

Faculty Perspectives and Values Toward Mathematics and Science Content Information Used in Teacher Preparation Admissions Processes

David Slavit

Amy Roth McDuffie

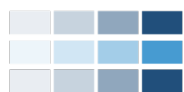
Nicole Griggs

Dan Goldhaber

Roddy Theobald

June 2023

WORKING PAPER No. 285-0623



CALDER

National Center for Analysis of
Longitudinal Data in Education Research



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David Slavit

Washington State University Vancouver

Amy Roth McDuffie

Washington State University

Nicole Griggs

Washington State University

Dan Goldhaber

American Institutes for Research / CALDER

University of Washington

Roddy Theobald

American Institutes for Research / CALDER

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Acknowledgments

This research was supported by the National Science Foundation, DUE # 1950030. The contents do not necessarily represent the views of NSF.

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CALDER • American Institutes for Research
1400 Crystal Drive 10th Floor, Arlington, VA 22202
202-403-5796 • www.caldercenter.org

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Abstract

This qualitative study examines the information collected about applicants to mathematics or science teacher preparation programs (MSTPPs) and how university faculty perceive and value this information in admissions decisions. Based on document review and interviews with MSTPP faculty and admissions directors, we found that broad measures of mathematics and science content background (e.g., achievement test scores, past mathematics and science courses taken) were used more frequently than information on applicants' specific mathematics and science content knowledge and dispositions. In many cases, application components (such as interviews and personal essay statements) were perceived by faculty to be conducive to surfacing applicants' content knowledge and dispositions; however, they were not constructed or employed in a way that afforded the obtainment of this information. We highlight salient examples of MSTPPs' collection and use of information related to mathematics and science and discuss implications for TPP admissions processes.

1. Introduction

This study examines the information collected about applicants to mathematics or science teacher preparation programs (MSTPPs) and how university faculty perceive and value this information in admissions decisions. Although research on admissions to teacher education programs (TPPs¹) can be traced back to the 1950s (Stripling & Horton, 1954; Stout, 1957), the actual information gathered about applicants and the processes used in the selection of teacher candidates has not received much attention from researchers. For example, while we know content admissions standards vary widely in TPP programs across the U.S., there is limited evidence on how content is judged or given importance by those involved in admissions decisions (Casey & Childs, 2011; Kajander et al., 2013; Levine, 2006).

The lack of information on TPP admissions processes has not gone unnoticed. For instance, in a review of TPP entry requirements in seven countries across northern Europe, Australia, and the United States, Parker (2018) called for more attention to TPP admissions processes, arguing “there is relatively little academic work dedicated to initial teacher education entry requirements *per se*” (p. 3, italics in original). Indeed, it is not clear if enacted processes reflect espoused goals for identifying effective teachers (Klassen et al., 2020) or rely on evidence-based methods (Klassen & Kim, 2021). Concerns about TPP admissions processes have also been raised regarding overreliance on test- and course-taking skills, overemphasizing writing, ill-designed interviews, or narrowly defining the role of a K-12 educator (e.g., a content provider or curriculum enactor) (Bowles et al., 2014). Given the abundant evidence that teachers have profound effects on both short- and long-term student outcomes (e.g., Chetty et al., 2014) and the importance of TPP admissions processes as a gateway to the teaching profession, further

¹ When discussing teacher education programs generally, we use TPP; the term MSTPP is used when discussing programs that contain a focus on mathematics or science.

research is critical, particularly in our current era of teacher staffing challenges (Fuller, 2022; Goldhaber et al., 2022).

The knowledge base about how and whether these processes comport with TPP faculty values is similarly quite limited. Childs & Ferguson (2015) address this issue in an analysis of TPPs in Canada, identifying a set of “problems” that TPP admissions processes are meant to solve. One such problem was the TPPs’ filtering for inadequate content knowledge, skills, and/or attitudes of potential teachers. They noted that, by addressing these attributes, TPPs can enhance their understandings of the nature of their applicants’ content knowledge, as well as clarify their own content expectations for applicants at both the entry and exit points of the TPP. Such information could help MSTPPs improve the development of content knowledge useful for teaching mathematics and science, which would ultimately impact the nature and quality of the teacher workforce. However, they caution that some content-related expectations, such as those for content specialists and secondary content teachers, lead to a situation where:

It is possible that some applicants may have the academic and other skills needed to succeed within the program, but may not have – and will not have the opportunity to gain during a one- or two-year program – knowledge, skills, and/or attitudes that will be needed when they enter the profession. (Childs & Ferguson, 2015, pp. 425-426)

Research related to the role and impact of content knowledge as admissions criteria is especially needed, as content knowledge understanding is a major component of modern teacher education accreditation standards for both practicing (e.g., National Board for Professional Teaching Standards), and future (e.g., Interstate New Teacher Assessment and Support Consortium) teachers. Such standards seem reasonable given that content knowledge has

important implications on the nature and quality of instruction, particularly in mathematics (Hill et al., 2008) and science (Kang et al., 2018). For example, Corven et al. (2022) found relationships between the mathematical preparation of teachers and their effective use of this knowledge as classroom teachers. On an international level, data obtained through the Teacher Education and Development Study in Mathematics (TEDS-M) revealed wide variance across countries regarding the level of mathematics required for TPP admissions (Tatto et al., 2012). Because TPPs play a key role in the content preparation of future teachers, it is important to understand the ways in which content knowledge impacts TPP admissions decisions.

2. Purpose

Our research focuses on the nature of the information collected during MSTPP admissions processes, and how information related to mathematics and science is perceived and valued by MSTPP faculty. Our analysis focuses on perceptions and values related to content background, knowledge, and dispositions. We attempt to distinguish the notions of knowledge and dispositions but combine these constructs in our research questions and analysis for multiple reasons. Specifically, knowledge and dispositions were interwoven in many of the admissions documents and processes we examined, as well as in several of the comments made by the faculty we interviewed. The majority of these instances involved content-related dispositions (e.g., a disposition towards teaching science as either inquiry or knowledge to be learned) that further combined these constructs.

We examined information collected and used in MSTPPs housed within five universities in the northwestern United States. The MSTPPs in our study consisted of elementary certification programs as well as middle- and secondary-level mathematics and science programs at both the undergraduate and graduate levels. We targeted these programs because of the important and often interconnected roles of mathematics and science in the K-12 curriculum, and

the specific role mathematics content considerations play in MSTPP selection (e.g., standardized tests of mathematics knowledge). Our research questions are:

1. As part of the admissions process, what information do MSTPPs collect from applicants with respect to mathematics and science content background, knowledge, and dispositions?
2. What perspectives do faculty hold regarding the information MSTPPs collect on applicants' mathematics and science content background, knowledge, and dispositions?
3. How do MSTPP faculty and programs value the information on applicants' mathematics and science content background, knowledge, and dispositions used in the admissions process?

3. Research on MSTPP Admissions Processes

3.1 *The TPP Admissions Process*

Childs and Ferguson (2015) define the TPP admissions process as “the process by which a program decides which of the individuals who apply may attend” (p. 421). We operationalize this definition to include application components (e.g., application forms, interviews, essays), information collected through these components (e.g., GPA, prior coursework, test scores, applicant demographics), selection criteria, and decision-making processes.²

Calls for increased scrutiny of teacher admissions processes go back decades (e.g., Barnard & Thornburg, 1980; Watts, 1980). There are claims that teacher education admissions standards are too low (Laman & Reeves, 1983) or that TPPs inadequately prepare teachers for classrooms (Greenberg et al., 2013), but the evidence supporting these views is limited (e.g.,

² In our larger project, recruitment is also included in the definition of admissions process. However, recruitment was not part of this particular study.

Cochran-Smith et al., 2017; Ishler, 1984). Disputes about TPP admissions standards exist in part because very few research studies have attempted to understand the precise ways in which TPPs use admissions data in their decision-making processes. Because links exist between teacher effectiveness and teacher candidate performance on metrics such as licensure tests (Goldhaber, 2007; Goldhaber et al., 2017), research that sheds light on the entry points to TPPs seems vital.

In our exploration of the literature, we found prior work related to two categories of information collected in MSTPP admissions processes related to our research questions: (a) content background, and (b) content knowledge and dispositions. We organize the review of the literature around these categories.

3.2 Relationships Between Content Background and Prospective Teacher Outcomes

In this study, we refer to content background as information readily available on most applications that provides insight on applicants' content-related experiences, abilities, or accomplishments. This includes information on past courses taken, GPA, and test scores. There is very little research on how information on content background is collected and used in the admissions process. Most studies have sought connections between content background and eventual teaching success.

Role of Prior Coursework

The evidence connecting prior coursework to later teacher outcomes is quite mixed. In a meta-analysis of the relationship between content knowledge and teacher qualification, Ahn and Choi (2004) noted the problematic nature of the assessments often used to measure teacher content knowledge, casting doubt on prior research. Lowrie & Jorgensen (2015) found no relationships between prospective teacher candidates' past mathematics coursework and their associated beliefs and attitudes related to inquiry-based teaching. By contrast, Monk and King

(1994) found that the number of undergraduate science, technology, engineering, and mathematics (STEM) courses a teacher takes is positively correlated with how well their students perform on mathematics and science tests, respectively. Boyd et al. (2009) found that beginning elementary teachers from TPPs that required mathematics courses were more effective in teaching mathematics. However, when Harris and Sass (2011) accounted for measures of precollege ability, they found no significant relationship between number of courses taken by prospective teachers and the achievement of their eventual secondary mathematics students.

Role of GPA

Overall, research suggests little relationship between GPA and eventual instructional success. Wilson and colleagues (2002) found that education coursework was a better predictor of student teaching success than incoming GPA. Casey and Childs (2011) also found little relationship between GPA and teacher candidates' preparedness to teach mathematics. While they caution that more research is needed, they claimed that GPA was not predictive of candidates' preparedness for promoting student learning, critical thinking, and use of technology. Hobson and colleagues (2018) found more extensive issues with the use of GPA, stating that "the 3.0 GPA rule provides little to no room for individuality of the special missions or foci of the diverse teacher education entities or meeting needs of individual learners" (p. 4).

Role of Achievement Tests

Achievement tests as measures of potential teaching performance have long been questioned (Zwick, 2013). McGraw and Fish (2018) found that large-scale measures of academic achievement did not reliably predict candidate success in the MSTPP programs they studied in Australia. Further, when these measures were not considered, they no longer acted as gatekeepers to admissions, and the change led to the enhanced use of other criteria. While harder

to assess than large-scale achievement measures, and often dispositional, these MSTPPs instead used “qualities of character” they felt to be more relevant to potential classroom practice. On the other hand, several studies found associations between some licensure tests and teacher effectiveness (Goldhaber et al., 2017; Clotfelter et al., 2010).

3.3 Content Knowledge and Dispositional Information Collected and Used in TPP

Admissions Processes

Content knowledge and dispositions are different but closely-related analytic constructs. Most of the research in this area has focused on candidate dispositions and was conducted in general contexts applicable to all TPPs (i.e., it is not focused on MSTPPs). Dispositional measures tend to be non-cognitive attributes of teacher candidacy involving affective, relational dimensions of teaching (Klassen & Kim, 2021). Helm (2006) provides a lengthy list of teacher dispositions that includes constructs such as kindness, caring, decency, pro-social behavior, trust, and empathy. Broader constructs include a sense of community, having high expectations for students and themselves, teaching students to think critically, having a strong work ethic, and having an appreciation of cultural diversity and social justice. Dispositions are becoming more frequently considered in TPP admissions processes, but because they are ill-defined (Borko et al., 2007; Choi et al., 2016) they have proven quite elusive to both assess and apply (Casey & Childs, 2011; Klassen & Kim, 2019; Klassen et al., 2020; Welch et al., 2010).

Over 30 years ago, Goodlad (1990) explored the role of dispositions in teacher education admissions processes, calling for the identification of candidates already equipped with the “initial commitments to the moral, ethical and enculturating responsibilities to be assumed” (p. 284). This notion led to a “Portrait of a Teacher” (Jacobowitz et al., 2000) as a model for the dispositions that candidates should have prior to application. This model assumed that acquiring

such dispositions during the brief years in a TPP is an unreasonable challenge (Jacobowitz, 1994). The approach of identifying and screening for a comprehensive list of predetermined, desirable teacher education candidate dispositions has been challenged by more recent work (Borko et al., 2007; Childs et al., 2011; Deluca, 2012; Holden & Kitchen, 2018). Specifically, these researchers view dispositions in more contextual, multi-dimensional ways and promote more flexible approaches to the assessment of candidate dispositions.

Given the somewhat elusive nature of various dispositions, it is not surprising that TPPs' efforts to develop ways of assessing dispositions are found infrequently in the literature (e.g., Al Hashmi & Klassen, 2020; Fallon & Ackley, 2003). The evidence suggests that TPP admissions data that incorporate dispositions are not easy to obtain, even when qualitative tools including interviews, written responses such as essays, and simulated classroom role play are used. Klassen and colleagues (2020) suggest that measures of dispositions from other fields be incorporated into TPP admissions processes. Specifically, situational judgement tests involve a context (such as a classroom situation) and several possible reactions or responses to the context. They found in the United Kingdom that assessments involving situational judgements measured dispositions better than other, more common assessment tools, such as interviews and essays. Kaufman and Ireland (2016) have argued that simulations, similar to situational judgement assessments, can be a tool for enhancing TPPs' assessments of candidate dispositions, including the use of simulated classroom activity and other potential student-teacher interactions. On the other hand, Choi and colleagues (2016) showed poor reliability when measuring dispositions generally, though there was better success with measures of high-level dispositions (such as "responsibility") than when trying to measure more fine-grained dispositional components (such as "takes initiative in defining and completing tasks").

Interviews are a common tool used to assess dispositions, but evidence on their effectiveness is also mixed (Caskey et al., 2001). Petrarca and LeSage (2014) asked:

If the admission interview process admitted individuals who were not successful in the program, then ostensibly the admission interview process may have rejected individuals who could have flourished in the program, and as teachers (p. 255).

There is evidence that some interviewers make early impressions of candidates, then spend the remaining interview trying to confirm them (Caskey et al., 2001).

3.4 *Summary of the Research on Content Background, Knowledge, and Dispositions*

In summary, the bulk of the available research on content-related information of PSTs has been on the reliability of broad, quantitative measures (e.g., GPA, achievement tests) (Casey & Childs, 2011; Hobson et al., 2018) with respect to candidates' eventual teaching effectiveness, and calls for the increased use of measures of candidate dispositions in the admissions process (Klassen et al., 2020; Kaufman & Ireland, 2016). We know that teachers' content knowledge influences the ways they support student development of content knowledge and understanding, particularly in mathematics (Boaler & Staples, 2008; Fennema et al., 1996; Hill et al., 2008) and science (Kang et al., 2018; McConnell et al., 2013). Further, specific forms of mathematics knowledge (Ball et al., 2008) support teachers in enacting currently recommended pedagogy, such as facilitating mathematics conversations (McDonald et al., 2013). Hence, there is a clear need for research that investigates the nature and role of the mathematics and science content knowledge and dispositions identified and used by evaluators (i.e., those faculty and staff tasked with admissions decision making) when making TPP admissions decisions.

4. Methods

This qualitative study analyzed the types of components collected and used by MSTPPs in admissions processes (e.g., application forms, essays, transcripts), information related to

mathematics and science collected about candidates through these components (e.g., GPA, test scores), and the ways in which MSTPP faculty perceive and value this information when making admissions decisions. This study is part of a larger mixed methods research project exploring connections between the attributes of potential teacher candidates, their admittance and enrollment in MSTPPs, and their later effectiveness and retention as mathematics and science teachers.

We targeted admissions documents in our analysis as well as interviews with teacher education faculty at five universities in a northwestern, U.S. state. Because some universities had MSTPPs at multiple locations, eight campuses comprised our research sites, with a total of 31 MSTPPs that aligned with the focus of our study (Table 1). The MSTPPs included the following numbers of programs by type: undergraduate (9), masters (14), and alternate certification (8). Among these programs, 18 focused on elementary and 13 focused on secondary mathematics and/or secondary science (with admissions processes often shared across mathematics and science). The MSTPPs ranged from highly selective (i.e., admitting about half of applicants) to nearly open enrollment (i.e., admitting almost all applicants who were already admitted to the university, subject to background checks). The main foci of many of the alternative certification programs was multilingual instructional support and the certification of paraeducators or “teachers of record”.

4.1 Data Collection

We collected admissions documents for all 31 MSTPPs, including application forms, interview protocols, scoring rubrics, process check sheets, and additional information available on university websites. To do this, we worked with key contacts (including admissions directors) at each institution in identifying a complete list of MSTPPs at each site, and then with a variety of additional institutional contacts (including faculty, staff, and administrators) to determine a

complete list of documents required of applicants and used by each individual MSTPP. The current versions of each admissions document were then secured and organized by campus, and then by program. We also conducted 20 semi-structured interviews with four mathematics and science education and/or content faculty from each of the five institutions. Faculty self-identified their areas of representation, which included six faculty from mathematics education, three from mathematics, six from science education, and five from science. These categorizations are not well-defined, and some faculty did not clearly fit into a single category based on appointment and courses instructed.

The 45- to 60-minute faculty interviews provided information on how faculty interpreted and made use of admissions data. They also provided specific information on mathematics- and science-related aspects of the MSTPP admissions processes, including which aspects faculty valued, the specific roles they had in the admissions process, and how they used content-related information in this process. Two interview questions were especially relevant to this study:

1. Describe the disciplinary or content knowledge you want applicants to have when applying for the program, especially in mathematics and/or science.
2. Describe the pedagogical knowledge, or knowledge of teaching methods, related to teaching mathematics and/or science that is important for applicants to have when applying for the program.

We conducted additional 60- to 90-minute interviews with administrators who directed or oversaw admissions processes at each site. These data were used for clarification, fact-checking, and additional information on admissions processes.

4.2 *Data Analysis*

To organize documents for analysis, we first created data matrices to compile information across the 31 MSTPPs along two key categories: applications and interviews. The application

matrix contained detailed descriptions of the information collected and/or prompts provided in each document, such as application forms, transcripts, and essays. The interview matrix contained information on interview prompts and scoring systems (e.g., rubrics, indicators for scoring) used by those MSTPPs that conducted applicant interviews in some form.

We then used a combination of axial and open coding on these two matrices, beginning with *a priori* codes (Saldaña, 2021) that included applicants' content background. We established these *a priori* codes from our initial matrices for admissions documents and interview prompts, as well as related literature. Next, we engaged in multiple cycles of data analysis that generated additional emergent categories (Saldaña, 2021). For the application matrix, these included criteria categorizations (e.g., GPA minimum requirements, content course prerequisites, teaching experience), personal essay prompts, and presence or manner of evaluator comments. For the interview matrix, emergent categories included interview goals, structural components (e.g., number of faculty and applicants present, individual or group format), categorization of prompts, and content-related interview aspects. The categories helped to further organize the data columns that contained components and information for each MSTPP. After this analysis, the matrix display of these data helped us to identify patterns and differences in the data to generate themes (Saldaña, 2021). We also compared the data from the MSTPP documents to current instructional recommendations in mathematics (e.g., National Governors Association & Council of Chief State School Offices, 2010) and science (NGSS Lead States, 2013).

A final phase of document analysis involved the construction of categories related to the extent that content was incorporated into the documents, particularly those related to essays, letters of recommendation, and interviews. Documents that did not address content in any way were labeled as having "no explicit content focus." Documents that contained prompts with the

potential to elicit information related to content but did not have explicit direction to do so, or that explicitly elicited information related to content but not necessarily related to mathematics or science, were labeled as having a “potential focus on content.” Such documents included requests for a letter of recommendation from an “educator” or to include information related to “academic background” or “teaching experience.” Finally, documents that contained explicit references to mathematics and science content were labeled as such (e.g., requesting a letter of recommendation from a mathematics or science content faculty member). Further examples of documents inside each of these categories are provided in the Results section.

Concurrent with our document analysis, we conducted and analyzed faculty interview transcripts to explore faculty perspectives on and uses of admissions materials, particularly as they related to mathematics and science. Three researchers conducted the interviews, with a single researcher interviewing all faculty at a given university. The interviews were analyzed in three phases. Phase 1 involved analytic memos recorded by the interviewer immediately following each interview which focused on faculty uses and perceptions of content background, knowledge, and dispositions in the admissions process. The researcher then created metamemos that categorized information and addressed themes across a single university. Preliminary results, potential information to be collected, and ideas for generating future codes were also included.

For Phase 2, three researchers manually and individually coded interview transcripts, and then collectively met to discuss the analysis. This allowed for clarifying existing codes, generating new codes, and establishing decision rules for coding. One researcher established interview stanzas (Saldaña, 2022) for each transcript, chunking the document into textual units and aiming for stanzas that were no longer than 25 lines. A typical stanza included an interview prompt, the faculty response, and any additional follow-up comments. After comparing codes for

five interviews, we began to use Atlas.ti software to apply codes, continuing to revise coding descriptions and decision rules. Two researchers coded each interview and then met to resolve differences, with a third researcher present to help resolve disagreements. This iterative process further clarified our codes and decision rules, as well as provided opportunities for researchers to collectively discuss and refine themes and results.

Phase 3 of the faculty interview analysis involved enhanced coding of content-related categories and themes. We analyzed all 20 transcripts with a focus on stanzas that contained the “content knowledge and dispositions valued by faculty” (C-KD) code (Table 2). The average number of C-KD stanzas across the 20 faculty was approximately six, with more stanzas occurring for mathematics-related faculty than science-related faculty, as well as more for content faculty than education faculty (Table 3). Subcodes in this final C-KD analysis included mathematics- and science-related application requirements, teaching approach valued by faculty (with a focus on mathematics and science teaching), beliefs about applicants’ past mathematics and science learning experiences, and theoretical grounding for faculty perspectives. Another data matrix was constructed using these subcodes with respect to the research questions. For example, the first subcode above helped address Research Question 1, while the final three subcodes helped address Research Questions 2 and 3. Searches for “content,” “math”, and “scien” were then conducted on all interview transcripts to ensure all relevant stanzas were included in this final phase of analysis, although these searches revealed very few new stanzas significant to our research questions. Thematic analysis of this data matrix led to refinements of our existing findings and construction of additional results.

5. Results

We begin by presenting the admissions process components used by MSTPPs, followed by a detailed discussion of the information available to evaluators on applicants' mathematics and science content backgrounds, knowledge, and dispositions. We then provide an analysis of faculty perspectives and values toward this information. As stated above, content knowledge and dispositions are closely related and, in practice, it was often difficult to separate the concepts cleanly throughout the analytic process. Moreover, during the interviews, faculty often treated the concepts interchangeably or responded in ways that led them to be interwoven. Hence, discussions of these two constructs are often intertwined, with distinctions and separations made as appropriate.

5.1 *Information Collected from Applicants*

We found that admissions data were collected in a variety of ways across the MSTPPs, although certain patterns emerged. To attend to the broader context, our discussion of academic background includes more contextual information as well as information related directly to mathematics and science background, knowledge, and dispositions.

Information Collected on Applicants' Contextual Backgrounds

All MSTPPs collected demographic information (i.e., date of birth, ethnicity, gender), and nearly all MSTPPs asked for applicants' parents' level of education. As Table 4 indicates, nearly all MSTPPs required applicants to submit a written essay (94%) and a statement of teaching experience (90%). In addition, most MSTPPs required letters of recommendation (84%), and over half conducted interviews (68%) and asked for a professional resume (62%). Because our focus is on the nature and use of data used by the MSTPPs related to mathematics and science content knowledge, we now provide detailed discussion of this area.

Information Collected on Applicants Related to Mathematics and Science Content

All MSTPPs made use of information related to mathematics and science, but to varying degrees and emphasized in different ways. We discuss this by focusing on the nature of the information afforded by the various components used in the admissions process.

5.2 Components that Provided Information on Mathematics and Science Content

The MSTPPs used a variety of components to collect information related to mathematics and science, with mathematics incorporated more thoroughly than science. All MSTPPs had a basic admission form, with all requiring high school and/or college academic records, intended degree and/or endorsement area, and scores on standardized tests (Table 4). Standardized test scores included the SAT and licensure tests of basic skills. Specific information used by MSTPPs from these components included prior coursework (e.g., number of courses taken), types of courses taken (e.g., remedial type courses, calculus, science laboratory courses), and grades. While helpful, this information is somewhat limited in providing specific information about applicants' content knowledge and dispositions. Further, many MSTPPs admitted students without a passing score on licensure tests, delaying this requirement until the start of the primary field internship.

Information on desired endorsements (21 MSTPPs, 68%) and prerequisite courses (17, 55%) referenced mathematics and science content background in explicit but general ways. Endorsement information was usually asked by supplying a checklist of possible endorsements or asking the candidate to fill in a blank. Regarding prerequisite courses, three MSTPPs at University C asked for grades obtained in these courses, while the other 14 MSTPPs required applicants to indicate that they have taken or plan to take the necessary courses. We found little difference between elementary and secondary MSTPPs in obtaining information on

endorsements and prerequisite courses, although undergraduate programs were more likely to ask for this information than masters programs.

All MSTPPs required additional components in their admissions processes that could potentially relate to mathematics and science, including teaching experience (28 MSTPPs, 90%), and resume (20, 62%). More robust information on such components was obtained in our document and faculty interview analysis related to the written essays (29, 94%), letters of recommendation (27, 87%), and interviews (21, 68%) (see Table 5). Our analysis of these three admissions components revealed no MSTPP explicitly incorporated mathematics or science content into their essay prompts, and only one MSTPP did so in their letters of recommendation guidance statement. However, there was wider variety in the role interviews played in eliciting content-related information (Table 5). We now discuss these three components and related information in more detail.

Essay prompts. Essay prompts for 28 of the 29 MSTPPs that required personal statements did not address content background, knowledge, or dispositions, but instead focused mainly on relationships with students, topics related to diversity, equity, inclusion, and justice (DEIJ), and positive classroom environments (Roth McDuffie et al., 2022b). One possible exception was an essay prompt in a University B undergraduate elementary program that asked how an applicant's talents, skills, and experiences might contribute to the teaching profession. However, an applicant could respond to this prompt without making connections to mathematics or science in a meaningful way.

Letters of Recommendation. Ten MSTPPs provided no guidance regarding the content of the letters of recommendation and three MSTPPs, all from University B, only asked that letters relate to teaching experiences. Three MSTPPs from University C asked for letters from

“educators” that afforded a potential focus on content. Ten MSTPPs, which included University B’s elementary and secondary masters MSTPPs and eight of University C’s MSTPPs, asked for an emphasis on both teaching experiences and academic background, also providing for a potential focus on mathematics and science content.

On occasion, these letters provided MSTPPs with information related to mathematics and science. For example, while not explicitly requested, it was common practice in University B’s elementary undergraduate MSTPP for one letter to be written by a mathematics education professor who instructed the *Math for Elementary Teachers* courses, a series of prerequisites for entering the MSTPP. These letters provided MSTPP evaluators with an insider’s view of the mathematics knowledge and dispositions for nearly all their applicants. The administrator for this program indicated this component often “carries the most weight,” and that further discussions with letter writers are sought if evaluators are “on the fence” regarding an applicant. However, the mathematics education professor, who rarely participated in the final decision-making deliberations, expressed doubts about the role of mathematics in these decisions, stating:

I teach the two math courses that all the preservice teachers applying have to take ... So I write a lot of the recommendations for the Program ... But I'm not sure the math comes up in the selection process. I definitely speak to it in my letters, in terms of how open they are to math and to learn the math and teaching math, you know. There are still some folks who just hated math and who've been teaching it, and I think that's important to know, but I don't know how much they actually take that into account.

Finally, letters for the undergraduate secondary mathematics MSTPP at University C were encouraged to come from content area faculty at the university, and TEP evaluators often sought out such recommendations if they were not included in the application materials.

Interviews. Eleven MSTPPs utilized interview prompts that related only to teaching experiences or DEIJ-related topics. Eight MSTPPs constructed interviews with the potential to elicit information about content, but without explicit direction to do so. These included two elementary masters and two secondary masters programs at University C that prompted participants to explain a concept of their choosing that elementary students should know. Two elementary and one secondary alternate certification programs at University D also prompted for discussions of content, but not necessarily in regard to mathematics and science. One program, the secondary masters MSTPP at University E, provided a potential focus on mathematics or science content by prompting participants to discuss potential endorsements and experiences with online courses.

Two MSTPPs from University D, one masters elementary and one masters secondary, incorporated mathematics and science explicitly into their interview questions. This involved groups of three to four MSTPP applicants collaborating to interpret, understand, and discuss students' mathematical thinking, as well as plan and teach a mathematics lesson. Evaluators were present to facilitate and assess the applicants throughout. These elementary and secondary programs at University D utilized the presence of content in the TEPs' overarching goals to provide applicants with the potential to discuss mathematics and science content in the admissions interview. Finally, an elementary masters level certification program at University C asked about general content background during interviews, but particular references to

mathematics or science were not made. These interview protocols and processes are discussed in greater detail below.

5.3 Faculty Perspectives on Admissions Information Related to Mathematics and Science

In line with prior research (Casey & Childs, 2011; McGraw & Fish, 2018), evidence from faculty interviews suggests that, overall, they perceived important limitations in the nature of the information available from the components used to determine applicants' mathematics and science backgrounds. Eight of the 20 faculty (nearly equally split across mathematics/science and education/content area) made specific comments to this effect, with information obtained through testing (5 faculty) and GPA (4 faculty) being mentioned most frequently as problematic. Four faculty expressed positive views, with letters of recommendation and interviews mentioned explicitly. In this context, we now discuss the perspectives faculty held with respect to the nature and value of content background, knowledge, and dispositions.

Faculty Perspectives on Content Background

While content knowledge was deemed important, faculty affiliated with both elementary and secondary MSTPPs perceived that many applicants did not have content backgrounds sufficient for teaching at the point of application. However, faculty held varying perspectives on the nature of this problem or how to address it. Of the five faculty who desired a content degree (e.g., a major in one of the sciences), all were science and/or science education faculty, and all but one had an association with a secondary MSTPP. Six faculty expressed concern about the way in which their university taught entry-level mathematics and science courses that were prerequisites for MSTPP admission. Interestingly, despite these concerns, several faculty suggested that some content prerequisites should be reduced or eliminated. A mathematics professor at University C spoke of the number of prerequisite courses as a "hurdle" to some

prospective secondary mathematics teachers, while a University C science education professor argued for reductions or alterations to existing courses intended to support content development in elementary preservice teachers:

I would like to remove the math and science prerequisites ... I think there are elements of the prerequisites that are important, but I don't know what would be a good replacement, given the limitations of the system ... Let's say you are a science major but haven't necessarily taken our course requirements. Or our program requires through Precalc, an Intro to Statistics class, and two Math for Teachers classes. And so, all of a sudden, they're looking at that, and if they want to start our program they still need to go back and take those classes ... And I think that has been the biggest barrier. It's important that they have that content knowledge. I get that. But ... (our) students are intimidated by those math (and science) classes.

However, the science education professor at University E argued for the maintenance or increase in prerequisite courses:

Now the faculty are pushing to have fewer math courses, and that flies in the face of knowing that effective teachers have to be adequately prepared. I don't think these faculty would say it would be okay for somebody to read and write on an eighth-grade level and become a teacher, yet that is what they're basically demanding in terms of math.

These faculty perceptions were consistent with their views related to the applicants' prior learning experiences. Fifteen faculty (nearly equally split across mathematics/science and education/content area) perceived that applicants were not taught "conceptually" or "inquiry-

based,” but “algorithmically” or “traditionally” in past high school and/or entry-level college mathematics and science courses. This led to perceptions that applicants needed additional content support, as a mathematics education professor at University C stated:

That’s our job. They’re going to come in, unfortunately, with whatever they saw in the past.

Faculty Perspectives on Content Knowledge and Dispositions

Compared to the above views on content background, there was more consistency in the ways that faculty expressed the nature of the content knowledge and dispositions they valued. Six of the 20 faculty referenced specific dispositions they desired in applicants during the interviews, including “enthusiasm,” “growth mindset,” “strong identity,” and “high self-esteem” towards mathematics and/or science. Overall, the majority of faculty looked for evidence that applicants have broad understandings of mathematics or science ideas and the curiosity to investigate mathematical or scientific situations, as contrasted with more traditional, skills-based knowledge. Fourteen faculty (equally split across mathematics/science and education/content area) indicated that they valued evidence of applicants’ knowledge and dispositions consistent with “student-centered” mathematics and science pedagogy that includes an “inquiry-based” focus. Other terms used included “active,” “constructivist,” “conceptual,” and “discussion(-oriented).” More specific comments included a desire for applicants to “see their own students as bright and capable” and to “value multiple strategies.” This was exemplified in the following statement by a mathematics education professor from University D, who connected the role of content knowledge to its potential impact on mathematics teaching:

I hope they come having had some deep, conceptually-oriented experience with content, where they've seen the need to deepen their own content knowledge ...

and that they sort of have almost a disposition to be asking that question of, “What would it mean to know this in a conceptual way.” An orientation to thinking about children's ideas, like, “My job is to figure out how they're thinking and use that to inform what I do next.” And that's really enhanced by having a deep knowledge of mathematics.

This professor noted that most applicants “do not have that coming in,” and that all of University D’s MSTPPs should support this kind of development in both content and pedagogy.

Faculty expressed specific views on the nature and amount of prerequisite content knowledge they desired in applicants, articulating this in terms of particular content areas (e.g., number and operations, algebra, proof) or by referencing specific courses (e.g., Chemistry, “lab courses,” “up through Physics”). Of the 20 faculty interviewed, 14 made explicit statements about the nature of the content knowledge they preferred in applicants. Four faculty emphasized both breadth and depth in desired content knowledge, 11 faculty indicated a desire for “breadth” or a focus on the “big picture,” while seven faculty articulated a specific desire for “depth” of content knowledge. Of the seven faculty who emphasized depth, six of these were from science, but were evenly distributed across education faculty and content faculty.

5.4 MSTPP Faculty and Programs’ Values Toward Content-related Admissions

Information

This section provides specific examples of the ways in which faculty valued information related to mathematics and science used in MSTPP admissions processes. The degree to which evaluators could gain an understanding of applicants’ content background, knowledge, and dispositions was dependent on the available information. In general, when only broad-scale data was available, such as test scores and grades, evaluators could construct understandings

consistent with this information. When more fine-grained information was available, evaluators were able to develop more nuanced understandings. We now provide discussions of the ways in which faculty valued specific forms of data in the admissions process.

MSTPP Faculty and Programs' Values Toward Broad-scale Information

While GPA and achievement scores were collected by all MSTPPs, faculty perceived problems in the way these data were used to make admissions decisions. Seven faculty made comments that connected GPA (4 faculty) and/or achievement tests (5 faculty, 2 of these overlapping with GPA) with their views of applicants' content knowledge or dispositions, and all seven of these faculty favored a removal of minimum requirements for these scores or a reduction of their use in admissions decisions. One reason for this desire to question GPA as a requirement was the perception that applicants who were not mathematics or science majors typically had much higher GPAs, a concern grounded in past research (Koedel, 2011). Given that minimum GPA was an admissions requirement, these faculty argued for exceptions and increased flexibility. A common perspective on the role of GPA and achievement tests in MSTPP admissions processes was offered by a science professor, who expressed a desire for a limited or flexible role for these measures:

I want to have a more holistic approach that's looking at the person, not just did you meet some sort of cut-off score on any given thing (i.e., achievement test), and not necessarily a set GPA cut off.

While not necessarily opposing GPA as information used in admissions decisions, this comment reflects the broader resistance amongst faculty on its use as a disqualifying measure.

MSTPP Faculty and Programs' Values Toward Fine-grained Information

The three application components collected by all MSTPPs (GPA, transcripts, test scores) did not provide information that extended beyond courses or broad measures of achievement. Therefore, it is important to consider how other application components (personal essays, interviews, letters of recommendation) that could provide more detailed, contextualized information were specifically used. Interviews were used most frequently by the MSTPPs in our sample and afforded the richest opportunities for MSTPP evaluators to elicit connections to mathematics and science (Table 5). We now focus on three specific examples.

Content as Part of MSTPP Overarching Goals. Faculty and evaluators at University B constructed four guiding principles in support of all their TPPs' development and processes. Two of these directly incorporated content knowledge. The first called for collaborative learning processes that invoke inquiry, reflection, and iteration, while the second stated that teachers should have flexible and sophisticated knowledge of content, students, and pedagogy. Faculty at University B referenced these principles in the interviews, and these principles played a role in the interview process. Specifically, all applicants read a vignette about a student and addressed questions on how they might react to him in various instructional situations, including attention to his assets and needs. After initial discussion, applicants read the MSTPP's four guiding principles and used them to make additional sense of the case study vignette. While faculty spoke during the interview more about applicants' connections with diversity, equity, and inclusion, which were the more prevalent themes amongst the principles, faculty also stated that they were able to gain content-related understandings of applicants from the information provided by the interview and rubric. The science education professor at University B stated:

I think the overall deliberation by faculty at the end of the interview process is about how you participated, how you communicated with each other, the content connections that you were able to make about the case study or the guiding principles, your professionalism. Those are some of the things on our rubric.

While not guaranteed, this interview process has the potential to focus applicants on specific mathematics and science understandings and dispositions, as well as approaches to instructing specific content. Further, as stated by this faculty member, the rubric supported faculty connections to content-related aspects of applicants' backgrounds.

Content Included in Interview Prompts. The interview protocol for University C's elementary masters level MSTPP contained a question that afforded connections to teaching content. It asked, "Imagine you are teaching a small group right now. Select a concept that students should know (appropriate for their age/subject). Explain that concept to us now." While not specific to mathematics and science, connections to these areas are possible, and the prompt allowed all applicants in this MSTPP the opportunity to discuss content-related ideas. The next example provides a more extensive example of how interviews can initiate content-related discussions with applicants.

Content Included throughout the Interview Process. Two MSTPPs at University D conducted a day-long interview as part of their admissions process. The interview component enacted by both of these programs afforded multiple opportunities to interact with applicants in professional and personal realms and in individual and group formats. The MSTPPs devoted a significant portion of this interview to the teaching of content, particularly mathematics and science.

In the group interview phase, applicants were provided guidance for instructing a specific middle-school mathematics task. This included a short article on launching mathematics tasks and a lesson plan template that included lesson objectives and instructional details, such as potential questions, sequencing, and materials. Finally, the students were given a processing tool with four prompts that provided additional instructional support for attending to context, making mathematical relationships explicit, supporting language use, and maintaining cognitive demand. After an opportunity to ask questions, applicants were given five minutes to launch the task to the other applicants, who played the role of 8th-grade students. During this time, evaluators recorded notes and completed a rubric using the following criteria: organization, effective mathematics communication, and student mathematics engagement. This entire process was then repeated for a middle-school science task, framed around the goal for the participants to “elicit students’ current ideas about a phenomenon or big question.”

After the instructional launches, applicants participated in a second content-related interview component. This focused exclusively on mathematics and included a videotaped case study with student work samples. Students were asked to articulate understandings of the mathematics embedded in the case study context, analyze two salient mathematics interactions amongst the teacher and students, analyze the mathematics work of one student, and discuss the nature of the mathematics problem-solving exhibited. A rubric was also provided to evaluators for scoring this interview component.

The attention to mathematics and science in this example afforded these MSTPPs multiple opportunities to engage applicants in a variety of discussions about their own understandings and dispositions, as well as how they might interact with learners in content-specific settings. Faculty also viewed this as an introductory learning experience that sets a tone

for the MSTPPs' overarching principles and approaches to teaching mathematics and science. While perhaps not feasible for other MSTPPs, this experience provided these evaluators in-depth, content-related information on both content knowledge and dispositions that was incorporated into the admissions process in a manner far beyond other MSTPPs in this study.

6. Conclusions

This study made use of a relatively small number of TPP programs in one state, so one should be cautious of generalizations of our results to other contexts. However, we note that other researchers can apply our methodology and investigate other contexts in a similar manner.

In summary, our analysis revealed that faculty perceived important limitations to the information related to applicants' content background, knowledge, and dispositions obtained in the admissions process. While many MSTPPs obtained information on applicants' potential endorsements and prerequisite courses taken, this offered only broad perspectives on applicants' backgrounds. For those MSTPPs that did utilize components with greater potential to surface detailed, content-related information on applicants, such as essays, interviews, and letters of recommendation, the prompts or structures of these components did not typically focus directly on fine-grained information related to content knowledge and dispositions. Many faculty expressed a desire for collecting additional content-related information that extended beyond coursework and broad measures of achievement, particularly those in MSTPPs that did not use other components (e.g., interviews) for this purpose. Put simply, the evidence suggests a degree of disconnect between the information faculty desire and what is available to them. The interview component examples provided in our study illustrate multiple ways in which MSTPPs can uncover fine-grained information on applicants, including information about mathematics and science dispositions that can often be elusive (Casey & Childs, 2011; Klassen et al., 2020).

Faculty voiced specific and uniform perspectives on the content knowledge and dispositions they desired in candidates. Most faculty expressed a desire for broad, conceptually-based content knowledge, as well as dispositions consistent with scientific inquiry and mathematical problem solving, such as confidence and self-efficacy. However, faculty perceived that most applicants did not possess such knowledge and dispositions because of limitations in their prior learning experiences. Further, the ways in which applicants might use their knowledge and dispositions to frame mathematics and science instruction was particularly important to faculty participants, who seemed to value active, student-centered forms of instruction.

7. Discussion

How to collect useful data on teacher candidates is a problem every TPP faces. Needs for efficiency are often pitted against a desire to obtain information deemed important or consistent with the overall goals of the TPP. Further, TPPs might require very little information if a less rigorous or universal acceptance policy is employed. However, we know content knowledge plays important roles in teaching actions and outcomes, particularly in mathematics and science (Hill et al., 2008; Kang et al., 2018). Further, we know the type of content knowledge teachers hold has specific impacts on the nature of student learning experiences (Ball et al., 2008).

This study uncovered specific data components related to mathematics and science background that were part of participating MSTPP admissions processes, as well as the ways in which these components afforded information used in admissions decisions. Our findings provide insights into the little-researched area of MSTPP admissions decisions that might support MSTPPs, and TPPs in general, in reflecting on and revising their admissions processes. Specifically, our research provides useful illustrations of the ways in which faculty and other evaluators consider mathematics and science in their admissions processes and decisions, and the nature of the data that guides these decisions.

Based on the findings for the 31 MSTPPs in this study, other faculty and MSTPPs might consider whether they are collecting and incorporating fine-grained information related to mathematics and science content background, knowledge, and dispositions into their admissions decisions. Under-informed decisions, particularly regarding content knowledge and dispositions, can limit MSTPPs in immediately recognizing needed supports for their candidates, or at worst, could lead to inappropriate admissions decisions. Given that admissions decisions are the gateway into the teaching profession, expanded use of components that surface fine-grained understandings of mathematics and science content knowledge and dispositions are needed. Our evidence suggests that this would not simply involve the use of components likely to do so (e.g., interviews, essays, situational judgements), but careful consideration of the composition of each of these components and their accompanying evaluative tools and processes.

Our findings further confirm the difficulties MSTPPs often face when operationalizing and assessing candidate knowledge and dispositions (Casey & Childs, 2011; Klassen et al., 2020). In a self-study of their teacher candidate selection procedures in Canada, which included an assessment of knowledge and dispositions, Kosnik and colleagues (2005) wondered:

How can so much be assessed on so little evidence? However, we believe that even with such limited evidence, the process could be improved substantially by making the criteria more explicit and working closely with the assessors to help them understand the criteria and their importance. (p. 119)

We agree and call for more research exploring how faculty and evaluators *understand* and *apply* these criteria. The interview process enacted by University D, which incorporated mathematics and science explicitly into their interview questions, is an informative case of how this can be supported.

However, anyone who has participated in TPP admissions processes must acknowledge the limited time often available to, or perhaps given by, evaluators (and applicants) as they engage in the admissions process. Time constraints can lead TPPs to limit evaluators' access to information or understandings of assessment tools, thereby decreasing their potential effectiveness. Therefore, while questions of evaluator understanding and application are important, we must also go beyond this issue and investigate the systemic affordances and constraints that impact evaluators as they attempt to make sense of and use information on applicants' content backgrounds, knowledge, and dispositions. Further, more research is needed to determine the practicality and effectiveness of those approaches with the potential to surface fine-grained, content-related information on applicants, as well as the specific impacts these efforts have on evaluator and MSTPP decision-making. Such research might employ observational and case study approaches. Further research could also probe different potential uses of applicant information, such as strict GPA cutoffs relative to holistic considerations of GPA in admissions decisions.

Overall, this study highlights some of the promising ways in which MSTPPs collect and use information related to admissions processes and identifies important gaps and limitations. We argue that overcoming existing limitations in MSTPP admissions processes is a multi-faceted, arduous task that requires creativity and flexibility in perspective and action. The limited research suggests that more work is needed to understand and enhance admissions processes as they relate to applicants' content background, knowledge, and dispositions.

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Tables

Table 1. TEP program types

TEP Program Type	UG Elem	UG Sec	Masters Elem	Masters Sec	AltCert Elem	AltCert Sec	Total
# of TEPs	6	3	6	8	6	2	31

Table 2. Detailed description of the Content Knowledge in and/or Dispositions toward Math and/or Science code.

Code	Description	Notes
Content Knowledge in and/or Dispositions toward Math and/or Science C-KD	<p>Responses related to disciplinary content knowledge and/or practices that a faculty member values (or sees lacking) (e.g., “I want them to have a deep understanding of [ratio, algebra, introductory chemistry]”).</p> <p>Responses related to dispositions toward mathematics and/or science disciplinary knowledge and practices: Positive dispositions might involve perseverance and productive self-efficacy. Negative dispositions might involve fear or dislike.</p> <p>Example topics:</p> <ul style="list-style-type: none"> • disciplinary knowledge • disciplinary practices (i.e., problem solving, perseverance) • application or "real world" connections • content connections to teaching approach (e.g., pedagogical content knowledge with math/science specifically connected to pedagogy). 	<p>Keep distinct from codes related to Education Background (A-ED). A stanza should only contain C-KD and A-ED if both are distinctly mentioned.</p> <p>Keep distinct from codes related to General Teaching Dispositions (D-TL) unless specific comments relate to both content dispositions and dispositions toward students/teaching more generally. If the student/ teaching disposition(s) being discussed all relate to content, only use C-KD.</p> <p>Note: For the interview question that asks about “the pedagogical knowledge related to teaching mathematics or science,” infer that the response is about C-KD.</p>

Table 3. Number of stanzas coded as C-KD by faculty type

Faculty Type	Math Content	Science Content	Math Ed	Science Ed	Math- related	Science -related	Educ- related	Content- related	Overall
# of stanzas	7	6.8	6.5	3.4	6.7	5.2	5.1	6.9	5.9
% of transcript	30.1	23.3	19.1	10.8	22.1	17.3	15.5	25.4	19.5

Table 4. Application components and common information collected by the TEPs

TEP Program Type		UG Elem (of 6)	UG Sec (of 3)	Masters Elem (of 6)	Masters Sec (of 8)	Alt Elem (of 6)	Alt Sec (of 2)	Total (of 31)	% of TEPs Collecting this Component
Application Components and Common Information Collected									
Sources of specific content background information	GPA	6	3	6	8	6	2	31	100%
	Transcripts	6	3	6	8	6	2	31	100%
	Testing Requirements	6	3	6	8	6	2	31	100%
	Desired Endorsement	3	2	3	7	4	2	21	68%
	Prereq Course Completion	5	1	2	3	5	1	17	55%
Sources that may contain information related to mathematics and science	Essay/Statement	5	2	6	8	6	2	29	94%
	Teaching Experience	4	2	6	8	6	2	28	90%
	Letters of Rec	3	3	6	8	5	2	27	84%
	Interview	2	2	4	6	5	2	21	68%
	Resume	0	0	6	7	5	2	20	62%
Average # of Components (of 10) Per Program Type		6.67	7.00	8.50	8.86	9.00	9.50	8.26	

Table 5. MSTTPs' focus on content-based information in essays, letters of recommendation, and interviews.

Essays, Included as Application Component for 29 MSTPPs

Program Type	No Explicit Content Focus ¹	Potential Focus on Math or Science Content ²	Explicit Focus on Math or Science Content ³
UG Elem	4	1	0
UG Sec	2	0	0
Masters Elem	6	0	0
Masters Sec	8	0	0
Alt Elem	6	0	0
Alt Sec	2	0	0
All MSTPPs	28	0	0
Pct. of 29 MSTPPs w/ Essays	96.6	3.4	0.0

Letters of Recommendation, Included as Application Component for 27 MSTPPs

Program Type	No Explicit Content Focus	Potential Focus on Math or Science Content	Explicit Focus on Math or Science Content
UG Elem	2	2	0
UG Sec	2	0	1
Masters Elem	1	4	0
Masters Sec	3	4	0
Alt Elem	3	2	0
Alt Sec	2	1	0
All MSTPPs	13	13	1
Pct. of 27 MSTPPs w/ Lets of Rec	48.1	48.1	3.7

Interviews, Included as Application Component for 21 MSTPPs

Program Type	No Explicit Content Focus	Potential Focus on Math or Science Content	Explicit Focus on Math or Science Content
UG Elem	2	0	0
UG Sec	2	0	0
Masters Elem	1	2	1
Masters Sec	2	3	1
Alt Elem	3	2	0
Alt Sec	1	1	0
All MSTPPs	11	8	2
Pct. of 21 MSTPPs w/ Interviews	52.4	38.1	9.5

¹ Documents not addressing content in any way.

² Documents that contain prompts with the potential to elicit information related to content but without explicit direction to do so, or that explicitly elicited information related to content but not necessarily related to mathematics or science.

³ Documents that contain explicit references to mathematics and science content.
