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Teacher Preparation Programs (TPPs) are able to draw upon a significant research base, as well as frameworks from professional organizations, to structure the learning environment for pre-service teachers. Effectively integrating the necessary content, pedagogical, and field elements into a typical four-year experience can be a challenge in terms of time and resources. Opportunities to observe the impact of these efforts on graduates are often sporadic and informal at best. Formalized feedback from graduates would serve as a valuable data source to reflect upon the implementation of learning opportunities for future pre-service teachers. The purpose of this study is to utilize graduates of one TPP as a resource to help inform the perceived connections between their preparation for the teaching profession and their practice as an in-service teacher.

Background

Teachers are a significant factor in what and how students learn. Hanushek (1992) argued that "the estimated difference in annual achievement growth between having a good and having a bad teacher can be more than one-grade level equivalent in test performance" (p. 108). It can be argued that one way to evaluate the quality of a teacher is the opportunity to learn that their students are afforded. For example, Hiebert and Grouws (2007) argue that "students can acquire conceptual understating of mathematics if teaching attends explicitly to concepts-to connections among mathematical facts, procedures, and ideas" (p. 383). Knowing how to effectively provide this instructional environment, the opportunities for students to learn, is not an innate ability. As Ball (2009) argues, teaching is unnatural work, and should be viewed "as a highly skilled practice, one that requires close training" (p. 508). For many teachers, matriculation through a TPP serves as one source of this training during their career.

TPPs can vary in many ways including coursework, field experiences, and length of program (Boyd et.al. 2009; Greenberg & Walsh, 2008). A common goal within this varied landscape is to provide pre-service teachers opportunities to develop their content and pedagogical knowledge that may be realized in their teaching practice. TPPs are guided in this effort via professional organizations such as The Association of Mathematics Teacher Educators (2017) and accreditation agencies such as Council for the Accreditation of Education Preparation (CAEP). For example one of the CAEP (2013) standards requires that TPP ensure "effective partnerships and high-quality clinical practice are central to preparation so that candidates develop the knowledge, skills, and dispositions

necessary to demonstrate positive impact on all P-12 students' learning and development" (p. 6).

Given the ability to apply the structure suggested by research and required by governing agencies, TPP are often in a position to be unaware of the long-term impact they have upon their graduates. One approach to examining the impact of TPPs has been a focus on program elements. Within program elements, researchers have examined course syllabi (Greenberg & Walsh, 2008) and field experiences (Boyd et al., 2009). While these data produce valuable feedback to teacher educators, there is a concern that focusing on the process of teacher preparation says, "little about what happens after candidates complete a program" (Coggshall, Bivona, & Reschly, 2012, p.12). An alternative approach in examining teacher preparation programs is to examine outcomes. Outcomes for teacher preparation programs could include examining a teacher candidate's performance on teacher certification tests (Goldhaber & Hansen 2010) and student achievement on standardized tests (Gimbert, Bol, & Wallace, 2007). More recently, researchers have shifted to look at student growth also known as a valued added measure (VAM) as means of assessing TPP outcomes.

While the value added approach provides promise in providing a common measuring tool across programs there is a concern in using this approach related to attribution error, bias, and nonrandom assignment of the graduates of teacher preparation programs to schools. In addition, "recent studies conducted by the National Center for Analysis of Longitudinal Data in Education Research found little variation in teacher training program effects as measured by VAMs, suggesting that teacher preparation programs are more similar than different in their effectiveness in terms of student test scores" (Coggshall, Bivona, & Reschly, 2012, p.13). Therefore, what is needed is a more nuanced examination of the connection between pre-service and in-service teachers that expands beyond measures such as standardized testing. As Suppa, DiNapoli, and Mixwell (2018) note, "there is very little evidence regarding specific qualities of teacher preparation programs or specific approaches to teacher training that affect graduates' specific teaching competencies and capabilities" (p. 26.)

An approach that has potential to provide insight into informing teacher preparation is to examine the ways in which current teachers apply their experiences from their TPP to their teaching practice. The work of Morris and Hiebert (2017) serves as one example of this approach. The authors examined graduates of one TPP, comparing their knowledge of mathematics topics taught and not taught in the program. Results of their work suggest that graduates were better able to apply their knowledge on topics taught within their preparation program, even five years after graduation. In a similar work, Hiebert, Berk, and Miller (2017) arrived at a similar conclusion, having recent teacher graduates complete video-based analysis of teaching tasks. These efforts suggest that data gathered from graduates of TPPs may be useful in identifying effective and non-effective elements within a TPP, and in identifying the "small sets of knowledge and skills that matter most for beginning teachers" (Morris & Hiebert, p. 555). The study described here continues this line of research by utilizing the lens of current teachers to focus on connections they perceive between their TPP and their

teaching practice. The specific research question addressed in this study is - *In what ways do teachers perceive connections between their teacher preparation program and their teaching practice?*

Methods

Participants

Participants (n=100) in the study consisted of practicing or recently practicing teachers who graduated with either an elementary (PreK-4th) and/or middle grades (4th-8th) teaching certification. The participants were recruited via email using an alumni database. The participants graduated from the same undergraduate preparation program within the past nine years of collection of the data. Limiting the participants to this time span made it more likely that their experiences in this TPP would be similar.

The TPP in this study offers a PreK-4th certification, where graduates are certified to teach all academic subject areas. The 4th-8th grade certification allows teachers to teach in all areas 4th-6th and must choose one or two content areas in which to concentrate. Within the area of content concentration, additional course work is taken and allows these teachers to teach these content areas on the 7th-8th grade level. The PreK-4th program requires a minimum of two-mathematics content and one mathematics methods course. The PreK-4th mathematics methods course does not have a field placement. The 4th-8th certification requires a minimum of two mathematics content and two mathematics methods courses, one for elementary and one for middle. The middle grades methods course does contain a field placement. If a middle grades teacher chooses to focus in mathematics, they take a minimum of five content courses and the two mathematics methods courses previously mentioned. Mathematics educators teach all methods courses. However, the content courses may be, but are not necessarily, taught by mathematics educators. Table 1 lists the certifications currently held by the participants and Table 2 describes the grade(s) level currently teaching.

The total count in Table 2 is greater than the number of participants due to the fact many of the teachers instruct on multiple grade levels. Teachers reporting other were either substitute teaching (2), had taught math but were not currently doing so (4), or working in early or special education intervention (2).

Table 1

Certification Types

Certification	Count
PreK-4th	58
4th-8th	35
PreK-4th and 4th-8th	7

Table 2

Grade Level(s) Currently Teaching

Grade Level(s)	Percent	Count
PreK	3.0%	4
Kindergarten	8.3%	11
1st	9.8%	13
2nd	9.8%	13
3rd	7.5%	10
4th	8.3%	11
PreK-4th Total		*62*
5th	7.5%	10
6th	8.3%	11
7th	13.5%	18
8th	15.0%	20
5th-8th Total		*59*
High School	2.9%	3
Other	6.0%	8

Data Collection

The first round of data was collected using an electronic survey (Qualtrics). The survey data (n=100) was collected over a two-month period of time. The survey collected data on the participants' educational and professional background, including area(s) of certification, current teaching position, and time spent teaching mathematics on a weekly basis. The survey asked the participants to rate, using a Likert scale, how they perceived their undergraduate TPP prepared them in each of the areas listed in Table 3. The Likert choices for teachers' choices were well prepared, moderately prepared, slightly prepared, and not well prepared.

Table 3

Areas Where Teachers Rated Their TPP

Area	Category
a) Overall preparation	
b) Developing a growth mindset	Disposition
c) Developing a positive attitude for problem solving and perseverance in mathematics	Disposition
d) Conceptual knowledge of mathematics	Disposition
e) Developing and implementing formative and summative assessments	Practice
f) Creating mathematical models for instruction	Practice
g) Creating effective mathematical tasks	Practice

The six areas, not including overall preparation, were divided into two categories. The first category consisted of development of disposition related to learning and teaching mathematics. In Table 3, b, c, and d are representative of this category. Conceptual knowledge of mathematics was placed in this category with the understanding that a certain intellectual curiosity, disposition, was needed in development of this knowledge. The second category consisted of practice-based knowledge, things that teachers do. In the table above, e, f, and g represented this category. Participants were able to provide further detail on their rating in an open-ended section of the survey (see Table 4).

Table 4

Short Answer Questions

a) Describe an experience during your pre-service teacher preparation program in the area of mathematics content or mathematics pedagogy that has impacted/influenced your current instructional practices.
b) Are there any other areas in which you felt strongly prepared to teach mathematics based on your pre-service experiences?
c) Describe an experience you encountered during your in-service teaching of mathematics where you felt your pre-service could have better prepared you.
d) Are there any other areas in which you would recommend increased focus in your undergraduate teacher preparations program in the area of mathematics pedagogy or content?

Four teachers were asked to participate in a follow up interview based on their responses to the survey. These four teachers were chosen as they represented specific cases where their responses indicated that they felt overall either a) well prepared, b) mixed but leaning towards well prepared, c) mixed but leaning towards not well prepared, and d) not well prepared. In the interviews, these four teachers were asked to elaborate on their answers from the survey and provide suggestions on ways in which their experience in the TPP could be improved. The interviews served to further clarify any trends that emerged in the initial data collection.

Data Analysis

Analysis of the data began with organizing the educational and professional data. The second stage of data analysis focused on responses to the Likert scale questions. Each Likert choice was assigned a value from one to four (e.g. not well prepared was assigned one). Mean scores and frequency percentages were calculated. The third stage of data analysis focused on responses to short answer questions. An open coding approach was applied, in which specific word(s) were highlighted and grouped into categories. Definitive codes then emerged from these categories. Efficacy of the codes was supported by having a researcher that was not part of this project review the codes and provide input into areas where additional clarity was needed. The fourth stage of data analysis focused on responses to the interviews. After transcribing the interviews, the data was analyzed using the codes developed from the open-ended analysis.

Results

One hundred PreK-4th and/or 4th-8th grade certified graduates currently or recently employed as teachers responded to the survey request. Of this group, 46% were teaching in the PreK-4th grade span and 44% teaching in the 5th-8th grade span (see Table 4). Given that it is possible to be an elementary or middle grades teacher and not be assigned to teach mathematics, it was a welcome result to find that the majority of the responding teachers were currently involved in mathematics instruction (see Table 5). For the 12 teachers that indicated they were not currently teaching mathematics, I was able to confirm that nine had taught mathematics since graduation. For the remaining three (all PreK-4th) that I was unable to establish if they had taught mathematics, their responses were removed from the data.

Table 5

Participants Weekly Time Spent Teaching Math

Hours Per Week	Percentage of Time	Count
0	11.88%	12
1 to 3	16.83%	17
4 to 6	33.66%	34
7 to 10	15.84%	16
More than 10	20.79%	21
Other	1.00%	1

Likert Responses

The results from the Likert section suggest that majority of the teachers felt prepared across the seven areas surveyed (see Table 6). Across all areas, the mean scores were greater than or equal to 2, which was the indicator for moderately prepared. When comparing the areas

related to disposition (b, c, and d) to areas related to practice (e, f, and g), the areas related to disposition had overall higher mean scores. The exception to this pattern was creating and implementing assessments, which had a mean score more in line with the areas related to disposition. Two areas where participants rated themselves particularly well prepared was in growth mindset (60%) and developing a positive attitude towards problem solving and perseverance (48%). Teachers also indicated they were very well prepared (47%) in conceptual knowledge of mathematics. In the areas of creating models and tasks for instruction, there was a trend suggesting a need for an increased focus in preparation. These two areas showed the lowest overall response of very well prepared, 31% and 25% respectively, and both have lowest overall mean scores (2) of all seven areas.

Table 6 also includes a break down for teachers holding PreK-4th (E), 4th-8th (M), and both PreK-4 and 4th-8th (EM). When the top two categories are combined, very well prepared and moderately prepared, teachers holding 4th-8th certification ranked themselves as more prepared than PreK-4th in five of the seven categories. The two categories where PreK-4th ranked higher than 4th-8th certified teachers were in the area of practice, developing and implementing formative assessments and creating mathematical tasks. PreK-4th certified teachers were more likely to indicate that they were not well prepared, ranking higher in five of the eight categories. In the categories of developing and implementing formative assessments and creating mathematical tasks, both PreK-4th and 4th-8th ranked at the same percentage for not well-prepared. The small group of teachers who held both certification had zero responses in either the slightly or not well-prepared categories.

In addition to certification type, another variable that may influence a teacher's response to the Likert questions is years of service. The data suggested for most of the categories' minor differences across years of experience. For example, Table 7 shows that in the area of conceptual knowledge of mathematics teachers with six or more years of service indicated being slightly well prepared at a higher rate than the other categories for years of service. One area that did show a more significant difference across years of service was growth mindset. As seen in Table 8, teachers with three or less years of service suggested feeling better prepared in the area of growth mindset than teachers with more than three years of experience.

Table 6

Response to Likert Questions

Question	Very Well Prepared (3)	Moderately Prepared (2)	Slightly Prepared (1)	Not Well Prepared (0)	Mean Score
a) Overall preparation	43% E=44% M=38% EM=75%	46% E=44% M=54% EM=25%	8% E=8% M=8% EM=0%	2% E=2% M=0% EM=0%	2.3
b) Developing a growth mindset	60% E=63% M=58% EM=100%	25% E=19% M=33% EM=0%	10% E=12% M=5% EM=0%	5% E=7% M=5% EM=0%	2.4
c) Developing a positive attitude for problem solving and perseverance in mathematics	49% E=45% M=50% EM=100%	40% E=38% M=44% EM=0%	8% E=12% M=6% EM=0%	3% E=5% M=0% EM=0%	2.3
d) Conceptual knowledge of mathematics	47% E=43% M=49% EM=100%	45% E=43% M=46% EM=0%	6% E=10% M=5% EM=0%	2% E=3% M=0% EM=0%	2.4
e) Developing and implementing formative and summative assessments	40% E=44% M=28% EM=75%	49% E=48% M=56% EM=25%	7% E=5% M=14% EM=0%	4% E=3% M=3% EM=0%	2.3
f) Creating mathematical models for instruction	32% E=32% M=24% EM=75%	46% E=38% M=65% EM=5%	17% E=23% M=8% EM=0%	5% E=7% M=3% EM=0%	2.1
g) Creating effective mathematical tasks	26% E=28% M=19% EM=75%	54% E=59% M=67% EM=25%	15% E=26% M=8% EM=0%	5% E=6% M=6% EM=0%	2.0

Notes. E=PreK-4th, M=4th-8th, EM=PreK-8th

Table 7

Responses By Years Teaching for Likert Question Related To Conceptual Knowledge Of Mathematics

Years Teaching	Very Well Prepared	Moderately Prepared	Slightly Prepared	Not Well Prepared
Less than Three Years	44%	48%	6%	2%
Three to Six Years	44%	53%	0%	3%
Six or More Years	46%	36%	18%	0%

Table 8

Responses By Years Teaching For Likert Question Related To Growth Mindset

Years Teaching	Very Well Prepared	Moderately Prepared	Slightly Prepared	Not Well Prepared
Less than Three Years	78%	20%	2%	0%
Three to Six Years	40%	42%	18%	3%
Six or More Years	50%	20%	20%	10%

Open Responses

Teachers' responses to the open-ended and interview questions broadly fell into two categories. The first category focused on areas in which teachers perceived positive connections between their TPP experience and their teaching practice. The second category focused on areas in which teacher perceived a disconnect. Patterns within each of these categories in term of certification held, years of teaching experience, and areas of disposition verse practice were examined.

Responses supporting connections. An area where teachers indicated a strong connection between their TPP experience and teaching practice was conceptual understanding of mathematics. Teachers referred to specific learning experiences that connected to their current teaching practice. For example, one teacher referred to an experience deriving the surface area of a sphere by peeling an orange.

> Surface area of spheres with an orange! This activity that was one of many that helped me to look at mathematics in a completely different way. This helped me to understand better how to teach my students the 'why' behind a problem rather than learn to just memorize a formula. (4th-8th, four to six years of experience)

The connection made by this teacher between developing conceptual understanding and the impact on their approach to mathematics instruction was a pattern seen in other teachers' responses. Responses related to conceptual understanding also indicated influencing their disposition towards learning and teaching mathematics. There were examples of this pattern across certification levels and years of experience.

> I remember my "Teaching Math" course and modeling adding fractions in word problems. I had never seen the method used before (ex: 1 and 3/5 + 3/10) to find the answer strictly using models. I had only known to find a least common denominator and go on from there. This was the first time I remember learning the more conceptual side of math. Once I was in the classroom, I took an interest in building my own conceptual knowledge and found that it greatly changed my math instruction. (PreK-4, more than six of experience)

A second area where teachers suggested a connection between their pre-service preparation and current teaching practice was developing a positive attitude for problem solving and perseverance in mathematics. In several examples, this was framed in experiences that challenged their previous conceptions of mathematics that affected their growth as an educator. Responses in this area focused on moments of reassessing their beliefs about mathematics and about themselves as mathematicians.

> During an upper level mathematics course, taught by Dr. X, I learned the importance of perseverance and making mistakes. As a child, I often noted myself as "not good at math." After taking this course, I realized this idea was one I imposed on myself because I did not have the natural skill set to persevere past difficult mathematical situations/problems. Not only did I gain new techniques for teaching skills, but I gained a perspective that I take to my classroom each day. It is not mystery to my students that mathematics is a content area I must push myself in more than others. Each day I make mistakes. But the perseverance I gained in this course gave me the confidence to share and model the importance of working through difficult, complex problem solving in my own classroom. I feel this honesty with my students is one of the reasons we have been successful this year as students of mathematics. (PreK-4tht, three years or less experience)

Responses indicating relating positive connection between TPP and their current teaching practice in the area of perseverance were balanced across grade levels, but were more likely to be included in responses from teachers with six or less years teaching experience. A similar patter occurred when looking at responses indicating a positive connection between their TPP and teaching practice in the area of mindset. Of the ten teachers that directly discussed mindset, none were in the category of six or more years teaching. For this teachers that did mention mindset, they indicated that it influenced their own disposition towards learning mathematics and influenced their instruction. "I think the growth mindset focus has really helped me, because I know that I can grow and learn as I develop as a teacher and I can model that for students" (PreK-4th, three years or less experience).

Responses indicating a disconnect. Results of the data analysis also suggested two categories in which teachers perceived a need for greater preparation. The first category focused on teaching skills needed to support instruction. The second area focused on a lack of practicum-based experiences in their TPP. Patterns within each of these categories in term of

certification held, years of teaching experience, and areas of disposition verse disposition were examined.

Teachers' response indicated a need for greater instruction in their TPP that focused on exposure to and application of curricula materials and instructional approaches. For example, one teacher focused on the need to learn more about "math workshop since a lot of schools are moving toward this concept" (4th-8th, three years or less experience). Another teacher suggested the need for exposure to mathematics curriculum materials.

> I feel there needs to be a course or a partial course that introduces undergrads to the popular curriculums that are out there. There are MANY programs being used all over and most training only occurs when a program is first purchased. There needs to be a means for fresh teachers to be introduced to these programs. (PreK-4th, more than six years).

The second area in which teachers perceived a need for greater preparation was on practicum experiences. Teachers focused on wanting opportunities to observe and implement content and practices addressed in their university classes. Responses suggested that these experiences would best be initiated prior to their formal student teaching experience. For example, "I wish there was a math practicum, similar to reading practicum. I felt that I had more hands-on experience teaching reading but not necessarily with math" (PreK-4th, three years or less experience). A similar response was provided by a 4th-8th grade certified teacher.

> Overall, I wish I had more experience teaching mathematics before I went into my current position. I wish that in my observations, it was a requirement to teach a math lesson in the classroom with an observation attached to it, like in student-teaching. I had the opportunity to only be observed in a language arts classroom, but never in a math classroom. I would have liked to have done the pre, during, and post observation standards that are utilized in evaluations for teachers. (4th-8th, three years or less experience)

Discussion

Limitations

Prior to considering the implications of the results of the study, the potential limitations should be acknowledged. While responses from the graduates provided valuable data, this sample represents less than 10% of the teachers graduating from this TPP over the past nine years. A larger sample, more purposely chosen, may provide additional insights. There may also be a skewed response rate in favor of graduates who viewed their experience in this TPP or experiences with the principal investigator (who is a mathematics educator at the TPP) in a positive light. Future studies may benefit from utilizing a neutral researcher in the collection of data. Given these potential limitations, the data indicate interesting and potentially useful trends.

Experiences Matter: Part One

Based upon mean score, teachers in this study were more likely to perceive connections between their TPP and teaching practice in areas related to disposition than in areas related to practice. However, this pattern does not hold when looking at teachers by certification level.

Teachers whose certification was in the 4th-8th grade span ranked themselves highest in all three disposition categories, where teachers in the PreK-4th grade level ranked their connection highest in two of the content areas. It may be that the additional coursework in mathematics that 4th-8th grade certified teachers took afforded opportunities to continue their growth in these areas. This may be particularly evident in the area of mindset. A potential explanation is the use of Mathematical Mindsets by Jo Boaler, first used starting in 2015, as a reading for a capstone course taken largely by 4th-8th grade certified teachers. This may account for more recent 4th-8th grade certified teachers suggesting they feel better prepared in the area of mindset.

What may be particularly useful is identifying the attributes of experiences teachers from both certification groups identify as positively impacting their disposition towards mathematics. A pattern that emerged was teachers identifying specific experiences that simultaneously challenged teachers 'content knowledge and views of themselves as learners of mathematics. An example of this experience may be the activity described by one participant where the formula for the surface area of a sphere was derived by peeling an orange. This suggests that pre-service learning experiences during math methods courses appear to be most impactful when they prompt pre-service teachers to make personal connections to their own understanding of mathematics, including how they learned math throughout their K-12 educations. This is a significant finding for mathematics educators in terms of considering the importance of creating learning opportunities for pre-service teachers. This finding also suggests that making personal connections to math content and skills may also be key to teaching young learners in more powerful and effective ways. This finding is also significant in that we as mathematics educators may not be aware of which of the learning opportunities are and are not creating these long-term impacts, and this further supports the need to seek feedback from our graduates.

Experiences Matter: Part Two

While the additional coursework taken by 4th-8th grade certified teachers may help to explain difference in responses, an additional factor that should be considered is the role of a field placement. Teachers in the 4th-8th certification span from this TPP participate in mathematics specific field placement, where PreK-4th do not have this as an element of their mathematics methods course. One possible consequence for this additional coursework and field experience is that 4th-8th certified teachers may be more likely to have built connections to areas in this study related to practice. However, the results of the study indicate otherwise. Teachers in the PreK-4th certification level suggested their connection to developing and implementing formative and summative assessments and creating effective mathematical tasks at a higher rate than 4th-8th grade certified teachers. Only in the area of creating mathematical models for instruction did 4th-8th grade teachers suggest a connection at a higher rate.

One possible explanation for the above result may be found in a common theme within the open ended and interview data related to field placements. Across certification levels and years of experience there was a common request for additional time teaching mathematics. This was of particular interest as the 4th-8th grade

certified did participate in a dedicated mathematics field experience. It may be that interpreting field placements and experience teaching mathematics as synonymous may be an error. The experiences that teachers wanted in their TPP may have less to do with time spent in a classroom, but instead with experiences applying knowledge learned in their own methods classroom. This would align with Ball's argument that, "situating teachers' learning in practice is less about where the learning takes place than it is about whether it is centered in the work of teaching itself" (2009, p.506). For this specific TPP, and for other TPPs, is an interesting finding that may be considered in designing opportunities for pre-service teachers to apply their knowledge related to teaching.

Conclusion

The design of this study provides an opportunity for one teacher educator to focus on the graduates of one specific program, but the results may be informative to other mathematics educators. Findings from this study suggest that the learning opportunities that mathematics educators provide pre-service teachers can have lasting impacts on their teaching practice. This appears to be more likely if pre-service teachers are prompted to make personal connections to their own understanding of mathematics. The results also support the need to increase opportunities for pre-service teachers to apply the skills of teaching, whether this be in a field placement or in another learning environment. Lastly, the results of this study may be best presented as an opportunity to reflect on how to utilize the resource of our graduates to help inform our own instruction. It is in the success of our graduates that mathematics educators can gauge the effectiveness of our own practice.

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