9 (18.8)	2 11.8 (4.2)	2 11.8 (4.2)	4 23.5 (8.3)	8 47.1 (16.7)	8 47.1 (16.7)	10 58.8 (20.8)	5 29.4 (10.4)	4 23.5 (8.3)
Interventions in Whole Numbers and Operations	5 29.4 (10.4)	9 52.9 (18.8)	1 5.9 (2.1)	2 11.8 (4.2)	4 23.5 (8.3)	5 29.4 (10.4)	7 41.2 (14.6)	9 52.9 (18.8)	2 11.8 (4.2)	1 5.9 (2.1)
Interventions in Rational Numbers	6 35.5 (12.5)	7 41.2 (14.6)	3 17.6 (6.3)	1 5.9 (2.1)	3 17.6 (6.3)	7 41.2 (14.6)	6 35.5 (12.5)	7 41.2 (14.6)	1 5.9 (2.1)	1 5.9 (2.1)
Schema-Based Instruction	4 23.5 (8.3)	6 35.5 (12.5)	3 17.6 (6.3)	4 23.5 (8.3)	2 11.8 (4.2)	8 47.1 (16.7)	6 35.5 (12.5)	10 58.8 (20.8)	2 11.8 (4.2)	3 17.6 (6.3)
Visual Representations	2 11.8 (4.2)	6 35.5 (12.5)	4 23.5 (8.3)	5 29.4 (10.4)	6 35.5 (12.5)	11 64.7 (22.9)	8 47.1 (16.7)	11 64.7 (22.9)	3 17.6 (6.3)	3 17.6 (6.3)

Note: =0-20.0% = 20.1-40.0% = 40.1-60.0% = 60.1-80.0%

Table 3. ***EBPs in General Education Math Methods Courses (continued)***

	Session Allocation				Ways Addressed					
Evidence-Based Practice	None	Partial	Whole	Multiple	Reading	Lecture	Discussion	In-Class Activity	Field Experience	Assignment
	5	5	3	4	6	4	6	8	2	4
Building Arithmetic Fluency	29.4	29.4	17.6	23.5	35.5	23.5	35.5	47.1	11.8	23.5
	(10.4)	(10.4)	(6.3)	(8.3)	(12.5)	(8.3)	(12.5)	(16.7)	(4.2)	(8.3)
	7	5	3	2	3	4	6	4	4	2
Progress Monitoring	41.2	29.4	17.6	11.8	17.6	23.5	35.5	23.5	23.5	11.8
	(14.6)	(10.4)	(6.3)	(4.2)	(6.3)	(8.3)	(12.5)	(8.3)	(8.3)	(4.2)
	6	5	4	2	4	4	8	6	2	2
Motivational Strategies	35.5	29.4	23.5	11.8	23.5	23.5	47.1	35.5	11.8	11.8
	(12.5)	(10.4)	(8.3)	(4.2)	(8.3)	(8.3)	(16.7)	(12.5)	(4.2)	(4.2)
	2	8	3	4	7	10	6	9	3	1
Mathematical Language	11.8	47.1	17.6	23.5	41.2	58.8	35.5	52.9	17.6	5.9
	(4.2)	(16.7)	(6.3)	(8.3)	(14.6)	(20.8)	(12.5)	(18.8)	(6.3)	(2.1)
	6	4	5	2	5	6	4	5	3	3
Segmenting Complex Skills	35.5	23.5	29.4	11.8	29.4	35.5	23.5	29.4	17.6	17.6
	(12.5)	(8.3)	(10.4)	(4.2)	(10.4)	(12.5)	(8.3)	(10.4)	(6.3)	(6.3)

Table 3. ***EBPs in General Education Math Methods Courses (continued)***

	Session Allocation				Ways Addressed					
Evidence-Based Practice	None	Partial	Whole	Multiple	Reading	Lecture	Discussion	In-Class Activity	Field Experience	Assignment
Modeling and Thinking Aloud	5 29.4 (10.4)	7 41.2 (14.6)	4 23.5 (8.3)	1 5.9 (2.1)	4 23.5 (8.3)	7 41.2 (14.6)	5 29.4 (10.4)	9 52.9 (18.8)	4 23.5 (8.3)	3 17.6 (6.3)
Supports and Prompts	3 17.6 (6.3)	6 35.5 (12.5)	4 23.5 (8.3)	4 23.5 (8.3)	7 41.2 (14.6)	12 70.6 (25.0)	7 41.2 (14.6)	6 35.5 (12.5)	5 29.4 (10.4)	2 11.8 (4.2)
Providing Feedback	4 23.5 (8.3)	7 41.2 (14.6)	4 23.5 (8.3)	2 11.8 (4.2)	6 35.5 (12.5)	8 47.1 (16.7)	10 58.8 (20.8)	6 35.5 (12.5)	1 5.9 (2.1)	2 11.8 (4.2)
Purposeful Practice	5 29.4 (10.4)	3 17.6 (6.3)	6 35.5 (12.5)	3 17.6 (6.3)	6 35.5 (12.5)	8 47.1 (16.7)	6 35.5 (12.5)	3 17.6 (6.3)	2 11.8 (4.2)	3 17.6 (6.3)

Table 4. ***EBPs in Special Education Math Methods Courses***

	Session Allocation				Ways Addressed					
Evidence-Based Practice	None	Partial	Whole	Multiple	Reading	Lecture	Discussion	In-Class Activity	Field Experience	Assignment
Universal Screening	2 7.1 (4.2)	13 46.4 (27.1)	6 21.4 (12.5)	7 25.0 (14.6)	18 64.3 (37.5)	19 67.9 (39.6)	17 60.7 (35.4)	21 75.0 (43.8)	9 32.1 (18.8)	12 42.9 (25.0)
Interventions in Whole Numbers and Operations	1 3.6 (2.1)	11 39.3 (22.9)	5 17.9 (10.4)	11 39.3 (22.9)	16 57.1 (33.3)	22 78.6 (45.8)	18 64.3 (37.5)	19 67.9 (39.6)	7 25.0 (14.6)	12 42.9 (25.0)
Interventions in Rational Numbers	1 3.6 (2.1)	10 35.7 (20.8)	8 28.6 (16.7)	9 32.1 (18.8)	15 53.6 (31.3)	20 71.4 (41.7)	16 57.1 (33.3)	21 75.0 (43.8)	6 21.4 (12.5)	13 46.4 (27.1)
Schema-Based Instruction	2 7.1 (4.2)	7 25.0 (14.6)	13 46.4 (27.1)	6 21.4 (12.5)	15 53.6 (31.3)	18 64.3 (37.5)	18 64.3 (37.5)	21 75.0 (43.8)	3 10.7 (6.3)	11 39.3 (22.9)
Visual Representations	2 7.1 (4.2)	7 25.0 (14.6)	9 32.1 (18.8)	10 35.7 (20.8)	16 57.1 (33.3)	19 67.9 (39.6)	20 71.4 (41.7)	21 75.0 (43.8)	5 17.9 (10.4)	12 42.9 (25.0)

Note: = 0-20.0% = 20.1-40.0% = 40.1-60.0% = 60.1-80.0%

Table 4. *EBPs in Special Education Math Methods Courses (continued)*

	Session Allocation				Ways Addressed					
Evidence-Based Practice	None	Partial	Whole	Multiple	Reading	Lecture	Discussion	In-Class Activity	Field Experience	Assignment
	6	13	4	5	13	13	14	15	5	8
Building Arithmetic Fluency	21.4	46.4	14.4	17.9	46.4	46.4	50.0	53.6	17.9	28.6
	(12.5)	(27.1)	(8.3)	(10.4)	(27.1)	(27.1)	(29.2)	(31.3)	(10.4)	(16.7)
	5	12	3	8	12	16	15	13	8	8
Progress Monitoring	17.9	42.9	10.7	28.6	42.9	57.1	53.6	46.4	28.6	28.6
	(10.4)	(25.0)	(6.3)	(16.7)	(25.0)	(33.3)	(31.3)	(27.1)	(16.7)	(16.7)
	3	17	3	5	12	17	16	12	6	6
Motivational Strategies	10.7	60.7	10.7	17.9	42.9	60.7	57.1	42.9	21.4	21.4
	(6.3)	(35.4)	(6.3)	(10.4)	(25.0)	(35.4)	(33.3)	(25.0)	(12.5)	(12.5)
	4	11	4	9	14	20	13	15	4	6
Mathematical Language	14.4	39.3	14.4	32.1	50.0	71.4	46.4	53.6	14.4	21.4
	(8.3)	(22.9)	(8.3)	(18.8)	(29.2)	(41.7)	(27.1)	(31.3)	(8.3)	(12.5)
	4	12	5	7	12	18	15	12	6	7
Segmenting Complex Skills	14.4	42.9	17.9	25.0	42.9	64.3	53.6	42.9	21.4	25.0
	(8.3)	(25.0)	(10.4)	(14.6)	(25.0)	(37.5)	(31.3)	(25.0)	(12.5)	(14.6)

Table 4. ***EBPs in Special Education Math Methods Courses (continued)***

	Session Allocation				Ways Addressed					
Evidence-Based Practice	None	Partial	Whole	Multiple	Reading	Lecture	Discussion	In-Class Activity	Field Experience	Assignment
Modeling and Thinking Aloud	3 10.7 (6.3)	13 46.4 (27.1)	5 17.9 (10.4)	7 25.0 (14.6)	15 53.6 (31.3)	17 60.7 (35.4)	18 64.3 (37.5)	16 57.1 (33.3)	4 14.4 (8.3)	7 25.0 (14.6)
Supports and Prompts	1 3.6 (2.1)	16 57.1 (33.3)	0 0.0 (0.0)	11 39.3 (22.9)	16 57.1 (33.3)	17 60.7 (35.4)	17 60.7 (35.4)	18 64.3 (37.5)	7 25.0 (14.6)	10 35.7 (20.8)
Providing Feedback	3 10.7 (6.3)	13 46.4 (27.1)	5 17.9 (10.4)	7 25.0 (14.6)	15 53.6 (31.3)	18 64.3 (37.5)	18 64.3 (37.5)	15 53.6 (31.3)	7 25.0 (14.6)	7 25.0 (14.6)
Purposeful Practice	3 10.7 (6.3)	7 25.0 (14.6)	5 17.9 (10.4)	13 46.4 (27.1)	14 50.0 (29.2)	19 67.9 (39.6)	19 67.9 (39.6)	15 53.6 (31.3)	5 17.9 (10.4)	8 28.6 (16.7)

Table 5. ***EBPs in Comprehensive Methods Courses***

	Session Allocation				Ways Addressed					
Evidence-Based Practice	None	Partial	Whole	Multiple	Reading	Lecture	Discussion	In-Class Activity	Field Experience	Assignment
Universal Screening	0 0.0 (0.0)	7 70.0 (14.6)	1 10.0 (2.1)	2 20.0 (4.2)	7 70.0 (14.6)	5 50.0 (10.4)	7 70.0 (14.6)	8 80.0 (16.7)	3 30.0 (6.3)	3 30.0 (6.3)
Interventions in Whole Numbers and Operations	2 20.0 (4.2)	4 40.0 (8.3)	1 10.0 (2.1)	3 30.0 (6.3)	4 40.0 (8.3)	7 70.0 (14.6)	5 50.0 (10.4)	8 80.0 (16.7)	1 10.0 (2.1)	1 10.0 (2.1)
Interventions in Rational Numbers	4 40.0 (8.3)	2 20.0 (4.2)	4 40.0 (8.3)	0 0.0 (0.0)	4 40.0 (8.3)	1 10.0 (2.1)	4 40.0 (8.3)	5 50.0 (10.4)	1 10.0 (2.1)	1 10.0 (2.1)
Schema-Based Instruction	2 20.0 (4.2)	5 50.0 (10.4)	2 20.0 (4.2)	1 10.0 (2.1)	3 30.0 (6.3)	3 30.0 (6.3)	5 50.0 (10.4)	5 50.0 (10.4)	1 10.0 (2.1)	2 20.0 (4.2)
Visual Representations	2 20.0 (4.2)	4 40.0 (8.3)	3 30.0 (6.3)	1 10.0 (2.1)	3 30.0 (6.3)	5 50.0 (10.4)	4 40.0 (8.3)	6 60.0 (12.5)	1 10.0 (2.1)	3 30.0 (6.3)

Note: = 0-20.0% = 20.1-40.0% = 40.1-60.0% = 60.1-80.0%

Table 5. ***EBPs in Comprehensive Methods Courses (continued)***

	Session Allocation				Ways Addressed					
Evidence-Based Practice	None	Partial	Whole	Multiple	Reading	Lecture	Discussion	In-Class Activity	Field Experience	Assignment
	4	2	2	2	2	2	4	3	3	2
Building Arithmetic Fluency	40.0	20.0	20.0	20.0	20.0	20.0	40.0	30.0	30.0	20.0
	(8.3)	(4.2)	(4.2)	(4.2)	(4.2)	(4.2)	(8.3)	(6.3)	(6.3)	(4.2)
	3	5	1	1	4	5	5	4	3	1
Progress Monitoring	30.0	50.0	10.0	10.0	40.0	50.0	50.0	40.0	30.0	10.0
	(6.3)	(10.4)	(2.1)	(2.1)	(8.3)	(10.4)	(10.4)	(8.3)	(6.3)	(2.1)
	1	7	1	1	6	2	7	5	3	2
Motivational Strategies	10.0	70.0	10.0	10.0	60.0	20.0	70.0	50.0	30.0	20.0
	(2.1)	(14.6)	(2.1)	(2.1)	(12.5)	(4.2)	(14.6)	(10.4)	(6.3)	(4.2)
	2	3	2	3	4	3	7	7	2	2
Mathematical Language	20.0	30.0	20.0	30.0	40.0	30.0	70.0	70.0	20.0	20.0
	(4.2)	(6.3)	(4.2)	(6.3)	(8.3)	(6.3)	(14.6)	(14.6)	(4.2)	(4.2)
	2	4	3	1	7	3	6	4	2	1
Segmenting Complex Skills	20.0	40.0	30.0	10.0	70.0	30.0	60.0	40.0	20.0	10.0
	(4.2)	(8.3)	(6.3)	(2.1)	(14.6)	(6.3)	(12.5)	(8.3)	(4.2)	(2.1)

Table 5. ***EBPs in Comprehensive Methods Courses (continued)***

	Session Allocation				Ways Addressed					
Evidence-Based Practice	None	Partial	Whole	Multiple	Reading	Lecture	Discussion	In-Class Activity	Field Experience	Assignment
Modeling and Thinking Aloud	3 30.0 (6.3)	5 50.0 (10.4)	1 10.0 (2.1)	1 10.0 (2.1)	2 20.0 (4.2)	4 40.0 (8.3)	3 30.0 (6.3)	6 60.0 (12.5)	2 20.0 (4.2)	1 10.0 (2.1)
Supports and Prompts	2 20.0 (4.2)	4 40.0 (8.3)	2 20.0 (4.2)	2 20.0 (4.2)	3 30.0 (6.3)	6 60.0 (12.5)	6 60.0 (12.5)	2 20.0 (4.2)	2 20.0 (4.2)	2 20.0 (4.2)
Providing Feedback	2 20.0 (4.2)	7 70.0 (14.6)	0 0.0 (0.0)	1 10.0 (2.1)	4 40.0 (8.3)	4 40.0 (8.3)	6 60.0 (12.5)	3 30.0 (6.3)	1 10.0 (2.1)	1 10.0 (2.1)
Purposeful Practice	2 20.0 (4.2)	4 40.0 (8.3)	0 0.0 (0.0)	4 40.0 (8.3)	6 60.0 (12.5)	4 40.0 (8.3)	6 60.0 (12.5)	3 30.0 (6.3)	2 20.0 (4.2)	2 20.0 (4.2)

Table 6. ***EBPs in Field Experiences/Practicum***

	Ways Addressed			
Evidence-Based Practice	Not Addressed	Observed Practice	Discussed with Cooperating Teacher	Implemented Practice
Universal Screening	2 6.7 (4.2)	20 66.7 (41.7)	20 66.7 (41.7)	19 63.3 (39.6)
Interventions in Whole Numbers and Operations	1 3.3 (2.1)	19 63.3 (39.6)	20 66.7 (41.7)	24 80.0 (50.0)
Interventions in Rational Numbers	9 30.0 (18.8)	18 60.0 (37.5)	13 43.3 (27.1)	14 46.7 (29.2)
Schema-Based Instruction	6 20.0 (12.5)	17 56.7 (35.4)	13 43.3 (27.1)	16 53.3 (33.3)
Visual Representations	2 6.7 (4.2)	20 66.7 (41.7)	16 53.3 (33.3)	24 80.0 (50.0)
Building Arithmetic Fluency	8 26.7 (16.7)	14 46.7 (29.2)	15 50.0 (31.2)	14 46.7 (29.2)
Progress Monitoring	5 16.7 (10.4)	19 63.3 (39.6)	17 56.7 (35.4)	13 43.3 (27.1)
Motivational Strategies	3 10.0 (6.3)	19 63.3 (39.6)	19 63.3 (39.6)	20 66.7 (41.7)

Note: = 0-20.0% = 20.1-40.0% = 40.1-60.0% = 60.1-80.0%

Table 6. ***EBPs in Field Experiences/Practicum (continued)***

	Ways Addressed			
Evidence-Based Practice	Not Addressed	Observed Practice	Discussed with Cooperating Teacher	Implemented Practice
Mathematical Language	6 20.0 (12.5)	17 56.7 (35.4)	17 56.7 (35.4)	17 56.7 (35.4)
Segmenting Complex Skills	4 13.3 (8.3)	17 56.7 (35.4)	16 53.3 (33.3)	19 63.3 (39.6)
Modeling and Thinking Aloud	3 10.0 (6.3)	20 66.7 (41.7)	13 43.3 (27.1)	22 73.3 (45.8)
Supports and Prompts	3 10.0 (6.3)	19 63.3 (39.6)	18 60.0 (37.5)	19 63.3 (39.6)
Providing Feedback	5 16.7 (10.4)	18 60.0 (37.5)	19 63.3 (39.6)	21 70.0 (43.8)
Purposeful Practice	6 20.0 (12.5)	16 53.3 (33.3)	18 60.0 (37.5)	19 63.3 (39.6)

Discussion

Interpretation of Findings

Overview of Key Findings. A number of our findings speak to the evolving nature of special education teacher preparation and in-service roles and responsibilities. In addition to documenting the current state of preparation for providing mathematics instruction and intervention to students with or at-risk for learning disabilities, these findings have implications for teacher training programs as we strive to comprehensively prepare special educators to improve academic outcomes for students.

Special Education Math and Comprehensive Methods Courses. Of our survey respondents, 58.3% reported that enrollment in a special education math methods course contributed to their preparation for teaching mathematics to struggling learners. While this indicates progress from previous models of special education teacher preparation that did not address pedagogy in academics (Brownell et al., 2005), special education math courses may not yet be prevalent enough to address the evolving job responsibilities of special educators. Vannest and Burke (2010) and Vannest et al. (2011) found that special educators spend more time engaged in academic instruction than any of their other job responsibilities but this amount of time is not sufficient to yield necessary improvements in student learning. Similarly, Gilmour (2020) reported low mathematics achievement of students with learning disabilities regardless of whether they were taught by general education or special education certified teachers. Given that EBPs are primarily addressed in special education math methods courses but such courses are only taken by about half of pre-service special educators, it is not surprising that research is demonstrating limited effectiveness of math instruction and intervention for students with learning disabilities. Completion of a mathematics methods course is not required for special education licensure in most states in the US. Consequently, some teacher training programs do not offer a special education math methods course while others offer it as an elective. A notable step in promoting effective mathematics instruction and intervention is making this type of coursework an available and expected component of special education teacher training.

Survey results further indicate that teacher candidates who took comprehensive methods courses received less training in EBPs for math instruction than those who took a dedicated math methods course. This finding makes sense, given that class time in a comprehensive methods class is necessarily split amongst multiple academic subjects. In addition to providing more time focused solely on mathematics methods, dedicated math methods courses are often developed and taught by faculty with expertise in mathematics content and EBPs. A dedicated course that is developed and taught by an expert allows for in-depth exploration of mathematical topics, specialized pedagogical strategies, and assessment practices that are specific to the unique challenges of mathematics education for students with or at-risk for learning disabilities. Research in English as a Second Language (ESL) teacher preparation indicates that a dedicated methods course more effectively prepares candidates than a comprehensive methods course or the practice of embedding ESL content within other required courses (Deng et al., 2021; Lopez & Santibanez, 2018). It stands to reason that dedicated courses in other domain-specific methods courses (e.g., math methods) would also be similarly important for effective teacher preparation.

Fluency. The low reported prevalence of instruction focused on building fluency is also an interesting finding in light of the volume and strength of the evidence in support of evidence-based fluency-building instruction and intervention for students with disabilities. For example, the most recent practice guide on mathematics published by IES, *Assisting Students Struggling with Mathematics: Intervention in the Elementary Grades* (Fuchs et al., 2021), reports a rating of 'tier 1/strong evidence' in support of the recommendation to "Regularly include timed activities as one way to build fluency in mathematics." Quick, accurate retrieval (i.e., fluency) with a variety of basic math facts, procedures, and/or concepts is a part of most multi-component mathematics interventions precisely because students with learning disabilities characteristically have difficulty building fluency (Baroody et al., 2009; Geary et al., 2012), and it is well-established that fluency is necessary to free up cognitive resources for and support comprehension of more complex math procedures and concepts (Baroody et al., 2009; Dyson et al., 2015). It follows that learning evidence-based strategies for helping students with learning disabilities build fluency in mathematics should be a learning objective in all special education math methods courses. Survey results indicate, however, that this may not be the case.

Universal Screening and Progress Monitoring. Another notable finding is the limited attention given to the EBPs of universal screening and progress monitoring in general education mathematics and comprehensive methods courses. Of the participants who completed a general education math methods course, 76.4% reported that universal screening was addressed for a partial session or not at all; 70.6% reported the same for progress monitoring. For comprehensive methods courses, 70% of respondents for that course type noted that universal screening was addressed for a partial class session (no indication that it was not addressed) while 80% reported that progress monitoring was addressed for a partial class session or not at all. This is a notable trend because universal screening and progress monitoring are key components of multi-tiered systems of support, including response to intervention frameworks, which are intended for use in general education settings (Fletcher & Vaughn, 2009). The purpose of using these assessments in general education is to readily identify students at-risk of academic challenges whether or not they have an identified learning disability and then to systematically document their learning to quickly address needs for support. When used in this way, universal screening and progress monitoring can significantly improve student achievement (Steckler et al., 2005; Ysseldyke & Bolt, 2007). This disconnect between EBPs and educational settings creates an opportunity for special education teacher preparation faculty to advocate to our general education colleagues on the value of universal screening and progress monitoring in general education settings and collaborate with them on how they might effectively be addressed with pre-service teachers.

Teaching and Learning Strategies. Survey results indicate that while teaching and learning strategies in math methods courses are varied, pre-service teachers receive fewer opportunities for applied practice than would be ideal. A robust body of research indicates that effective teacher training incorporates active learning (i.e., opportunities to design and practice implementing instruction) with expert support and feedback and opportunities for reflection (Darling-Hammond et al. 2017). Exposure to EBPs through lectures, readings, and other more passive learning activities does not adequately prepare candidates to use EBPs effectively in the classroom. While candidates may or may not be able to engage in applied practice with actual students during a math methods course, instructors can provide opportunities for applied practice implementing instruction by having candidates plan and then implement instruction with peers acting as students or by using simulation tools (e.g., Mursion, ArborXR, TLE TeachLive, etc.).

Need for Evidence-Based Practices. Practicum/field experience was both the most common preparation course type reported by the participants (62.5%) and the one to most comprehensively address EBPs for mathematics instruction and intervention for learners with or at-risk for learning disabilities, giving the teacher candidates opportunities to implement many of the practices. These experiences demonstrate the need for evidence-based instructional practices as a classroom reality. Further, they support the recommendations of scholars who advocate for the importance of pre-service teachers learning to utilize EBPs aligned with explicit instruction, representational models, and problem-solving strategies (e.g., Bouck et al., 2018; Cook et al., 2020; Gersten et al., 2009). Teacher candidates would likely benefit from increased exposure to and active learning opportunities for EBPs during more traditional coursework so that practicum/field experience can serve as a more advanced learning and practice opportunity.

Limitations

Although the sample of survey respondents is nationally representative across the United States, the sample size is small. A larger number of participants could reveal different preparation trends. The small sample size could also be indicative of bias if recent graduates were motivated to respond by particularly positive or negative experiences. Although survey research designs have notable benefits such as efficiency and representativeness, self-reported experiences may not be as accurate as observed experiences due to differences in perception among respondents or the need to recall events over time. In our survey, we did not inquire about the quality of preparation in EBPs, only time allocations and teaching/learning strategies. We have assumed that greater time allocations and active teaching/learning strategies indicate higher quality of learning, but this may not be accurate. Finally, we did not explicitly distinguish whether comprehensive methods courses focused on special education or general education.

Future Research

Future research regarding the preparation of special educators to provide mathematics instruction and intervention to students with or at-risk for learning disabilities could continue a similar line of inquiry used here with a larger sample. The quality of preparation would also be important to discern. Researchers should consider preparation quality from recent graduates for proximity to the preparation program and early career teachers who have developed a better understanding of their professional responsibilities and capabilities.

Conclusion

The current study demonstrates that pre-service special educators in the US enroll in a variety of coursework to prepare to teach mathematics to students with or at-risk for learning disabilities. However, not all teacher candidates engage in such coursework nor do these courses consistently or comprehensively prepare teacher candidates in EBPs. While the current preparation practices are an improvement over previous models that did not address academic pedagogy, more work can be done at the pre-service level to support special educators in effective mathematics instruction and intervention.

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