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Understanding Practice: A Pilot to Compare Mathematics Educators' and Special Educators' Use of Purposeful Questions

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Abstract

Despite calls for alignment, descriptions of best practices from special education and math education researchers continues to diverge. However, there has been little discussion of how special education teacher educators and mathematics teacher educators compare in *practice*. This paper describes a study in which a range of teacher educators (*N*=51) were asked to evaluate a series of questions asked in response to a struggling student with a learning disability. The results indicate that teachers from both groups ranked initial assessment questions highly, and questions that lowered the cognitive demand of the task much lower. Differences between math education and special education teacher educators indicate that they have different approaches to reading and vocabulary, as well as provide opportunities to reason by proposing simpler, analogous problems. Implications of these findings and directions for future research are discussed.

Understanding Practice: A Pilot to Compare Mathematics Educators' and Special Educators' Use of Purposeful Questions

In the United States, a fundamental problem for teacher education programs is a lack of consistency across disciplines (Clarke, Triggs, & Nielsen, 2014; Darling-Hammond, Hammerness, Grossman, Rust, & Shulman, 2005; Levine, 2006; Little, 1993). Teacher educators from different fields have different theories of teaching and learning and different ideas about best practices, and they pass these differences on to their students. If the differences are not highlighted and explained, pre-service teachers (PSTs) are left to make sense of contradictory messages and reconcile conflicting mandates. One site where this difference manifests itself is the intersection of mathematics education and special education (Boyd & Bargerhuff, 2009; Woodward & Montague, 2002).

Special educators and mathematics educators in k-12 classrooms increasingly share responsibility for teaching children mathematics, often as co-teachers in inclusive classrooms. In addition, special education teacher educators and mathematics teacher educators are jointly responsible for teaching PSTs about mathematics instruction. However, research in these two fields has led to different descriptions of *best practice*, stemming from different ideas about content, students, learning and teaching and foundational research. Certainly, diversity of opinion is important, and variety of frameworks enrich research and practice. However, the differences between special education and math education research risk leading not to enrichment, but to incoherence. This has led to calls for greater collaboration between researchers and practitioners in these two fields in an effort to forge common understandings and consistent messages (Boyd & Bargerhuff, 2009; Pugach, Blanton, & Correa 2011).

We used Wenger's (2000) social learning system theory to contextualize our examination of special education and mathematics education faculty views of practice. Despite the apparent lack of alignment between special education and mathematics education *research*, there have been few attempts to examine whether special education and mathematics education faculty differ in their *practice* and in their ideas about mathematics teaching and learning. We assert that in order to create a more coherent approach to mathematics education for all teachers, we need to learn more about how mathematics teacher educators and special education teacher educators actually compare to each other. Does their practice and their rationale for that practice differ? This study was designed as a first step to determine, a. how best to measure how special education faculty and math education faculty approach instruction, and b. what similarities and differences exist between how these faculty members address a student who is struggling during a math lesson.

Theoretical Framework

Wenger (2000) defined social learning systems as communities made up of individuals that learn and grow together in ways that contribute to, and reinforce, the strength and self-definition of the community and the individuals themselves. Community members are "bound together by their collectively developed understanding of what their community is about and they hold each other responsible to this sense of *joint enterprise* (Wenger 2000, p. 229). Although postulated as a theory that could be applied to a broad base of professional and other learning communities defined as *communities of practice*, Wenger's theory has been utilized to examine teacher education (Cuddapah & Clayton, 2010; Korthagen, 2010). For teacher educators, the joint enterprise is clear; preparing effective teachers for the demands of today's classroom.

Wenger described three forms of belonging that contributed to the strength and vitality of a social learning system, *Engagement*, *Imagination*, and *Alignment.* In this study, the focus is on *Alignment*, described by Wenger as "a mutual process of coordinating perspectives, interpretations and actions so they realize higher goals" (2000, p. 228). More specifically, we examined the alignment between the *repertoire* of different community members, a repertoire made up of shared artifacts, language, stories, traditions and methods (Wenger, 2010). In other words, when faced with a common problem of practice, do different members of this community share the same "traditions, methods, standards, routines and frameworks?" (Wenger, 2000, p. 231).

Literature Review

Educational researchers and policy makers have long argued that teacher education programs are plagued by a lack of continuity (Clarke et al., 2014; Darling-Hammond et al., 2005; Levine, 2006; Little, 1993). Educational researchers do not ascribe to a unified theory of teaching and learning, nor do they agree upon essential questions or techniques (Hiebert & Grouws, 2007). Because PSTs take courses from a variety of teacher educators representing different approaches, they are likely to be exposed to conflicting theories of teaching, learning and schooling. One area where the differences seem especially pronounced is the intersection of mathematics teacher education and special education teacher education (Boyd & Bargerhuff, 2009; Woodward & Montague, 2002).

Mathematics education

Over the last 30 years, mathematics education researchers, as well as mathematics teacher professional organizations, have developed a consensus about the nature of mathematics content, the best way that students learn that content, and what that means for teaching. This consensus starts with a description of mathematics as more than simply procedures and rules to follow (National Council of Teachers of Mathematics, 2000; National Research Council, 2001). Deep knowledge of mathematics is the goal of instruction, and is marked by connections between techniques, ideas, representations and justifications (Hiebert et al., 1997).

Mathematics education researchers also generally ascribe to a social constructivist understanding of learning, in which people learn by making sense of new information and ideas by connecting them to what they already know, all in the purpose of creating a taken-as-shared understanding (National Research Council, 2005). This happens in the context of solving problems - when students work to solve problems that are new to them, they have to make sense of new mathematical relationships and justify their thinking using logical arguments. For mathematics educators, solving problems is not only the goal of mathematics class, it is the way that people learn new mathematical material (NCTM, 2000; Stein, Boaler, & Silver, 2003).

Although there is no single teaching method that supports this learning, what researchers have found is that teaching for deep understanding requires that students engage in productive cognitive struggle with important mathematics (Hiebert & Grouws, 2007; Hiebert et al., 2005), and that teachers attend to concepts and ideas (Hiebert et al., 2005). One specific ramification of this idea for mathematics teaching is that in order for students to learn how to reason, communicate, justify and understand important mathematical concepts, they need to engage in solving non-routine problems in which they do the mathematical thinking (Stein, Grover, & Henningsen, 1996; Stein & Lane, 1996).

Special education

Special Education researchers tend to describe mathematics and effective pedagogy differently than mathematics education researchers. They have generally been very skeptical of problem-based learning in mathematics, arguing that students with disabilities struggle unproductively with the multiple demands of the problem-solving tasks advocated by mathematics educators (Bottge et al., 2015; Carnine, 1997; Kozioff, LaNunziata, Cowardin, & Bessellieu, 2001). Instead, they have consistently argued that direct and explicit instruction is the most effective method for teaching mathematics to students with disabilities (Carnine, 1997; Doabler & Fien, 2013; Gersten et al., 2009; Kroesbergen & Luit, 2003; Miller & Hudson, 2007; Swanson & Hoskyn, 2001). In direct instruction, teachers model techniques for students, and then provide opportunities for scaffolded practice with frequent teacher feedback, gradually moving to independent practice.

Much of this understanding of mathematics and pedagogy is rooted in an, “Behaviorist or Instructivist” tradition. In this tradition, learning is a measurable change in behavior, and is the result of students attending to, and then replicating, teacher models and explanations. Effective instruction combines clear explanations of concepts, procedures and goals, as well as effective assessments that evaluate mastery and focus effort (Kozioff et al., 2001, cited in Boyd & Bargerhuff, 2009). In addition, special education researchers see problem solving as the *aim* of instruction, not the avenue. Teachers carefully explain and model, and then students practice those same methods with teacher feedback. Such a pedagogical approach is aligned with learning how to enact mathematical procedures quickly and accurately or to memorize important mathematical facts and definitions (Miller & Hudson, 2007).

As content standards and curriculum materials have moved to emphasize conceptual understanding and problem-solving, special education researchers have applied explicit and direct instruction to these newly ambitious goals (Gersten et al., 2009; Powell, Fuchs, & Fuchs, 2013). Special education teachers, in compliance with both the Individuals with Disabilities

Education Act (IDEA) (2004) and the Every Student Succeeds Act (ESSA, 2015) requirements that instruction be evidence based, have argued for continued use of explicit and direct instruction, in which the teacher stresses not only procedures, but also concepts, and conceptual connections. In such instruction, students continue to learn through example and explanation, but teachers ensure that their explanations include larger ideas (Carnine, 1997; Doabler & Fien, 2013; Powell et al., 2013). In addition, it is recommended that teachers model strategies for solving complex problems; then students can practice these strategies and gain mastery (Doabler & Fien, 2013). Several studies have focused on schema instruction, where students learn to recognize the type (or schema) of the problem and then solve it utilizing a graphic organizer (Fuchs et al. 2008; Jitendra, DiPipi, & Perron-Jones, 2002; Jitendra & Hoff, 1996; Xin & Zhang, 2009). Special education researchers further argue that students left to "discover" these ideas on their own (Kozioff et al., 2001) risk becoming frustrated and developing math anxiety (Wu, Barth, Amin, Malcarne, & Menon, 2012). Finally, special education researchers assert that before attempting complex problems, students need a firm understanding of basic skills (Bottge et al., 2015; Gersten et al., 2009; Kozioff et al., 2001; Powell et al., 2013).

The 21st century classroom

In the United States, legislation has mandated that students with disabilities be educated in the "least restrictive environment" (Individual with Disabilities Education Act [IDEA], 2004). For most students with disabilities, this means that they are enrolled in general education classes alongside students without disabilities, taught by general education teachers. Instruction for students with Individual Education Programs (IEPs) must be delivered by, and/or developed in consultation with, a special educator. These students may experience complex barriers to mathematics learning, barriers that are often outside the general education teachers' experience and expertise. Special education teachers are newly responsible for teaching a wide range of mathematics to a wide range of students, perhaps pushing them to interact with unfamiliar and advanced math content, and new classroom cultures and routines. In response, teacher education programs are much more likely to require mathematics courses for their pre-service special education teachers, and to require special education courses for their pre-service mathematics teachers (Blanton & Pugach, 2007).

Given this increased shared responsibility for teaching students and preparing teachers, the apparent differences between mathematics education and special education research described above have ramifications for students and teachers. Novice teachers may hear one set of messages about content, learning and pedagogy from special education teacher educators, and a different set of messages from mathematics teacher educators. Differences in approach are not necessarily bad, professionals can learn from different perspectives, and different students may require different supports and instructional methods. However, differences can also lead to incoherence and confusion. Teachers mayhave different goals for students, different ideas about how students learn, and different teaching methods. Students in these classrooms may get mixed, perhaps even contradictory messages about mathematics, and what is expected of them in mathematics class.

There is some evidence that despite the differences in their ideas and theoretical approaches, there may actually be important areas of agreement between teacher educators from these two fields (Boyd & Bargerhuff, 2009). However, there is little research that describes what special education teacher educators and mathematics teacher educators actually do and think. Do these different theoretical stances result in similar approaches or do they result in different reactions to common problems of practice?

Examining teacher educator practice

Choosing a context and a problem of practice. In comparing different teacher educators' practice, researchers must confront the problem of context, and its relationship to knowledge and practice. Educational researchers have described expert teachers' knowledge as "situated" in two distinct ways (Lampert & Clark, 1990). First, expert teachers' knowledge is situated in the specific contexts where they use it. The moves effective teachers make, and more importantly, the way they decide which moves to make, is very much determined by their understanding of specific student needs, specific institutional constraints, and a large number of other contextual factors unique to each classroom. Expert teachers have specific knowledge for teaching *this* content to *these* students in *this* setting. This has led to general calls to ground theoretical knowledge in context and practice, or practice-based teacher education (Ball & Cohen, 1999; Ball & Forzani, 2009; Darling-Hammond et al., 2005)

As teachers, teacher educators also develop and apply knowledge in specific contexts; their pedagogical knowledge is also "situated." In designing our study, we sought to provide special education teacher educators and mathematics teacher educators with an opportunity to demonstrate this situated knowledge by asking them how they would respond to a specific, common problem of practice, one that would be very familiar to both mathematics teachers and special education teachers. We decided that working with a student with learning disabilities who asked for help in the face of a problem involving elementary mathematics would be familiar problem of practice and involve mathematics that a wide range of participants would understand.

Choosing a practice and a purpose. Despite the differences between various fields of education, a widespread consensus has developed around the importance and impact of effective questioning in many areas of learning (Cotton, 2001; Davoudi &

Sadeghi, 2015; Korthagen & Kessels, 1999; Wilen & Clegg, 1986). Indeed, the National Council of Teachers of Mathematics made “Posing Purposeful Questions” one of eight mathematical teaching practices that can strengthen teaching and learning. As they write, “Effective teaching of mathematics uses purposeful questions to assess and advance students’ reasoning and sense making about important mathematical ideas and concepts” (NCTM, 2014). By making effective purposeful questions the focus of our study, we provided teachers with very different perspectives an opportunity to choose which questions they thought would be most effective. We asked our participants to rank a set of questions to ask a student with identified learning disabilities who raised their hand after being given the problem above, and said, “I don’t know what to do.” We intentionally provided a very general description of the student to avoid over prescriptive responses from the subjects. We essentially let them fill in the gaps based upon their experience.

Research Questions

Our research questions were:

1. When asked to rank a set of proposed purposeful questions in response to a hypothetical student with learning disabilities asking for assistance, how do the rankings of special education teacher educators and mathematics teacher educators compare?

    a. In what ways are their rankings similar?

    b. In what ways are their rankings different?

    c. Do they provide similar rationales for their choices?

2. What tool will determine a teacher's approach to teaching math to a student with a disability and elicit understanding for why the teacher made that choice.

Method

Participants

We recruited participants through snowball sampling; sending e-mails to mathematics educators and special educators from colleges and universities throughout the United States, who were members of Special Education and Mathematics education professional organizations. Fifty-eight people completed the survey. Of those 58, 51 people responded that they had taught a college level methods course. We split treated the respondents as three separate groups, teachers of mathematics education courses (n=14), teachers of special education courses (n=12), and teachers who taught both mathematics education and special education courses (n=25). Participants represented a range of expertise and experience within mathematics education and special education. However, it was notable that the K-12 teaching experience for most of our math teacher educators was in middle or high school settings (Table 1).

Table 1.
Participant Information

	Math	*Special Education*	*Both*
Race			
Asian	0	1	4
White	12	9	18
Mixed Race	2	1	0
Hispanic Latino	0	0	1
I prefer not to respond	0	1	2
Total	14	12	25
Gender			
Male	6	1	5
Female	8	11	20
Teaching Expertise*			
Early Childhood	1	2	2
Elementary	3	4	10
Middle School Math	6	1	4
High School Math	12	1	8
Special Education General	0	8	11
Special Education Students with Learning Disabilities	0	4	6
Special Education Students with Severe Disabilities	0	5	5
Years Teaching			
Elementary (k-4)			
1-3years	1	3	7
4-9 years	0	2	5
10+ years	0	4	3
Middle School Math			
1-3 years	4	6	5
4-9 years	3	2	5
10+ year	0	0	2
High School Math			
1-3 years	4	4	6
4-9 years	3	1	3
10+ years	0	3	3
Special Education General			
1-3 years	0	0	2
4-9 years	0	4	9
10+ years	0	7	5
Special Education Students with Learning Disabilities			
1-3 years	0	0	2

Table 1 (continued)
Participant Information

4-9 years	0	4	9
10+ years	0	7	5
Special Education Students with Severe Disabilities			
1-3 years	0	0	2
4-9 years	0	4	9
10+ years	0	7	5
Special Education Undergraduate Methods			
1-3 years	0	6	8
4-9 years	0	5	9
10+ years	0	1	8
Mathematics Pedagogy Undergraduates Methods			
1-3 years	3	0	12
4-9 years	7	0	10
10+ years	4	0	3

**Participants could select more than one expertise/ certification*

Instrument

Pilot. A preliminary instrument was developed and piloted with a convenience sample of four participants (two special education professors and two mathematics education professors). These participants were asked to complete the survey in hard copy and then discuss their thoughts and concerns about the instrument with the researchers. The primary change that resulted from the pilot included changing the question about purposeful questions from "*Choose the best question*" to "*Please rank order the questions from 1-9*". The revised instrument was piloted for a second time (N=9) on the platform Qualtrix. The survey was emailed to special education and mathematics faculty known personally to the researchers. Changes were made to several of the demographic questions to provide additional clarification to the questions.

Final Instrument. The final survey consisted of questions to determine the participants expertise (mathematics education and/or special education) and years teaching in the K-12 classroom and undergraduate/ graduate classroom. The participants were presented with:

- A description of "Posing Purposeful Questions"
- A description of a classroom and a student identified as having special needs.
- A word problem involving finding the difference between two three-digit numbers.
- A series of nine possible "purposeful questions" (See Appendix for the entire case).

Rationale for the problem. The problem presented to participants was: **José and Claire both collect pokémon cards. José has 325 cards. Claire has 287 cards. How many more cards does Claire need in order to have as many as José?** This task was chosen because is a problem that is embedded in a context that many third graders might find familiar. Three digit subtraction and addition is a standard for second and third grade. There are a variety of ways to do this problem, counting up from 287 to 325, using a variety of tools (number line, fingers, etc.) counting back from 325 to 287, using the traditional algorithm.

Solving problems in context is a common curricular goal, and is a key feature of tasks that help students use knowledge that they have, as well as engage them in making sense of mathematics. Furthermore, the idea of who has more of something is an idea that students would have had lots of real-world experience with.

This particular task presents a variety of processing problems. Most adults would see this as a subtraction problem, but the wording of the problem includes the word more, which many students have been taught to associate with addition. This is difficult for younger students to model, because there is no action, there is no "adding on" or "taking away". It is a comparison problem, which are traditionally the most difficult for students to make sense of. They cannot "act it out". Deciding which operation to use is difficult for students who struggle with making sense of operations.

Rationale for the questions. The questions were specifically crafted to reflect a variety of approaches to mathematics teaching and learning and special education. One idea in math education is reducing the cognitive load, or taking much of the intellectual work out of the problem by reposing it in a simpler way. This means that the student ends up not having an opportunity to think about the math that the original question asked about. Another idea is funneling, questions that are designed to elicit the right answer, rather than focus student thinking. These also contain examples of proceduralizing, moving quickly to a procedure rather than making sense of the problem. Examples include:

- What kind of problem is this, an addition problem, a subtraction problem, a multiplication problem, a division problem or another kind of problem?
- If we wanted to find out how much less which would we use, subtraction or addition?
- What is 325 minus 287?

Questions also addressed the distinction be between assessing and advancing. Some of these questions seem to be more about gathering information from the student, and others seem to be more about pushing the student to think about a specific thing or an aspect of the problem. Some of our question choices were designed to appeal to teacher educators who favored a problem-solving approach foregrounding sense-making. These responses prompted students to think about the problem situation and the relationships in the situation. Examples of these kinds of questions were:

- Can you explain to me what is going on in the problem?
- Could you draw a picture of this problem?
- What do you understand about this problem?

One question was designed to appeal to educators who preferred to activate prior knowledge, and who also might wish to assess that prior knowledge was

- Is this like any other problems we have done in class?

A question that was designed to appeal to educators who sought to scaffold student reasoning by providing a conjecture for them to reason about and to help students make sense of the meaning of a solution by proposing one that involved relatively simple numbers.

- If Claire has 100 more cards, how many will she have? Will that be the same as Jose?

Finally, we included a question that was designed to echo a common strategy for word problems, the "key-word" strategy. This strategy prompts students to look for words that correspond to specific operations, like "less" for subtraction, "more" for addition, etc.

- Could you underline some important words in this problem?

Participants were asked to identify the question that was the best question that they could ask. They were then asked to rank all of the choices from 1-9. They were also asked to write an explanation for their top and bottom choices.

Analysis

The responses of the members of three groups (teachers of mathematics education courses [n=14], teachers of special education courses [n=12], and teachers who taught both mathematics and special education courses [n=25]) were analyzed both within and across groups. We looked at each question's mean rank, and the standard deviation. This gave us a sense of the specific questions that each group saw as particularly effective. We ranked the questions from first to last within each group. In addition, the open-ended responses were compared to determine if participants provided different rationales for their choices.

We identified questions about which there was general agreement between groups and questions about which there seemed to be disagreement. We then conducted a Kruskal-Wallis H test for each question to determine if there were significant differences in the mean ranking for each question between the groups. Finally, we examined the rationales provided by the participants for ranking questions either first or last to determine if the rationales provided supported the intent of the questions (e.g. Did the teachers view the intent of the questions as we did in developing the instrument?).

Results

Agreements

The responses of the groups tended to be more similar than different. Initial assessing questions (Q3, Q5, Q7 and Q2) were highly ranked (top 5) by all groups. Those questions that focused on operations or just asked students to complete a calculation (Q8, Q4) were ranked low (8^{th} and 9^{th} by all groups) and described as overly leading by members of all groups (Table 2)

The two questions that had the lowest mean (closest to being ranked first) overall were, *Can you explain to me what is going on in this problem?* (*M* = 2.53) and *What do you understand about this problem?* (*M* = 2.69). The rationales provided by participants who ranked these questions first focused primarily on the teacher accessing the student's understanding and focusing the student on the problem and their prior knowledge. Examples of these statements included:

- Finding out what the student understands so that the teacher can build from there. (Mathematics Group)
- For him to be able to concentrate on what he understands and also what is frustrating him. For him to realize the parts that can help him overcome the problem. More on what he understands than getting frustrated. He has a learning disability so to help him differentiate between what he understands and what he doesn't (Math/Sped group)
- To prompt the student to explain his view of the problem. When he realizes what he does know, it may help him get past his frustration and then focus on where he needs more math-related help. (Sped group)

The question that was ranked last (had the highest number ranking and overall mean) by all three groups was *What is 325-278?.* The rationales provided by participants who ranked this question last included:

- This question (sic) is asking the student to demonstrate (sic) procedural fluency in subtraction (sic) and has decontextualized that fluency and taken away the responsibility for deciding on [a] solution process (and turned it into a closed-middle problem in the process). (Mathematics Group)
- Removing the literacy and problem-solving components of the problem to become simple a matter of subtraction. (Math/Sped group)
- This simply gets to the task he needs to do to solve the problem. It does all the problem solving for him rather than helps him build such skills. (Sped group)

Differences

The question that showed significant differences between groups when evaluated using a Kruskal-Willis test was *If Claire has 100 more cards, how many will she have? Will that be the same as Jose?* [$\chi 2(2) = 11.37$ $p = 0.03$] with a mean rank score of 20.11 for the Math only group, 38.17 for the Sped group and 23.46 for the Math/Sped combined group. A Dunn Post Hoc test confirmed this finding. The mean score for this question for the special education only faculty was higher ($M = 8.17$) (indicating a lower rank) than the mean score for members of the math/sped group ($M = 6.4$) and the mathematics only group ($M = 6.14$) (Table 3).

Two of the rationales for the low ranking (from the special education group) included:

- To provide a strategy or model some mathematical reasoning.

- It's very leading and asks the student to use a different operation than required by the problem - I can see how it could be common core-y but for a student who is already confused leading them in a different direction seems wrong.

Although not significant there were notable differences between the groups for two questions. The first question was *Could you underline some important words in this problem*. The mean score for this question for the special education only faculty (*M* = 3.58) was lower (indicating a higher ranking) than both the math/sped group (*M* = 4.64) and the mathematics only group (*M* = 5.00). Two rationales from members of the sped group provided for ranking this choice first were:

- Understanding math vocabulary. Acquiring a sense of what the student knows around math literacy.
- Identifying academic language and using context clues.

Two rationales from members of the math/sped group provided for ranking this choice last were:

- To identify key words that lead to an association with a specific operation.
- I avoid the keyword method (too many exceptions, goes against research evidence) and teach students a more schema-based approach to problem solving.

The second question with notable differences between groups was, *Can you explain to me what is going on in this problem?*, Although all of the groups ranked this question as 1st , there was more difference (a larger mean and standard deviation) among the special education group than the other groups. One respondent (from the special education group) ranked this question as last and provided the rationale for that choice as the question was too open ended.

Table 2
Mean responses for each purposeful question as compared by teacher group

Question	*n*	*Rank*	*Range*	*M*	*SD*	*Median*
Q3. Can you explain to me what is going on in this problem?						
Total	51	1	1-9	2.53	1.77	2.00
MATH	14	1	1-7	2.00	1.71	1.00
MATH/SPED	25	1	1-4	2.52	1.60	3.00
SPED	12	1	1-9	3.17	2.08	3.00
Q5. What do you understand about this problem?						
Total	51	2	1-9	2.69	2.16	2.00
MATH	14	2	1-9	2.42	2.07	2.00
MATH/SPED	25	2	1-9	2.56	1.83	2.00
SPED	12	2	1-8	3.25	2.90	2.00
Q7. Can you draw a picture of the problem?						
Total	51	3	2-9	4.08	1.83	3.00
MATH	14	3	2-8	3.93	1.73	3.00
MATH/SPED	25	3	2-9	3.92	1.71	3.00
SPED	12	5	2-7	4.58	2.23	4.00
Q2. Is this like any other questions we have used in class?						
Total	51	4	1-9	4.35	2.13	4
MATH	14	4	3-8	4.71	1.59	4.5
MATH/SPED	25	4	1-9	4.48	2.52	5.0
SPED	12	4	1-6	3.67	1.78	3.5
Q9. Could you underline some important words in this problem?						
Total	51	5	1-9	4.49	2.26	5.00
MATH	14	5	1-8	5.00	2.18	5.00
MATH/SPED	25	5	1-9	4.64	2.31	5.00
SPED	12	3	1-7	3.58	2.15	4.00
Q1. What kind of problem is this, an addition problem, a subtraction problem, a multiplication problem, a division problem or another kind of problem?						
Total	51	6	1-9	5.67	1.99	6.00
MATH	14	6	2-9	6.07	2.13	6.5
MATH/SPED	25	6	1-9	5.68	2.17	6.0
SPED	12	6	4-6	5.17	1.40	6.00

Table 2 (continued)
Mean responses for each purposeful question as compared by teacher group

Q4. If we wanted to find out how much less which would we use subtraction or addition?						
Total	51	7	1-9	6.33	1.77	7.00
MATH	14	7	4-9	6.64	1.45	7.00
MATH/SPED	25	7	1-9	6.48	1.64	7.00
SPED	12	7	2-8	5.67	2.31	6.00
Q6. If Clair has 100 more cards, how many will she have? Will that be the same as Jose?						
Total	51	8	1-9	6.75	1.79	7.00
MATH	14	8	4-9	6.14	1.61	5.50
MATH/SPED	25	8	1-9	6.40	1.87	6.00
SPED	12	8	7-9	8.17	.937	8.50
Q8. What is 325- 287						
Total	51	9	2-9	8.31	1.26	9.00
MATH	14	9	2-9	8.21	1.85	9.00
MATH/SPED	25	9	5-9	8.52	.714	9.00
SPED	12	9	6-9	8.00	1.35	8.50

Table 3
Differences between teacher groups (Kruskal– Wallis test)

Question	*Chi Square*	*df*	*Sig.*
Q1. What kind of problem is this, an addition problem, a subtraction problem, a multiplication problem, a division problem or another kind of problem?	2.27	2	.322
Q2. Is this like any other problems we have done in class?	1.66	2	.436
Q3. Can you explain to me what is going on in this problem?	4.51	2	.105
Q4. If we wanted to find out how much less which would we use subtraction or addition?	.963	2	.618
Q5. What do you understand about this problem?	.092	2	.955
Q6. If Claire has 100 more cards, how many will she have? Will that be the same as Jose?	11.38	2	.003*
Q7. Could you draw a picture of this problem?	.908	2	.635
Q8. What is 325 minus 287?	1.231	2	.540
Q9. Could you underline some important words in this problem?	3.139	2	.208

**indicated $p<.01$*

Discussion

There is an increased need for general education teachers who teach mathematics and special education teachers to collaborate to support diverse learners in the classroom. Research has shown that effective collaboration is facilitated by a shared vision and common professional language (Fullan, 2002; Pugach & Johnson, 2012). This is consistent with Wenger's theory on social learning systems whereby *alignment* is identified as a key component of effective learning communities (Wenger, 2000). The goal of our research was to begin to examine if mathematics and special education teacher educators were aligned in the questions they chose to ask a student who was struggling with a mathematics problem.

Alignment

First, when examining the rationales for choices, we found that teachers from all three groups, with few exceptions, described the intent of the questions similarly. This indicates a common language and knowledge base about the goals of questions. Our findings showed that most participants chose, as a first question for the struggling student, one of the questions that were designed to gain more understanding about what that student knows about the problem. The large majority of teacher educators chose questions designed to encourage the student to verbally explain what they knew about the problem (n = 20), or the question cueing the student to engage with the problem and connect the problem to prior understanding (n = 20). These findings showed that teacher educators in mathematics and special education are often aligned in the way that they initiate questioning to support a struggling student. These findings are supported by the research in both fields that prioritizes both student assessment and having a student engage with a word problem by verbalizing their understanding at the beginning of a lesson (Fuchs, et al., 2008; Gersten, et al., 2009; Spooner, Saunders, Root, & Brosh, 2017; NCTM, 2014).

Teachers from all groups also collectively rejected the questions that provided the number sentence to the student. They reported that the question “told the student what to do”. Again, this reflects the best practice literature from both mathematics education and special education whereby the goals of mathematics education extend well beyond arithmetic (Gersten et al., 2009; Hiebert & Grouws, 2007; Hiebert et al., 2005; Powell, et al., 2013). Both communities seem to value, in practice, as well as research, maintaining the initial cognitive demand of tasks. Questions that remove the need to intepret the problem (what is 325 – 287?) or sought to immediately direct the student to a specific operation (What kind of problem is this? Is it an addition problem, a subtraction problem, a multiplication problem or a division problem?) were rejected by all the groups.

This apparent agreement and alignment is somewhat surprising and significant. Much of the literature cited above indicates that special education and mathematics education differ significantly in terms of both theory and practice. We hypothesized that these differences would lead to significantly different rankings for purposeful questions. However, we found, at least with this relatively small sample of teacher educators, that there appears to be substantial agreement around effective purposeful questions. Apparently, for these participants, a widespread belief in the power of direct instruction for special education students can co-exist with a belief in the importance of maintaining cognitive demand. Similarly, a constructivist emphasis on having students make sense of problems and create their own solution methods does not preclude assessing students and focusing their thinking on important mathematical relationships or important prior knowledge. Our findings indicate that extreme versions of these two communities, where special educators immediately simplify difficult problems and math educators leave students to struggle on their own with no guidance, simply do not capture the considerable overlap that may exist between these two fields.

However, this study does not allow us to describe or delimit that overlap in great detail. There seems to be a widespread tendency to begin working with students by assessing what they know, and to avoid immediately guiding them towards a specific solution; however, similar initial questions still allow for quite large differences among participants in terms of basic beliefs about the nature of mathematics teaching and learning. For example, some of our participants, might use the knowledge that they gain from initial assessing questions to implement a direct instruction approach, directing a student towards a particular solution. Others might engage in a more open-ended approach, asking students to apply their reasoning to a potential solution, for instance, or providing more access to the context.

Supporting Students: The Challenge of Language

One question where we found a difference between the groups was the question, "*Could you underline some important words in this problem?"* The special education faculty ranked this question significantly higher (3st) than the other two groups (5th). We hypothesize that this difference may be attributed to a different reading of the question based on different orientations.

Both mathematics education researchers and special education researchers have documented the importance of language, both as a tool for communicating and making sense of mathematical ideas, and as a potential barrier to access for diverse groups of students (Davoudi & Sadeghi, 2015; Gersten et al.,2017). Both communities agree that working to help students make sense of mathematical language and supporting them in learning mathematical vocabulary is an essential element of effective mathematics teaching (Doabler, Fien, Nelson-Walker, & Baker, 2012; Dunston & Tyminski, 2013; Powell & Driver, 2014). The special education community is especially attuned to the difficulties students may have with language and how that may impact their mathematical achievement (Fuchs et al., 2008*). Many special education teachers have extensive training in supporting students who struggle with language, and have a wealth of knowledge around specific language difficulties and specific strategies to support students with those difficulties. Given this, it is not surprising that special education teachers would gravitate towards a question that focuses student attention on language by having them identify important words in the problem. Identifying and clarifying important words seems like a clear way to support students in making sense of problems.

However, not all attention to language is helpful. A common strategy for teaching students how to solve word problems is the "key word" strategy. For instance, take the following problem:

> *Johnny has 15 jelly beans. Sally has 7 less than Johnny. How many jelly beans does Sally have?*

A student using the keyword strategy would read this problem, underline the word "less" in the problem and identify the problem as a subtraction problem, because "less" is a word that goes with subtraction. They would then solve the problem by creating and solving the number sentence 15 – 7 = ? Similarly, a student might use the keyword strategy to solve this problem:

> *Maria has 13 jelly beans. Keyshawn has 21 jelly beans. How many jelly beans do they have altogether?*

Using the key word strategy, a student might underline the word "altogether" and then identify the problem as an addition problem (since altogether is a word used in addition problems). The student would then create the number sentence 13 + 21 = ? and solve it to find the answer. [1]

Despite its widespread use, both special education and mathematics education researchers have rejected the key word strategy as a teaching method because it has too many exceptions and subverts meaning-making and problem solving (Jitendra & Star, 2011; van de Walle, Karp, & Bay-Williams, 2013). For example, we could re-write the problem above in this way:

> *Sally has 15 jelly beans. Sally has 7 less than Johnny. How many jelly beans does Johnny have?*

A student using the keyword strategy would underline the word less, as above, and identify this as a subtraction problem, and then do 15-7 = 8; Johnny has 8 jelly beans. However, this would be wrong, since Sally has less jelly beans than Johnny; Johnny has 22 jelly beans.

The dangers of the key-word strategy may explain why those outside the special education group ranked "*Could you underline some important words in this problem?"* lower.

[1] For more examples of the keyword strategy explained, see educationandbehavior.com or visualthesaurus.com.

Teacher-educators with more of a mathematics education background might have interpreted this question as a key word approach; indeed, the faculty who ranked this as their last choice referenced the ineffectiveness of the key-word strategy in their rationales.

Hence, perhaps one group read this question as a check on vocabulary and reading comprehension and the others as a key word strategy question. However, because most of the participants did not discuss their rationale for where they ranked this question (as it was not #1 or #9), we cannot be sure if some participants actually do advocate the keyword strategy.

Comparative Chaos

Interestingly, the greatest difference between the groups was the response to the question *If Claire has 100 more cards, how many will she have? Will that be the same as José?* Although the position of this question in the mean rankings was the same for all of the groups (8^{th}), the numerical value of the mean ranking of this question was significantly higher (indicating a less attractive choice) for the special education only group. The rationales for why participants chose this question as the least appropriate highlighted the fact that it was too complex, or misleading for the student. One teacher described it as "common-core-y". Although this question can be viewed as an attempt to present a student with a simpler problem to try (Reys, Lindquist, Lambdin, & Smith, 2014), special education research calls for mathematics instruction to be explicit and limit a students' exposure to incorrect responses (Kroesbergen, van Luit, & Maas, 2004).

This speaks to another subtle, but important possible difference between how mathematics education researchers and special education researchers define best practices in mathematics instruction. For many mathematics education researchers, mistakes are important sites for learning, providing opportunities for students to reason and make sense of important mathematical ideas. Indeed, making sense of solutions, both correct and incorrect, is a core element of mathematical thinking (Yackel & Cobb, 1996). This is intimately connected to the idea that students make sense of mathematics themselves, through reasoning and connecting what they already know with new information. This conflicts with the tradition of direct instruction, in which mistakes are to be minimized and are seen as potential sites for confusion. The teacher's role is to provide correct examples, and to correct mistakes quickly so that students are not presented with incorrect models that they might mistakenly learn to apply. Clearly, our participants who were mathematics teacher educators did not see this question as a valuable way to prompt reasoning through the analysis of an incorrect answer, but their tendency to rank it higher than the special education only group indicates that they may be more comfortable with exposing students to incorrect answers.

Survey development and next steps

The findings of this study and the additional questions raised demonstrate the need more nuanced and in- depth data collection. We anticipate making two significant changes to the survey as a result of this study. Our goals going forward include determining what the teachers anticipate the student's response to the assessing questions will be and what instructional step that teachers plan to take, and learning more about the participants' understanding of the similar but simpler problem and the key-word strategy.

Although our finding of a trend toward asking questions to assess students' understanding first is consistent with best practice methodology in the fields of both mathematics pedagogy and special education pedagogy, this first exploration revealed additional questions about what information participants were hoping to gain in order to progress to the next teaching move. Future iterations of the survey will include follow up questions to determine what participants expect the student's response to be and how the participants would react to that anticipated response.

Participants were only asked to provide a rationale for their first and last choices. There were differences between the groups on several of the questions ranked in the middle (specifically the key word question and the similar but simpler problem). The updated tool will attempt to determine the participants perspective of all of the question options.

In addition, the rationale options were open ended. As a result, some of the rationale responses addressed the purpose of the question, and others the appropriateness of the use of the question in this instance. The survey will be changed to include several options responses (based upon the responses provided by these participants), as well as an open ended "other" choice.

Limitations

A limitation of this study is the relatively small number of participants, and the relative lack of information about their backgrounds. However, Math Education faculty and Special Education faculty prepare hundreds of preservice teachers, demonstrating that even a small sample has a broad impact. This study was an initial foray into the question of how groups of teacher educators and educators at large may differ in their actual practice. Clearly, neither special education teacher educators and mathematics teacher educators are monolithic groups. Adapting the instrument to gather more nuanced information from larger groups of teacher educators and comparing the responses of different subgroups would help us better understand and begin to unpack and understand the differences between and within these groups. Examining whether teacher educators from research institutions differ significantly from those at teaching institutions, or whether teacher educators with secondary backgrounds differ from those with elementary backgrounds would allow us to answer our questions with greater nuance.

Conclusion

The findings of this study are a first step in determining where to begin strengthening understanding and alignment in the community of practice for special education faculty and mathematics education faculty. By determining how teacher educators approach a student with learning disabilities we are more able to ascertain what differences exist in practice, as opposed to theoretical differences, between two groups that share the responsibility of preparing tomorrow's teachers. Our findings show that there may be wide agreement on the importance of assessment as a first step in supporting struggling students, and on the dangers of too quickly reducing the cognitive load of the problem. These could be important ideas and practices to build on in creating a dialogue about practice with a goal of a more aligned community. However, shared first steps may hide continued differences. What teachers do after they assess may differ, depending on fundamental ideas about best practices. Our findings also suggest that differences remain between the two communities. There appear to be differences in how members of the two communities interpret and understand the importance of language and literacy, and how to best identify and support students struggling with these issues. There also appear to be differences in the role of mistakes and reasoning about those mistakes, although teachers from neither community seem eager to introduce incorrect answers in initial questions.

Our community of practice will be enriched and strengthened through continued negotiations and development of a common understanding. In order to understand and address differences, we need to engage in active dialogue with community members to ensure that our PSTs enter the field with clearly established teaching goals, knowledge of effective practices that support those goals, and a commitment to work collaboratively to support the diverse needs of the student in today's classrooms. In addition, our community of practice will be enriched and strengthened through continued negotiations and development of a common understanding of practice.

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Appendix

Case Study

Pose purposeful questions. *Effective mathematics teachers use purposeful questions to assess and advance students' reasoning and sense making about important mathematical ideas and concepts*.

Here is a problem that was posed in a third grade classroom: **John and Claire both collect pokemon cards. John has 325 cards. Claire has 287 cards. How many more cards does Claire need in order to have as many as John?**

Ms. Watson, a third grade teacher, has given this problem to her students to solve. Justin is one of her students. He has an identified learning disability. He is reading on a mid-second grade level and struggles to remember basic addition and subtraction facts. He gets frustrated easily and will put his head down during math when he does not understand something. Justin raises his hand. When Ms. Watson comes over, he says, "I don't know what to do?" Ms. Watson wants to pose a purposeful question. Which of the following is the best "purposeful question" that Ms. Watson can ask?

Q1. What kind of problem is this, an addition problem, a subtraction problem, a multiplication problem, a division problem or another kind of problem?

Q2. Is this like any other questions we have used in class?

Q3. Can you explain to me what is going on in this problem?

Q4. If we wanted to find out how much less, which would we use subtraction or addition?

Q5. What do you understand about this problem?

Q6. If Clair has 100 more cards, how many will she have? Will that be the same as Jose?

Q7. Can you draw a picture of the problem?

Q8. What is 325- 287

Q9. Could you underline some important words in this problem?