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ORIGINAL PAPER

Moving beyond reflection and toward disruption in the post-field context of mathematics teacher education

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Abstract
Prospective teachers bring countless stories of success and failure from different mathematics classrooms to their post-field teacher education courses. These reflective stories often glorify school mathematics classrooms and dominant traditions within, instead of confronting the marginalization of diverse groups in school environments. Mathematics teacher educators have a significant role to play in teaching prospective teachers to reflect critically on their field experiences and, in doing so, create spaces for *disruption* and *disruptive pedagogies*. Drawing on critical and equity-based theories applied within the fields of mathematics education and teacher education research, we propose a *disruptive pedagogy* analytical framework that enables us to study the roles and practices of mathematics teacher educators as they conduct their work in these post-field contexts of teacher education. In this paper, we introduce our disruptive pedagogy framework and present the results that followed from using it to analyze data from a research study in which mathematics teacher educators from across Canada and Norway were interviewed. We claim that our analytical framework can be used to identify those disruptive and transformative practices initiated by mathematics teacher educators—practices that are necessary to bring about shifts in inequitable and unjust classroom practices of school mathematics and in becoming a teacher. Unfortunately, however, results reported here point to the need for further shifts and growth toward more explicitly disruptive practices initiated by mathematics teacher educators in the post-field context.

Keywords Mathematics teacher educator · Disruptive pedagogy · Teacher education · Post-field contexts

1 Introduction

In university teacher education programs, considerable attention is focused on the practice components of field placement, including both pre- and post-field contexts. When referring to post-field context in teacher education, we mean the lessons/courses taking place at a given university after a shorter or longer period of field placement. In the post-field context, teacher education experiences are to a greater or lesser extent influenced by the stories of success and failure prospective teachers (PTs) bring back from their field placement, many of which serve to sustain status quo practices instead of confronting dominant traditions within mathematics classrooms. It is not well known to what extent mathematics teacher educators (MTEs) engage in the 'unpacking' of these placement stories: "Little is known about the way in which teacher educators integrate prospective teachers' actual experiences when they return to university after fieldwork" (Eriksen & Bjerke, 2019, p. 9). This 'unpacking', however, is relevant in its potential to give the post-field context a more prominent role in teacher education.

In response, the research described in this paper seeks to better understand how MTEs can move beyond reflective stories and toward "disruption" of current practices. We claim that MTEs must play a significant role in teaching PTs to reflect critically on their field placement and, in doing so, create spaces for *disruption* and *disruptive pedagogies* (Anderson & Justice, 2015). By disruptive pedagogy (DP), we are referring to pedagogical practices which disrupt normalising discourses and "marginalising processes by encouraging students to identify and to challenge the assumptions inherent in, and the effects created by,

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discourses constructing categories of dominance and subservice within contemporary society" (Mills, 1997, p. 39). In this way, such challenges serve to disrupt the reproduction of status quo and inequitable practices (Weis & Fine, 2001).

In this paper, following from the literature on DP, we suggest that the roles played by MTEs in unpacking PTs' field experiences include challenging, or *shifting away from*, certain current beliefs and practices, while also promoting, or *shifting toward*, other beliefs and practices (Bjerke & Nolan, 2022). In this regard, we introduce our DP analytical framework (grounded in the language of *challenge* and *promote*) and present the results that followed from using it to analyze data from a research study in which 21 MTEs from across Canada and Norway were interviewed. We claim that our DP analytical framework can be used to identify those disruptive and transformative practices initiated by MTEs—practices that are necessary to bring about shifts in inequitable and unjust classroom practices of school mathematics and becoming a teacher. Unfortunately, however, results reported here point to the need for further shifts and growth toward more explicitly disruptive practices initiated by MTEs in the post-field context, as will be discussed.

2 Literature review

Research on theory-practice transitions in teacher education programs has been extensive (Allen & Wright, 2014; Britzman, 2003), including transitions from university (theory) to field placement (practice), as well as transitions from teacher education to that of being a teacher in schools (Nolan, 2015). The key transition in teacher education programs which has captured our interest in our research is, however, the under-researched transition from field placement (practice) back to university (theory) where we feature the voices of MTEs. This transition is important in signifying a critical 'moment' where MTEs can highlight and discuss the highly problematic aspects of the field (PTs' school practica) that require disrupting, even if the PTs themselves do not notice these on their own. MTEs in teacher education programs are well-positioned to educate new teachers on the inequities and marginalization of learners that happens in school mathematics classrooms. Yet, research has shown that mathematics teacher education programs have made very little progress toward addressing issues of equity, diversity, and social justice in the preparation of mathematics teachers (Civil & Hunter, 2019). For MTEs, it is time "to sharpen our sociopolitical lenses in order to notice and disrupt manifestations of privilege and oppression in mathematics education" (Willey & Drake, 2013, p. 68).

To move forward toward a better understanding of the research on MTEs' practices, this paper is informed by two main areas in the existing research literature: theory-practice transitions in mathematics teacher education and the roles and voices of MTEs within. We continue here by briefly reviewing these two research bodies, before proceeding to discuss research texts focusing on DP and our proposed DP analytical framework.

2.1 Theory-practice transitions in mathematics teacher education

We draw here on theory-practice (and practice-theory) language to study the role of MTEs in disrupting and reimagining knowledge constructed in the transitions from university to field and back to university. Suggesting that there is a prevalent gap that needs to be bridged (Hansén et al., 2023), research proposes ways to bridge the transitions based in, for example, close university-school collaborative partnership models (Bradbury & Acquaro, 2022; Reynolds et al., 2013), professional learning communities (Nolan, 2015, 2018), use of hybrid educators (Risan, 2020), and third spaces (Williams, 2014). These studies on prevalent gap extend into mathematics teacher education as well: Charalambous and Delaney's (2019) extensive (and critical) review of the literature that summarises two decades of research on how MTEs make practice a central source of prospective mathematics teachers' learning. Regardless of these efforts, there is still a continuing need to study the theory-practice transitions (Llinares, 2023), especially given the move afoot in some countries to initiate a shift away from theory in teacher education and toward, for example (in the case of the UK), "a vocational employment-based model of training located primarily in schools" (Brown, 2021, p. 52). This is not, however, a view endorsed in this research study, where instead we seek to understand how theory can gain a stronger foothold in teacher education.

While the abovementioned literature includes a focus on theory-practice transitions in the field of mathematics teacher education, elsewhere (Bjerke & Nolan, 2023), we argue for the importance of focusing also on the less researched practice-theory transition. In that study, we found that MTEs are challenged by a number of issues as they work with PTs upon their return to university teacher education courses after their school field placement: the teacher education program's core structure; what happens (or does not happen) during field placement; the collection of stories PTs bring back from placement; PTs' resistance to university input; the demands of reform teaching; and MTEs' looming feelings of resignation. Not only does this research invert the teacher education transition typically studied, it also features the voices of MTEs. As noted by Anthony et al. (2016), while it is significant to understand how PTs negotiate theory-practice transitions, it is also highly significant to explore and understand the practices of MTEs with regard to these transitions. Yet, our survey

of the research literature suggests that a focus on the roles and voices of MTEs is not all that common in research studies focusing on these transitions.

2.2 The roles and voices of mathematics teacher educators

Research which considers the roles of MTEs is, for the most part, non-specific to a particular stage of the teacher education program (i.e., pre-field or post-field). Instead, much of the research sets out to understand the role of specific tools or stances adopted in MTE practice. For instance, Lin et al. (2018) investigated the tensions that MTEs experience when introducing theory to teachers during professional development sessions. These tensions included teachers expressing "the view that theory is not useful for teaching" and that often they choose to attend "workshops to learn something new that they could directly apply in their classroom" (p. 201).

Prompted by the tensions associated with the practices of MTEs, the body of research featuring the voices of MTEs mostly emerge from self-studies. The field of self-study research conducted by and for MTEs has grown considerably in the past 10–15 years (Lovin et al., 2012). Some researchers draw on self-study methodology to specifically assist with articulating MTEs' thinking around in-the-moment actions. These are designed to transform "educative challenges involving dilemmas and tensions into the driving forces for self-growth in professional development" (Yang et al., 2015, p. 34). Others set out to explore and present personally reflective accounts of how and where MTEs notice contradictions or mismatches between their espoused beliefs and their actualized practices (Chauvot, 2009; Lovin et al., 2012). One aim of these personally reflective self-studies is to propose pedagogical or theoretical models that can be adopted by MTEs to assist PTs in navigating theory-practice connections (Flessner, 2012). Another aim is to shed light on how some MTEs unintentionally endorse "an uncritical approach to the pedagogy of teaching mathematics" (Alderton, 2008, p. 96). The importance of highlighting MTE self-study research here resides in the hope that MTEs' reflections on their post-field practices can help other MTEs to become aware of situations where their fundamental beliefs may not be as evident in their practices, and thus to consider the possibilities that more disruptive pedagogies hold. That is, the premise of this research is that the spaces of transition between field placement and university are where MTEs' voices and critical perspectives are most needed in the education of new mathematics teachers. Yet, there is inadequate understanding across the research about how to make these post-field spaces more productive and disruptive.

2.3 Literature specific to disruptive pedagogies

In returning to the roots of DP, and how it initially emerged out of innovation with respect to technologies (Christensen, 1997), we found that, to date, few teacher education studies have a non-technology focus with respect to DP, and fewer still (if any) turn the lens of DP toward mathematics teacher education and MTEs specifically. Nevertheless, we found some promising research around disruption that spoke specifically to how DP was being defined/conceptualized, including its aims and examples of what it looks like in classroom practice. Elsewhere (Bjerke & Nolan, 2022), we describe in greater detail our process of locating these DP-inspired research texts. In short, we found that in teacher education, a key aim of DP is to mentor/support PTs to "fully engage in transformative, radical educational acts… required to constantly reposition, redefine, and rethink their roles and to deconstruct and redesign their objects of study" (Bastos, 2009, p. 5), and to disrupt traditional practices of teacher education courses by creating "a participatory environment that publicly challenges [PTs'] epistemologies… through both their engagement with the content and interactions with their peers" (Anderson & Justice, 2015, p. 404). Through our careful synthesis of ideas in located research texts on the issue, and by drawing on critical (e.g., Mills, 1997) and equity-based theories (e.g., Beighton, 2017) applied within the fields of mathematics education and teacher education research, we noticed that, in some cases, researchers sought primarily to *challenge* current status quo or traditional practices through DP while, in other cases, the goal was focused more on *promoting* different practices which were intended to disrupt and/or replace some current practices (Bjerke & Nolan, 2022). In this way, it became clear how the DP literature suggested the existence of certain current pedagogies and practices teacher educators want *to challenge*, or *shift away from*, and also pedagogies and practices they want *to promote, or 'shift towards'*. Thus, in this paper, the research on DP theory and analysis is expressed through the language of *challenge* and *promote*.

Our new knowledge of these two DP-inspired shifts (grounded in the language of *challenge* and *promote*) motivated us toward studying the practices of MTEs in the post-field context, where we believe MTEs play a key role in moving beyond a reflection-focused post-field experience and toward the initiation of disruptive and transformative practices. As we directed our attention in this way, we further developed these shifts through the construction of an analytical framework that highlights the promising concept of disruption in the context of MTE practices. The

DP analytical framework provides us with four data-driven questions:

Q1 What do MTEs see *as challenges* (i.e., what are MTEs challenged by) in the post-field context?

Q2 What are MTEs doing *to challenge* specific beliefs/practices in the post-field context?

Q3 What are MTEs doing *to promote* specific beliefs/practices in the post-field context?

Q4 Why/how do MTEs choose NOT to challenge specific beliefs/practices in the post-field context?

We previously addressed and reported on Q1 in a paper focusing on what MTEs saw as challenges in the post-field context of mathematics teacher education (see Bjerke & Nolan, 2023). Now, armed with a better understanding of the challenges faced by MTEs, in this paper we move forward and focus on Q2 and Q3 from our analytical framework. However, as will be discussed in the methods and analysis sections, we did not, for this study, conduct classroom observations to see what MTEs *do*. Instead, we conducted interviews with MTEs where they report on their actions. In this paper then, we focus our analysis of that interview data on addressing Q2 and Q3, posing the following DP-inspired research question: *What do MTEs report doing to challenge and/or promote specific beliefs/practices in the post-field context?* Thus, we are guided by Q2 and Q3 in our analytical framework in conducting a thematic analysis for this paper.

3 Methods

The larger research study began as a dialogue between the two authors reflecting on the issues and challenges that we, as MTEs, encounter in the post-field context of mathematics teacher education in our respective contexts, Canada and Norway (Nolan & Bjerke, 2021). Grounded in more than four decades' experience between us as MTEs, this dialogue motivated us to widen our approach. We invited MTE colleagues working in teacher education institutions across both countries to participate in our research study, which we clearly situated in the post-field context of mathematics teacher education.

Although field placement is organised somewhat differently within and across Norway and Canada, all university programs include post-field periods with lessons/courses taking place at a given university after a shorter or longer period of field placement. For the sake of clarifying our two research contexts, we next provide brief portrayals of how teacher education programs are organised in these two countries, with specific attention to their field and post-field contexts.

Norway's teacher education institutions are obliged to follow a set of national guidelines and regulations when designing their teacher education master programs for grades 1–7 (ages 6–13) and grades 5–10 (ages 10–16). Across the first eight of ten semesters, each program must facilitate a minimum of 110 days in the field for their PTs. These days are typically evenly distributed, leaving approximately 15 days in the field in each of the first eight semesters (the two last semesters are devoted to the master's thesis). Hence, in Norway, the post-field context refers to the mathematics teaching sessions taking place after approximately 15 days in the field and before the end of a semester.

In Canada, education is provincially mandated and, as such, teacher education programs across the different provinces and territories are structured around provincial curricula demands. Across Canada, more than 60 institutions offer a teacher education program, varying in duration from 1-year post-graduate to 5-year undergraduate degrees. The design and duration of field placement, or school practicum, across these programs is diverse. For example, at the University of Regina (author 1's primary institution), field placement in a 4-year undergraduate degree program builds gradually toward a 13-week continuous field placement in year four, which is then followed by a 4-month semester of post-field courses back at the university. Such an intensive in-school practicum is not, however, the norm across all teacher education programs in Canada. For instance, one participant (CMTE7) discussed the post-field context as evening classes at the university after PTs had been in their field placement all day.

While the post-field contexts in Norway and Canada can, in some respects, be characterized by different structures and duration, it is the commonalities between these contexts that are being emphasized in our study; that is, in both contexts, we are interested in studying the role played by MTEs in unpacking PTs' field experiences. In what follows, we introduce our research participants and the interview guide before providing a detailed account of the process for analysing our data.

3.1 Research participants and interviews

We draw on 21 semi-structured interviews conducted via Zoom, 10 from Norway (NMTE1-NMTE10, where e.g., NMTE1 is the Norwegian mathematics teacher educator no 1) and 11 from Canada (CMTE1- CMTE11). The 10 Norwegian MTEs, three identifying as male and seven as female, work at seven of the 11 governmental institutions accredited to provide teacher education for grades 1–7 and 5–10 in Norway, with experience ranging from two to 25

years. The 11 Canadian MTEs, eight identifying as female and three as male, work at 11 different universities across six provinces, with most of the universities offering both elementary (K-8) and secondary (9–12) teacher education programs, with experience as MTEs ranging from one to 18 years.

We opened each research interview with a general "ice-breaker" question:

(1) Please share some details about your university position, the design of your teacher education program (especially regarding post-field contact), and any initial thoughts you have on theory-practice and/or practice-theory transitions.

To better understand what MTEs view as challenges in the field-back-to-university (practice-theory) transition, in the next part of the interview we presented participants with a list of challenges associated with theory-practice (university to field) transitions that we had identified across the research. These challenges included PTs in the role of visitors in the mentors' classrooms; tensions associated with the different roles of the involved parties; the divide or gap between university and school expectations; and the demands of teaching through reform-based approaches (Nolan & Bjerke, 2021). Having presented this list of theory-practice challenges, we proceeded with interview questions as listed:

(2) As an MTE and course instructor, what are the most significant challenges you experience in your work with PTs upon their return from a field experience? How do your challenges relate to the list of theory-practice challenges?
(3) What pedagogical strategies do you draw on in your post-field courses that you think might, intentionally or unintentionally, further re-affirm a university-school divide between theory and practice?
(4) What pedagogical strategies do you draw on in your post-field courses that you think might challenge and/or disrupt the division between university/theory and field/practice classrooms, and instead portray them in a different relationship with each other?
(5) What theoretical tools do you draw on in your post-field courses to 'unpack' the field? How and to what end do you draw on these tools to understand, disrupt and/or support PTs' thinking and growth?
(6) In the context of your post-field courses, do you strive to disrupt field practices, principles, and beliefs? Describe successes and failures in these efforts to disrupt.

Next, we provided our participant MTEs with a definition of DP from Anderson and Justice (2015), who describe a pedagogy as disruptive if it "requires students to challenge or change their epistemologies and participation in their learning" (p. 400). In addition, we offered how Mills (1997) refers to DP as "teaching practices which promote change in the existing relations of power within schools" (p. 39), and asked:

(7) With these ideas in mind, to what extent would you describe your post-field pedagogy as disruptive?
(8) What concerns or reservations do you have about viewing teacher education practices through this disruptive pedagogy lens?
(9) What do you view as your primary role(s) as an MTE in the post-field context?

3.2 Description of analysis

Given that MTEs clearly noticed many challenges (reported on in Bjerke & Nolan, 2023), we sought to understand what, if any, actions they reported taking *to challenge* and/or *promote* specific beliefs and/or practices in the post-field context. That is, what DP-inspired shifts in their practices did they report.

After having fully familiarised ourselves with the 21 semi-structured research interviews that were transcribed verbatim, 10 in Norwegian and 11 in English, we started identifying themes that responded to Q2 and Q3 of our framework. We manually generated initial codes with references to what MTEs report on doing *to challenge* (Q2) and codes with references to the closely connected question of what MTEs report on doing to *promote* (Q3) in the post-field context. This step was conducted individually and separately by each researcher and resulted in a collection of text extracts/quotes that were used to discuss our reflexive reading of the data. Once a common understanding was reached, we began generating themes (Braun & Clarke, 2019). While thematic analysis is a more well-developed qualitative analysis approach in psychology (Braun & Clarke, 2006) and health care (Braun & Clarke, 2014), it is, to date, less developed in the field of education. We draw here on Xu and Zummit's (2020) step-by-step guidelines in data coding and identification of themes, which are themselves based on the work of Braun and Clarke (2006, 2019).

In the end, we were able to identify four distinct themes on practices and beliefs that MTEs seek to challenge accompanied with understanding the specific beliefs or practices MTEs promote instead. Next, we unpacked each of the four themes with an aim of "identifying the 'story' that each theme tells" (Braun & Clarke, 2006, p. 92). Within each theme's story, we identified evidence (in the form of relevant data extracts) to demonstrate the prevalence of the generated

themes (Braun & Clarke, 2019). The four themes are presented in 4.1–4.4 in the next section.

In presenting our analysis, extracts were chosen if they were illustrative of ideas that were typical for that theme's story, regardless of context/country affiliation. In fact, it became apparent during the analysis process that data from both contexts of Norway and Canada were represented in each of our themes, providing further support for the appropriateness of combining (instead of comparing) data from both countries for our analysis. We consider it a strength that drawing on data from two countries geographically distanced and with different cultural contexts, instead of one, will make our findings pertinent and recognisable for a larger group of researchers and MTEs across more contexts/countries. However, despite these strong similarities that, we felt, gave us permission to combine the data, we remain aware of the fact that the different ways in which post-field contexts are defined, when they occur and their duration across the countries and contexts could be viewed as a limitation of our study's analysis and findings.

4 Analysis

As noted in our methods section, during our analysis we first upheld clear lines between MTE-reported actions *to challenge* (Q2) and actions *to promote* (Q3) but as we mined the data for themes it became clear that the two actions were much more intertwined than first thought. In our interviews, there was a tendency for MTEs to begin by sharing what they did to challenge certain beliefs and practices before shifting within the same sentence or narrative into what they promoted instead. For the sake of clarity on what we are describing as two distinct actions (to challenge and to promote), we present results on the two actions separately within each theme, while attempting to adhere to the language of challenge and promote in line with the structure of our DP analytical framework.

The four key themes identified within which MTEs act *to challenge* certain beliefs and practices, and then *to promote* other/alternative beliefs and practices instead are: Theory-practice relationships; Reflection on field placement; What it means to learn mathematics; what mathematics is. It is important to remember that we discuss these four themes in the context of MTE data focused on *post-field* contexts, even though we acknowledge that aspects of the data and discussion may in fact describe other stages of the teacher education program also (e.g., *pre-field* contexts).

4.1 Theory-practice relationships

Within the first theme, we identified actions that MTEs take to challenge aspects of the system which, they believe, serve to sustain a theory-practice (and practice-theory) divide. Then, in turn, we identified distinct actions that MTEs take to promote alternative beliefs and/or practices toward greater synergy between university and the field.

4.1.1 Challenge aspects of the system

Theory-practice relationships could be considered one of the most 'talked about' concepts in research on student–teacher transitions in mathematics teacher education. In our analysis, we noted for instance how CMTE9 talked about a mentor teacher pushing back at what is done in university, coaching the PTs instead on what works in "the real world" and to not worry about "what all those professors told you". CMTE9, among other MTEs in this study, strongly believe that this language of 'what works in the real world' must be disrupted and challenged in the post-field context.

Further actions to challenge the system ranged from challenging/disrupting those activities that are generally considered a priority in teacher education programs (such as lesson planning and grading) to awareness and questioning of structures and discursive practices that perpetuate the 'we-they' language of university-school relationships. For example, CMTE10 spoke about challenging some of the ideas behind designing lesson plans from scratch as an important activity in both pre-and post-field contexts, stating that "there's enough good material for beginning teachers to start with to do a better job than creating it from scratch if you don't have a strong conceptual understanding."

4.1.2 Promote greater synergy

Together with acting to challenge aspects of the system which serve to sustain a theory-practice (and practice-theory) divide, MTEs make it part of their post-field work to promote greater synergy and stronger connections between research/theory and field placement experiences. For instance, some MTEs promoted the idea of "working within the system to disrupt the system" to "growing that space [for change], in small, small, meaningful ways" (CMTE 9). In fact, CMTE9 refers to this approach as her "modus operandi".

While the above is an example of how some MTEs promoted systemic changes to teacher education programs, others advocated for minor shifts in post-field activities, such as lesson planning. For instance, remembering how CMTE10 is challenged by the ideas behind designing lesson plans from scratch, CMTE8 changed this full lesson plan approach to one where she would advise PTs to "spend your time creating that [inquiry] task, because that's what will be hard for you to do. And that's one of the changes I want you to think about in your teaching."

Furthermore, in posing the question of "What happens when they come back?", NMTE10 offers: "I think we need to take the stories they bring back as a point of departure (…) and connect it to the theory they have had." Overall, promoting stronger connections between theory and practice was expressed in a variety of ways by MTEs. CMTE8 spoke about encouraging the shift from traditional to reform teaching as a gradual ongoing process that "doesn't need to be all or nothing". By bringing readings into the post-field context that have been published in professional journals and written by teachers, she spoke about how she tries to motivate the PTs to reconsider the idea that theory can seem very far from practice. Also, regarding the role of theory, CMTE5 claimed that he would be doing a disservice to PTs if he does not "make theory explicit to them, try to make connections so that they can also develop the language of talking about those experiences and grounding those experiences in theories as educators."

Several MTEs commented on their desire to have better synergy between what happens in schools and at university. CMTE4 promoted the idea of "integration with the school" such that PTs could prepare a lesson at university, go teach it in the school classroom and then return to the university classroom to debrief it. In a similar manner, NMTE3 describes a cycle where PTs move back and forth between schools and campus; they plan lessons at campus and try them out in schools. To unpack this process, MTEs select 'golden moments' to discuss in class at campus: "… we are trying to extend and sort of drag the practical experience back into the classroom at the college by discussing, showing these video clips and discussing them." (NMTE3)

Promoting stronger connections and synergy between university and school in the post-field context is closely tied to the next theme generated from the data—the ways in which reflection is carried out in the post-field context.

4.2 Reflection on field placement

The second theme identified in the data concerns reflection on field placement, whether and how it should be done. MTEs challenged the idea that stories from the field are adequate for reflection, while also acting to promote deliberate and critical reflection on specific issues.

4.2.1 Challenge that stories from the field are adequate for reflection

PTs tend to bring many stories of success and failure from different mathematics classrooms to their post-field teacher education courses, and a prevalent approach in the post-field context is to reflect on these stories from the field. There are several strategies reported by MTEs in how they act to challenge or move beyond a 'stories from the field' approach and toward more critical reflection. Firstly, by making explicit connections with pre-field course material and curriculum core elements, and secondly, by being quite deliberate in the choice of readings in the post-field. As CMTE1 noted, "the readings that I choose, I choose them because they push the agenda, then the students reflect on it (…) I really depend on the literature to do the push for me." Finally, to challenge and disrupt the highly individualized 'stories from the field' approach to reflection, one MTE commented that it is their role to use these post-field reflection contexts to challenge the view that the perfect (pedagogical) approach exists:

> They have tried out something in placement that worked very well in one class, and when doing exactly the same in another class it didn't work at all. These things are exciting to talk about after placement, that is, why it worked and why it didn't. (NMTE2)

4.2.2 Promote deliberate and critical reflection

As MTEs shared ideas on how and what to challenge around post-field reflection, they suggested several ways to promote a more deliberate reflection in the post-field context on specific issues. First, regarding PTs' mathematical knowledge, one MTE suggested that focused reflections around the knowledge needed when teaching mathematics in their placements may help PTs see "that that they must actually *know* the mathematics" (NMTE1). In this regard, NMTE2 noted how it is possible to use examples from field placement to uncover misconceptions in PTs' mathematical knowledge:

> I think it is important to show student examples, both with misconceptions and other types (…) I use this consciously; if I know that they struggle with algebra, I use the fact that students in school think this is hard (…) they discover misconceptions I fear they have themselves (…) In this way I use examples from practice to strengthen their mathematics understanding. I am kind of tactical, right, I pretend that they know that this isn't right, but say instead that some students may believe this is true….

Secondly, our analysis uncovered how MTEs used stories of 'risky' pedagogy to promote a more deliberate reflection in the post-field context. In the words of CMTE8, sharing successful reform-based teaching experiences "will encourage the other students [who] think that this is not possible." CMTE6 expressed confidence that everyone can benefit from hearing "yet another example of reform-based teaching from a peer who's doing it in a real-life classroom." In line with this idea, NMTE1 shared a strategy of asking PTs to discuss in small groups a "mathematics lesson that had not been traditional":

> I think that some of the students felt that others had dared to try, and in a way, felt they had managed to conduct a slightly different type of teaching. So, it may be that, in a way, hearing that the fellow students dare to make it happen is, in a way, more inspiring for them than hearing that we, teacher educators, who they know are professionally confident, say that they can do it.

A third way of promoting a more deliberate reflection in the post-field context was to involve mentors more. In speaking about how mentor teachers are often involved at campus before field placement, NMTE5 had a moment of insight about how to use the mentor teachers in the post-field context. She stated "you made me think that it's something we'd like to do afterwards as well, that they can come in [at campus] and reflect with us." A similar idea was expressed by NMTE10 who advises: "[g]et the voices of the practice teachers on campus. This could be a way to try to bridge things since we are all teacher educators [both MTEs and mentors]."

4.3 What it means to learn mathematics

In the third theme generated from the data, we learned how important it is for many MTEs to challenge what it means to learn mathematics by disrupting PTs' negative experiences in learning mathematics and, in turn, acting to promote more meaningful ways to learn mathematics.

4.3.1 Challenge negative experiences in learning mathematics

Analysis of the interview data revealed that MTEs commonly adopt an explicit focus on disrupting PTs' negative past experiences in learning mathematics by having PTs first acknowledge that experience and then "challenge them to move past what they think they already know about teaching" (CMTE3). Similarly, CMTE7 reported trying "to disrupt the kinds of experiences they had as learners of mathematics," while NMTE8 noted that her "task is to show [PTs] alternative ways of seeing things."

To disrupt the perception that mathematics is about speed, memorization, and accuracy, CMTE1 offered: "I'm trying to work against their past experiences, and what their understanding of math is—math is fast and something you do alone, and you strive for accuracy, etc. I'm pushing against that." According to CMTE7, this kind of push is especially important for elementary teachers, who "all have something tragic in their mathematical autobiography." Also, with respect to elementary PTs, CMTE9 shares: "I haven't used the word disrupt, but that's exactly what I'm doing. I'm trying to disrupt the narrative about mathematics and what it means to learn and to teach mathematics."

On the other hand, with secondary PTs, who generally report more positive learning experiences, CMTE9 attempts instead to "push back" and draw attention to the fact "that this way of working, worked for them [but] they really need to acknowledge and see who it didn't work for… who was being excluded?"

4.3.2 Promote more meaningful ways to learn mathematics

As discussed in the section above, actions to challenge were often expressed by MTEs as actions that "push back". Together with pushing back on and challenging what it means to learn mathematics, MTEs reported that it is part of their post-field work to promote and introduce more meaningful ways to teach and learn mathematics. They do this through, for example, modeling reform lessons and rich discussions, and helping PTs to notice this modeling.

CMTE8 reported taking advantage of the post-field context to work with PTs "to open up their minds," telling them that "there is much more to mathematics education than what you were exposed to when you were a student (…) there is a world of different approaches and different things that you can learn and you can try with your students." To promote these different approaches, NMTE1, for example, offers: "I try all the time to give them tasks that demands of them to think differently when solving them. I try to throw them into the tasks." In a similar manner, CMTE7 disrupts what PTs have experienced as learners by promoting and living out the mantra he refers to as "do first, talk second"; that is, immerse the PTs in a task they have not experienced before as learners and then "pull them out of that experience, and unpack it as teachers. So, what did you notice about your experience? What did you notice about yourself? What did you notice about me as the teacher?… so, there's that really pragmatic piece, but then I lift from there into some of the theory, right?"

It is common for MTEs to promote reform or inquiry-based lessons and rich mathematical discussions through the action of modeling. As NMTE9 shares, "I can try by 'the power of the example' and demonstrate some during the lessons." While this 'power of example,' or modeling approach, was promoted by several others, some MTEs reflected that modeling can sometimes be 'lost on' PTs. They recommended using an approach that helps PTs notice when and how the modeling is being done. For instance, CMTE1 shared "what I'm trying to do is model [what's in] the readings we have (…) So sometimes, towards the end of [the course], I will get a student reflecting, they'll read the article and say, 'Oh, that's what you've been doing in class. You know, I get it now'." According to CMTE3, modeling

often results in PTs "really wanting to turn around and do it themselves."

4.4 What mathematics is

The fourth theme identified in the data focuses on MTE reported actions that call into question how mathematics itself is viewed. MTEs reported actions to challenge what mathematics is through critical reflection with their PTs on how mathematics is currently defined and experienced. Then, on the actions to promote side of things, MTEs offered ideas toward a different vision/reality for what mathematics is or can be.

4.4.1 Challenge what mathematics is

While some MTEs reported focusing on improving/increasing PTs' mathematics content knowledge, others noted their explicit focus on challenging and changing how mathematics is viewed. CMTE7 notes: "I decided a long time ago that it's much easier to shift what mathematics is [than] to shift the learner to match mathematics." He comments on the difference between these two approaches when working with PTs:

> [My] goal is to shift what mathematics is, so that they can build a relationship with mathematics by changing what math is. And I would say that some of my peers do it the other way—they still think that if we just focus a lot on content, I can shift the learner or the teacher closer to where mathematics is.

CMTE8 also commented on the importance of helping PTs work toward building a different relationship with mathematics by reminding them that "there is more to math, it's not only about procedures, it's not only about memorizing (…) So that's what I'm doing, changing that relationship, opening up their minds."

This theme of challenging what mathematics *is* differs significantly from the previous theme (4.3), which focused more on opening up what it means to *learn* mathematics. CMTE9, for example, conveyed how part of her role in the post-field context is to "break apart what they think they know [about mathematics], to put it back together." CMTE9 claimed:

> And to me that isn't just about the pedagogy, but it's also about the mathematics (…) if I can get them to think mathematically in different ways, and to see how things are connected, that they never thought about before, then that, to me, is a huge win, because then they're opened up to something a little bit different.

To build and/or change one's relationship with mathematics, NMTE6 advocates for digging deeper into mathematics (what it is and how it could look different from what PTs have experienced): "we build the mathematics bit by bit and (…) [the PTs] enter a new world, sort of like a fantasy world, and it disrupts, because the mathematics becomes so different from what they know from before."

Finally, NMTE 5 spoke about those PTs who have done well in mathematics because they have solved as many tasks as possible in the shortest possible time: "We must challenge them on what mathematics *is*, and next, what *is* mathematics teaching?"

4.4.2 Promote a different vision/reality

Together with challenging what mathematics is, MTEs report that part of their post-field work is to promote a different vision/reality for what mathematics is or can be. To do this, MTEs suggested focusing post-field reflection on PTs' beliefs about mathematics and being/becoming a teacher while at the same time promoting a mathematics for all approach which displays patience and humanism. With respect to beliefs, CMTE3 shared how she tries to "push [PTs] beyond thinking about math as what their experiences have been up to this point," offering:

> I have them look at their own stories and unpack where those beliefs came from. And are those beliefs that they want for their own students? (…) Don't tell your students you didn't do well in mathematics, because now you're normalizing that it's okay not to do well in mathematics.

Regarding a mathematics for all approach, CMTE1 clarifies: "[M]y big push is that mathematics is for everyone. It's not for the gifted. It's not for the privileged. (…) Not only is mathematics for all students, I think it's for all teachers."

According to CMTE6, a mathematics for all approach would include conversation with PTs to "reinforce that we're all people, that they themselves are people, so they need to tend to themselves and take care of themselves mentally, physically, emotionally."

5 Results and discussion

Given these four themes 'to challenge' and corresponding actions 'to promote', we now return explicitly to discuss the role these challenges and promotions play as two questions in our DP-framed analytical framework. While the design of our study, including our interview questions, explicitly focused on the language of disruption and DP, MTEs' comments around post-field disruptions and DPs emphasized the careful and nuanced approaches that are necessary. MTEs highlighted the need to take small steps toward disrupting the dominant. For example, CMTE9 reflected that "some of the words in [the DP definitions] seem really strong

and forceful, and an image [I have] is like running amuck through the streets of mathematics [shouting] 'Nobody's gonna learn Pythagorean Theorem', or whatever." Similarly, CMTE7 offered a perspective that supports the approach we have taken in this paper in presenting actions to challenge and actions to promote together, as a complementary pair:

> When we disrupt, we can't just walk in and drop the bomb and then walk out, but we have to be there to clean up the mess that the disruption creates… I'm trying to get students or teachers to reject the current paradigm, but I'm doing it hand in hand with… 'okay, if we're going to reject that, here's an alternative'. Rather than reject, reject, reject, reject, reject (…) when we disrupt, we make a mess, and we can't wait too long to clean it up.

Overall, we found that MTEs were supportive of how, in this study, we have carried DP from its roots in technology innovation and related issues (e.g., Beighton, 2017; Christensen, 1997; Mills, 1997) into the fields of mathematics teacher education research. With that said, our findings—presented through these four themes—place us in an uncomfortable position with respect to the goals of our DP framework. Carfeul study of the themes and corresponding supporting data excerpts draws us to question whether MTEs' reported actions are, in fact, explicitly disruptive to normalizing discourses, as described by Mills (1997), or if they publicly challenge [PTs'] epistemologies, as put forth by Anderson and Justice (2015). It is our interpretation that the actions reported by MTEs in this study do not go far enough toward disrupting practices that PTs see and do in their field placements. As noted earlier, too little progress is being made toward addressing issues of equity, diversity, and social justice in the preparation of mathematics teachers; marginalizing discourses must be explicitly acknowledged and disrupted. A soft (that is, non-disruptive) approach of, for example, discussing lesson planning, reflecting on attempts at reform pedagogy and inviting mentors into post-field conversations is not enough to bring about shifts in inequitable and unjust classroom practices of school mathematics and becoming a teacher.

To gain a more productive perspective on the disruptive (or, as the case may be, non-disruptive) nature of MTE reported actions in the post-field context, we propose the construction of a DP continuum as a tool for visualizing and assessing MTE actions. We claim that MTE actions can be seen to fall somewhere along a Disruptive Pedagogy Continuum, as depicted in Fig. 1.

The quotes in Fig. 1 from CMTE10 and NMTE10 (presented in the first and second themes in the results section) provide, we think, clear examples of actions in the post-field context which do not serve to disrupt PTs' beliefs and epistemologies in any deliberate manner. The challenges/disruptions that these two MTEs talk about (structured lesson planning and including mentor voices) are not new or critical issues. Even though these MTEs identified these issues as

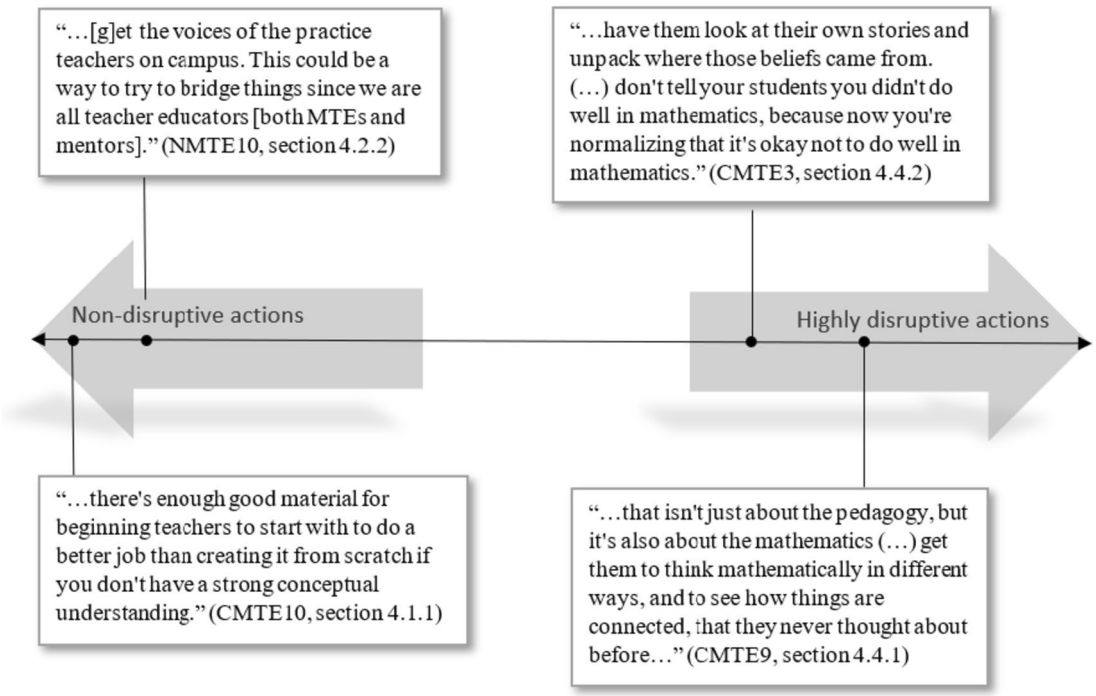

Fig. 1 Disruptive pedagogy (DP) continuum

contributing to a disruptive pedagogy, it is our interpretation that they do little to further an agenda focused on challenging dominant discourses currently sustaining status quo practices and the marginalization of many students in school mathematics classrooms.

On the other hand, we interpret the words of CMTE3 and CMTE9 as demonstrating progress toward the highly disruptive end of the continuum. CMTE3 cautions against 'normalising' the discourse commonly heard among students in school mathematics—that one is either good at or not good at mathematics—a discourse that serves to sustain "the dominant culture characterizing mathematics education [as] a culture of exclusion" (Vithal et al., 2023, p. 6). CMTE9's quote is one example of how some MTEs spoke about their actions to challenge dominant forms of mathematics by promoting alternative forms of knowing and doing mathematics. In sum, CMTE3 challenges the idea that only some students can be successful in learning the dominant, western forms of mathematics whereas CMTE9 directly challenges the dominant, western forms of mathematics, to "think mathematically in different ways."

6 Conclusions

In this study, we aimed to gauge where the field is presently positioned in terms of disruptive practices in mathematics teacher education post-field contexts. To this end, we have interpreted our data and findings by imagining a continuum, from not very disruptive at all (non-disruptive actions) through to actions which clearly modeled some of our definitions for DP (highly disruptive actions). Given the themes generated from the 21 MTE voices, we are not yet overly optimistic that MTEs are working in a focused and deliberate manner to disrupt certain beliefs and/or practices in the post-field context. However, given our explicit moves to introduce and define disruption in our research interviews, we note that some MTEs reflected on how the language of disruption is promising:

> I think I present some ideas for discussion in class that are disruptive in nature, although I think I never labeled them like that. So, I think I never thought about what I'm doing in class as something that carries that meaning of a disruptive approach to education, but I think I would fit in that category. (CMTE8)

Until the language of disruption becomes more common, we claim that actions seeking to disrupt will likely remain inadequate. To move along the continuum from non-disruptive to highly disruptive actions, MTEs will need to more fully embrace the language and actions of DP. Without this, PTs and MTEs are unlikely to have disruption-focused conversations in the post-field context.

This research points to the value of seeking out and listening to the voices of MTEs as well as creating spaces for them to support and act together, as a collective, on these issues of disrupting. Possible spaces for this to happen are discussed in Bjerke and Nolan (2023) as hybrid "post-field third spaces" where there can be an explicit focus on unpacking the field placement toward "teaching practices which promote change in the existing relations of power within schools" (Mills, 1997, p. 39). We fear that if this does not happen—if these spaces are not created—then MTEs could become resigned to doing nothing to disrupt.

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Declarations

Conflict of interest The authors have no competing interests to declare.

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