

Mapping the Landscape of Mathematics Teacher Educator Practices, Preparation, and Support

Stefan Zehetmeier
University of Klagenfurt

Hilda Borko
Stanford University

Birte Friedrich-Pöhler
University of Potsdam

Ronnie Karsenty
Weizmann Institute of Science

Francisco Rojas
Universitat Autònoma de Barcelona

Bettina Rösken-Winter
University of Münster

Received: September 2025 || Accepted: August 2026

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This article presents a comprehensive mapping of the field of professional practices, preparation, and support for mathematics teacher educators (MTEs). It synthesises insights from three editions of the international conference (Congress of the European Society for Research in Mathematics Education [CERME]) dedicated to this crucial yet often under-examined area of educational research and practice. The conferences, held between 2021 and 2025, have served as critical junctures for sharing cutting-edge research, innovative practices, and pressing concerns related to those who prepare and support the next generation of mathematics teachers. This conceptual contribution aims to delineate the field's historical development, identify core theoretical frameworks, analyse prevalent empirical methodologies, summarise key research findings and articulate emerging issues and future desiderata. It is grounded in the collective expertise of a team of researchers actively involved in these conferences and possessing extensive experience in mathematics teacher education. This article synthesises significant conference contributions, offering a systematic and integrated overview that reveals the field's contours, interconnections, and gaps, and draws a holistic map of the field as it has evolved over recent years.

Keywords • mathematics teacher education research • teacher educators • frameworks • methodologies

Introduction and Rationale

The quality of mathematics education hinges on the expertise and preparation of those who educate teachers. Although extensive work has investigated mathematics teachers—their knowledge, practices, beliefs, and professional development—the role of Mathematics Teacher Educators (MTEs) has received comparatively less attention. This oversight is consequential because MTEs mediate the intersection of mathematical content knowledge, pedagogical expertise, understandings of teacher learning, and responsiveness to dynamic educational contexts. Consequently, the effectiveness of teacher-preparation programs—and, ultimately, student outcomes in mathematics—depends on these often-unseen professionals.

MTEs come from diverse backgrounds (mathematicians, practising teachers, and mathematics education researchers), each of which poses distinct challenges for novice practitioners. In in-service contexts, the feasibility of scaled professional development (PD) hinges on the quality of the MTEs who facilitate sessions: they must remain faithful to program goals while attuning to teachers' needs and contexts (Borko et al., 2014). In pre-service settings, MTEs are expected to be adaptive—delivering tasks that develop core mathematical ideas while tailoring instruction to prospective teachers (Goos & Beswick, 2021).



A substantial body of work in mathematics education has explored PD and MTEs from multiple angles—preparation, learning trajectories, and development (e.g., Borko et al., 2015; Goos, 2009; Schüller & Rösken-Winter, 2018); MTEs’ skills and knowledge (e.g., Elliott et al., 2009; Lesseig et al., 2017; van Es et al., 2014); evolving practices (e.g., Coles, 2019; Prediger & Pöhler, 2019); and methodological considerations (Prediger et al., 2019). Recent references (see the following section, “Historical Trajectory”) underscore that this field is still unfolding.

This paper arises from the need to synthesise existing knowledge and map the evolving field of MTE research. It reflects the collective insights of researchers engaged in CERME’s three editions (2021–2025) within the dedicated Thematic Working Group (TWG) on MTEs’ professional practices, preparation, and support. European Society for Research in Mathematics Education (ERME) conferences have served as pivotal platforms for sharing advances, innovations, and pressing concerns related to those who prepare and support mathematics teachers.

The field of MTE research is increasingly recognised as distinct and rapidly evolving, yet a consolidated overview is lacking. While teacher research spans a longer history, MTEs have only recently been synthesised into a coherent domain. This nascent status motivates a systematic field map to delineate core themes, theoretical frameworks, and methodological approaches, providing a resource for researchers, policymakers, and MTEs and identifying avenues for future work. Additionally, the research landscape draws on diverse theoretical perspectives and traditions, often without a unified synthesis. This paper addresses that gap by identifying common themes and clarifying connections across research streams, aiming to produce a more coherent understanding that informs both preparation programs and support structures for MTEs.

To ground the synthesis, we draw on CERME’s TWG 27 materials—conference proceedings, presentations, and discussions from the past three conferences. The analysis was iterative, involving multiple rounds of discussion and refinement among the author team. A thematic analysis identified recurring themes, patterns, and relationships within the data. The data scope was defined with explicit inclusion and exclusion criteria to ensure consistency across years, and a structured data inventory (source type, conference year, author, and excerpt location) supported traceability. Researchers engaged in read-and-re-read cycles, recording analytic memos to capture emerging questions and tensions.

This article offers a holistic map of MTE research as it has evolved in recent years, tracing historical trajectories, examining theoretical frameworks (situated learning, sociocultural theory, activity theory, reflective practice), and prevalent empirical methodologies. By articulating gaps and drawing connections across studies, the synthesis aims to stimulate future work and inform the design of more effective MTE preparation and support. We synthesise recent developments to inform future work.

Historical Trajectory: The Evolution of the Thematic Working Group

Recognising the vital importance of MTE research, a TWG was established at ERME conferences to focus explicitly on MTEs’ professional practices, preparation, and support. This TWG (noted in CERME as TWG 27) is dedicated to current research concerning MTEs, at both the pre-service and in-service levels. Two important (and interconnected) developments should be noted as a historical background for the forming of the group (see also figure 1): The first is the separation of teacher research from MTE research, with the latter gradually emerging as a research domain in its own right within ERME, and the second is the establishment and flourishing of various other formats focused on MTE research, which also affected the recognition of the need to create TWG 27. We provide a brief account of each of these developments.

Separating Teacher Research from MTE Research

Teacher research was present in the ERME conferences from the very beginning. In CERME 1, held in 1998, Working Group (WG) 3 was titled, “From a study of teaching practices to issues in teacher



education,” and although MTEs were mentioned in the introduction to the group’s papers in the proceedings (Krainer & Goffree, 1999), it was mainly in the context of their interactions with teachers and not as an object for research on their own account. Nevertheless, at this early stage, Krainer and Goffree (1999) already advocated that MTEs’ professional communication and growth, with a focus on sharing the problems and challenges they face, should be included in future discussions of teacher education. They recommended forming a research community of MTEs, yet at this stage, MTEs appeared to be seen as researchers who educate mathematics teachers as part of their role.

At CERME 2, within the same group (WG 3), MTEs were still primarily mentioned as researchers rather than as research subjects. The group leaders, however, noted that one of its tasks was to investigate the professional growth of pre-service teachers, qualified teachers and teacher educators (Furinghetti et al., 2002). MTEs’ professional development was seen as a goal, mainly by investigating their practice (Krainer, 2002).

In CERMEs 3, 4 and 5 (2003; 2005; 2007, respectively), as the conferences grew and the number of WGs doubled, teacher research was discussed under WG 12, similarly titled, “From a study of teaching practices to issues in teacher education.” Despite the overall growth and more than 20 contributions in WG12 each year, there was no mention of MTEs as a research subject.

However, these were the years when the seeds of MTE research began to appear. Following isolated pioneering publications, such as Zaslavsky and Leikin’s (2004) and Even’s (2005) studies on the development of PD providers, in 2008, the fourth volume of the *International Handbook of Mathematics Education* was dedicated to “The mathematics teacher educator as a developing professional” (Jaworski & Wood, 2008). This advancement slowly but steadily permeated into the ERME conferences, and in CERME 7, held in 2011, Sierpinska’s plenary lecture was already attuned to it. In the written version of her lecture, she highlighted MTE research as a distinct topic:

Considerable effort has been put into mathematics education research towards the development of knowledge that could serve as a basis for a professionalisation of the work of mathematics teachers. In recent years, a similar effort has been expended on the work of the mathematics teacher educator.

(Sierpinska, 2011, p. 9)

At the CERME 7 conference, one paper presented in the WG on teacher education (WG 17) argued that teacher professional development should also consider teacher educators’ learning (Zehetmeier & Krainer, 2011). This direction was further intensified in CERME 8 (2013), which saw a considerable increase in WG 17, with 45 papers accepted to this group. For the first time in CERME, MTEs were the focus of research. In a paper by Rowland and colleagues, the introduction stated: “This paper is a contribution to a young field of research, which seeks to understand how teacher educators (specifically, mathematics teacher educators) can gain in wisdom, competence and effectiveness in their work” (Rowland et al., 2013, p. 3227).

CERME9 (2015) was a turning point, with WG 17 replaced by three different groups (now called Thematic Working Groups—TWGs): Mathematics teacher education and professional development (TWG 18); Mathematics teachers and classroom practices (TWG 19); and Mathematics teacher knowledge, beliefs and identity (TWG 20), with a total of 75 papers accepted to these teacher-related groups. The most relevant group for MTE research was TWG 18, which listed this as one of its research topics. Several papers in TWG 18 presented research explicitly focused on MTEs, for example, a protocol for analysing MTEs’ practices (Kuzle & Biehler, 2015) or the instructional coherence of MTEs (Rojas & Chandía, 2015). Another paper investigating two trainee MTEs appeared in TWG 19 (Kalogeria & Psycharis, 2015).

Awareness of MTE research within CERME thus increased at CERME 9. In her plenary lecture at that conference, Novotná noted this increase and emphasised the importance of studying MTEs to our understanding of mathematics teacher education (Novotná, 2015).

Interestingly, at CERME 10 (2017), no papers in TWG 18 explicitly referenced MTE research. In CERME 11 (2019), however, it became clear that this field was more relevant than ever, with participating researchers putting the spotlight on diverse issues such as identity formation of MTEs (Goos & Bennison, 2020); becoming MTEs (Helliwell & Brown, 2020); MTEs’ understanding of



mathematical knowledge for teaching (Dahlgren et al., 2020), and more. Not only was the professional development of MTEs mentioned as part of the agenda for TWG 18, but also an emerging issue resulting from the group's discussions was, "The crucial role of the teacher educator/mediator/facilitator and how he/she may be trained" (Zehetmeier et al., 2020, p. 3189).

At this point, the ERME board suggested separating MTE research from teacher research and creating a new TWG focusing on the former. As mentioned earlier, this decision was also affected in many other ways by the field's development, as detailed next.

The Establishment and Flourishing of Various Formats Focused on Mathematics Teacher Educator Research

The years 2009–2019 were prominent in the development of this research field, marked by the following occurrences:

- The biennial conference Educating the Educators (ETE) was established, continuing to gain popularity from its first event in 2014 in Essen, Germany (to date, five ETE conferences have been conducted).
- Journal Special Issues featuring studies on various kinds of MTEs were published, for example, Interactive practices in promoting professional development of didacticians and teachers of mathematics (*ZDM*, 46(2), 2014); Evidence-based CPD: Scaling up sustainable interventions (*ZDM*, 47(1), 2015); Designing, facilitating, and scaling-up video-based professional development: Supporting complex forms of teaching in science and mathematics (*International Journal of STEM Education*, 4, Article 27, 2017).
- Academic events were held, such as the symposium, "Preparing lead-teachers to become facilitators of peers in professional development scenarios," held at the Weizmann Institute of Science in 2016, the Working Group, "Exploring the role of facilitators in video-based professional development for mathematics," held at PME 42 (2018), and the Theme Group discussing facilitators as supporters of teacher collaboration in the ICMI Study 25, that published its call in 2019.

These activities and trends, identified within and beyond CERME, led to the establishment of TWG 27 ("The Professional Practices, Preparation and Support of Mathematics Teacher Educators"). ERME approved the group at the end of 2019, and the first call for papers and posters was published in preparation for CERME 12. The first leading team included Ronnie Karsenty as leader, and (in alphabetical order), Hilda Borko, Alf Coles, Birte Friedrich-Pöhler, Bettina Rösken-Winter and Stefan Zehetmeier as co-leaders. Prior to CERME 14, Alf Coles was replaced by Francisco Rojas.

Due to the COVID-19 pandemic, CERME 12 was postponed, and the group's first experience was a two-hour virtual event held in February 2021, with 110 registered TWG participants from 36 countries. At this event, the initial agenda of TWG 27 was set around six themes: Conceptualising the profession of MTEs; Knowledge, beliefs, skills and practices of MTEs; Preparing MTEs; Designing professional development experiences for MTEs; Scaling up programs for mathematics teachers; and The influence of current global issues on the role and practices of MTEs.

At this stage the group adopted an important vocabulary distinction: given that various kinds of MTEs are referred to in the literature by many different terms (e.g., facilitators, leaders, mentors, didacticians, PD providers, multipliers, pedagogical instructors, and more), TWG 27 decided to use the terms facilitators and educators to denote MTEs who support the learning of practising teachers and prospective teachers, respectively. This distinction proved useful throughout the group's encounters at three consecutive conferences, though other terms were introduced from time to time (e.g., coaches).

This initial agenda, discussed at the 2021 virtual event, was sustained when TWG 27 met at CERME 12 (also held virtually) in February 2022. At this meeting, 13 papers and three posters were presented (out of 17 submitted contributions) with 21 TWG participants attending the group's sessions (Karsenty et al., 2022). TWG participants were a mix of experienced and novice researchers from nine countries, enriching the discussions. As a result of the meeting, emerging issues were added to the group's



agenda, which we detail later. At CERME 13 (2023), the group finally met face-to-face for the first time in Budapest, with 24 TWG participants from 10 countries who presented 13 papers and 2 posters. The group gained greater visibility through an invitation to present its activities in the designated ERME column of the European Mathematical Society (EMS) Magazine (Karsenty et al., 2024). At CERME 14, TWG 27 saw growth in its scope, with 26 submitted contributions, 16 papers and 4 posters accepted, and 29 TWG participants from 11 countries attending the sessions. More emerging issues were added to the agenda, reflecting previous group discussions. TWG 27 has become a “home” in CERME for researchers actively advancing this emerging field, using multiple theoretical lenses and methodologies.

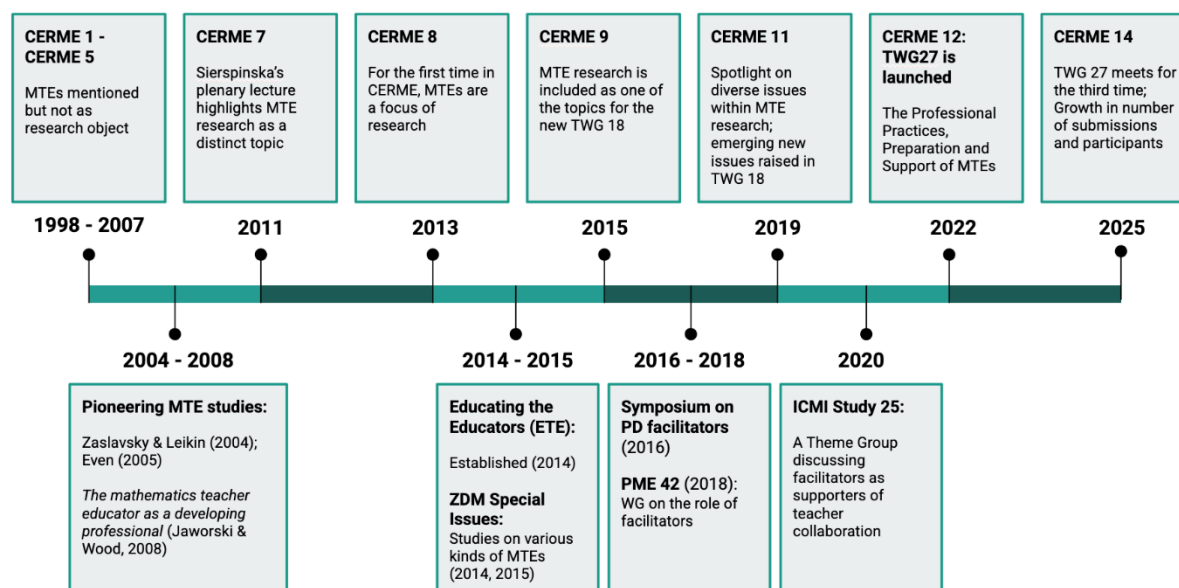


Figure 1: Historical timeline - the evolution that led to establishing TWG 27.

Features of Current Research: Frameworks

Several overarching theoretical frameworks have informed research on the roles and practices of MTEs and on the design of programs to prepare and support MTEs. In addition, more specific conceptual frameworks have guided research and design related to the knowledge, beliefs, skills, and practices of MTEs, as well as their preparation and support. In this section, we first describe the theoretical frameworks most frequently used for MTE research and design. We then focus on the conceptual frameworks.

Overarching Theoretical Frameworks

The theoretical frameworks most typically used to conceptualise the roles and preparation of MTEs include situated learning and communities of practice, sociocultural theory and activity theory, reflective practice and action research, and critical theory. Several papers in TWG 27 are grounded in a situated perspective on knowing and learning. These frameworks emphasise the importance of understanding MTEs' work within its specific contexts and recognising the role of social interaction in shaping MTE knowledge and practice. Learning is conceptualised as changes in participation in socially organised practices (Lave & Wenger, 1991), and the social context in which a person learns is a fundamental part of what is learned (Putnam & Borko, 2000). A situative perspective on learning of practices thus suggests the importance of focusing on authentic activities in which the practices occur.

Coaching, the focus of several papers presented in TWG 27 (e.g., Munson et al., 2025), is one MTE role and set of practices that situates teacher learning in authentic teaching activities. Another situated approach to MTE preparation and support is to use artefacts such as lesson plans and video recordings to bring classroom experiences or Teacher PD (TPD) sessions into the Facilitator PD (FPD) setting (e.g., Borko et al., 2025; Schwartz et al., 2022). Grounded in the concept of communities of practice, Gibbons and Nieman (2023) studied teacher learning in a teacher workgroup supported by a facilitator who structured the group's conversations to foster productive collaboration.

In several projects presented in TWG 27, sociocultural theory and activity theory provide conceptual frameworks for understanding the impact of cultural and social contexts on MTEs' practices and on their learning. Whereas sociocultural theory broadly describes learning as socially and culturally situated, activity theory (Engeström, 2001) considers the activity system—e.g., the individual, goals, tools, and community—in which learning is situated. For example, Marshman and Goos (2025) examined the impact of their respective departments on the experiences of mathematicians and mathematics educators who collaborated to integrate mathematics content and pedagogy into university coursework for preservice teachers. Also, Bogiatzi and Triantafillou (2023) analysed MTEs' activities and the challenges they faced in a lesson on environmental socio-scientific issues through the lens of activity theory.

Reflective practice and action research frameworks emphasise the importance of MTEs engaging in ongoing self-reflection and systematic inquiry to improve their practice. Both frameworks encourage teachers to examine their decisions and actions, as well as the reasons behind them. Action research guides reflection on an area for improvement through planning, acting, observing, reflecting and revising (Kemmis, 2009). Several TWG participants shared what they learned from a systematic inquiry into their practice. For example, Opheim (2025) conducted an action research project to address the question: "How can I design a professional development course for Teacher Specialists in mathematics to make them successful change agents in their workplace?" In a less typical project, Montenegro et al. (2025) investigated the professional learning of a group of MTEs enrolled in an online self-instructional course in which they identified and studied a problem of practice in their experiences educating prospective teachers.

A few papers focused on ways to disrupt the status quo in mathematics education and teacher education. We grouped these papers under the umbrella of critical mathematics education—a theoretical perspective that emphasises social, political and ethical dimensions of mathematics learning; and involves questioning and frequently challenging the status quo. For example, Coles (2022) used the lens of critical mathematics education to consider how global issues and challenges, such as climate change, might be relevant to MTEs' work with preservice and practising teachers. Bjerke and Nolan (2022) used the idea of disruptive pedagogies—pedagogies that challenge the status quo and promote different practices—to investigate MTEs' roles in unpacking prospective teachers' field experiences.

Conceptual Frameworks for Researching Mathematics Teacher Educator Expertise

One group of TWG papers uses general frameworks of knowledge, skills, and practices to study MTEs' expertise. Another group uses these same frameworks to investigate the preparation and support of MTEs. For example, several studies have examined the specialised and pedagogical content knowledge (Shulman, 1986; Ball et al., 2008) required of MTEs (Borko et al., 2014). They used various terms to characterise MTEs' specialised content knowledge (e.g., MCK, MTESK) and pedagogical content knowledge (e.g., MPCK, MTEPCK). Other studies examined MTEs' skills and practices, including feedback practices and the balance between goal focus and responsiveness.

Other articles used more specialised frameworks to design the content of FPD and TPD programs and to study MTEs' expertise. Several studies conducted by scholars at universities in the DZLM (German Center for Mathematics Teacher Education) network used the framework for content-related PD facilitator expertise conceptualised by Prediger et al. (2022). The two main components of this framework are jobs (the situational demands of facilitating TPD most relevant to a specific PD program)



and practices (recurrent patterns of facilitators' actions and statements for managing those jobs). Practices are characterised by four underlying elements that the facilitator implicitly or explicitly draws upon: Pedagogical tools, categories for noticing and thinking and orientations. TPD programs can tailor this framework to specific PD content, such as an area of mathematics or language-responsive mathematics teaching. Several CERME papers used these tailored frameworks to study their TPD programs. For example, Griesse et al. (2022) examined facilitators' views on content goals, thinking categories and pedagogical tools related to teaching conditional probability. Shure et al. (2023) and Wensing et al. (2023) used this framework, together with Leufer et al.'s (2019) FOMSC framework (briefly described below), to examine facilitators' adaptations of the core ideas of PD activities on the operations of dividing and multiplying natural numbers, respectively.

The FOMSC (Follow, Omit, Modify, Sort, Create) framework, developed by Leufer et al. (2019) to study facilitators' practices for adapting TPD materials, guided studies reported in several CERME papers. Other specialised frameworks for studying MTEs' expertise in the CERME papers include professional noticing skills and feedback practices.

Conceptual Frameworks for Designing and Researching Facilitator Professional Development Programs

Several TWG participants presented research about the processes used in programs to prepare and support MTEs. These FPD programs typically were characterised by specialised conceptual frameworks grounded in situated perspectives on MTE learning. The Three-Tetrahedron (3-T) model of Professional Learning Design and Research, developed by Prediger et al. (2019), was used in several studies by scholars affiliated with DZLM (e.g., Bardy et al., 2023; Baumanns et al., 2025), as well as other institutions (e.g., Jarry-Shore et al., 2023). The model extends the didactic triangle of content, students and teachers to a classroom-level didactic tetrahedron by adding the element "classroom resources." Drawing upon the fact that these four elements are also essential to the professional development of teachers and facilitators, Prediger and colleagues (2019) created a TPD tetrahedron in which teachers are the learners; facilitators are the teachers, the PD contents are the aspects of teaching and learning addressed in the TPD program, and the resources are the activities and materials in that program. Similarly, at the FPD level, the facilitators are the learners; MTEs who prepare facilitators are in teaching roles, the content is the substantive focus of the FPD, and the resources are the materials and activities used in the FPD program. The 3-T framework also includes three general strategies for designing programs and conducting research at the TPD and FPD levels, which were illustrated in several papers: lifting, nesting and unpacking. A lifting strategy elevates design and research approaches from the classroom level to the TPD level or from the TPD level to the FPD level. Nesting refers to a design strategy in which aspects of the complete classroom tetrahedron are nested within the TPD content, and aspects of the TPD tetrahedron are nested within the FPD content. Finally, unpacking is a design-based research strategy in which the content at one level is unpacked or analysed in terms of the elements of the tetrahedrons at lower levels. The elements of the three tetrahedrons and their relationships within and across them capture the complexity of learning and teaching at the classroom, TPD, and FPD levels.

Other frameworks have been used less frequently to study FPD programs. For example, the nested model of facilitator professional learning described by Moeller et al. (2023) is very similar to the 3-T model. However, it is based on the didactic triangle rather than the tetrahedron. The Learning to Facilitate Framework (LTFF) (Borko et al., 2025) draws upon a framework for preparing teachers developed by Grossman et al. (2009) that consists of three teacher education pedagogies—representations, decompositions, and approximations. The LTFF lifts this framework to the FPD level and makes three adaptations: 1) adding a fourth pedagogy of selecting a situational demand central to TPD facilitation; 2) replacing decomposing with unpacking—whereas decomposing focuses on practitioners' observable practices, unpacking also surfaces the rationales underlying visible practices and the planning that precedes these practices; and 3) allowing flexibility in the order and recurrence



of pedagogies. Other presentations focused on preparing facilitators to lead specific TPD programs and were grounded in the programs' TPD conceptual frameworks; for example, preparing facilitators for the Professional Learning Opportunities for Teachers (PLOT) program (Ferreira et al., 2022) and for the Viewing, Investigating and Discussing Environments of Learning Mathematics (VIDEO-LM) project (Schwartz et al., 2022).

Features of Current Research: Methods

Various methods are used in research on MTEs, particularly regarding their roles and practices. In this section, we do not provide a complete survey of these methods; rather, we show which methods are represented in the papers of TWG 27 at CERME 12, 13, and 14. This collection of contributions can be seen as an international sample of state-of-the-art research in the focused domain (see figure 2).

Most of the papers used qualitative approaches. Quantitative approaches are the exception and are mostly combined with qualitative analyses. (e.g., Montenegro et al., 2025; Moeller et al., 2023). For example, Montenegro et al. (2025) reported conducting their study in a quasi-experimental, mixed-methods, pre-post design with 28 MTEs. In addition, most studies (especially those presented at CERME 12 and 13) researched groups with fewer than 10 MTEs (e.g., Coles, 2022; Jarry-Shore et al., 2023; Marshman & Goos, 2025). Larger PD programmes (such as QuaMath in Germany or Math for all in the United States) have recently enabled the collection of larger samples (e.g., Shure et al., 2025; Baumanns et al., 2025, each with more than 140 MTEs, and Moeller et al., 2023).

The research area and the contributions submitted to TWG 27 for CERME 12, 13, and 14 employed various empirical methods with distinct potentials and objectives. These include studies with a cognitive perspective with a focus on MTEs' knowledge; a situated perspective with a focus on the analysis of MTEs' practices, for example, by means of videos of PD courses, video vignettes or discussions of exemplary teacher statements; and also studies that combined the advantages of both perspectives (Prediger et al., 2022).

Many of the studies presented at the three CERME conferences are case studies (e.g., Gibbons & Nieman, 2023; Pérez-Montilla et al., 2025), which provide in-depth understandings of MTE roles, identities, practices or knowledge in specific contexts like the teaching practicum or the collaboration between the mathematics and education discipline communities. Some MTEs also conduct self-studies, which provide, for example, insights into their own perceptions of the MTE role, identity, practice, or knowledge, and help MTEs explore and enhance their practice (Lovemore, 2025). Some of these studies have a longitudinal design (e.g., Marshman & Goos, 2025) in which the trajectories of MTEs are traced and revealed. In addition, action research (e.g., Lovemore, 2025; Opheim, 2025) and design-based research (e.g., Keijzer & Veldhuis, 2023; Wensing et al., 2023) are conducted in this area. The aims are to investigate the impact of interventions on MTE practice and to derive implications for the development and adjustment of a PD course.

For data collection, often also interviews with the MTEs are used to explore their beliefs, values and experiences, to gain insight into their views on their professional roles, contents or goals for PD courses or their perception of their practices and to understand their design decisions (e.g., Alfaro-Viquez, 2025; Coles, 2022; Jarry-Shore et al., 2023). In addition to the interviews (online or in person) with the MTEs, in some cases, group interviews with teachers or focus groups (Montenegro et al., 2025) of teachers are conducted to investigate the impact of MTEs' practices or to analyse what teachers who participated in a PD course consider crucial topics and opportunities for strengthening mathematics teacher educators' professional development. The interviews are often semi-structured (e.g., Alfaro-Viquez, 2025) and, less frequently, narrative in nature (e.g., Coles, 2022). In addition, interviews with MTEs reflecting on classroom videos shown (Rodríguez-Segarra et al., 2025) or problem-centred interviews (PCI) for investigating why particular views, opinions or beliefs of MTEs are prevalent and for making MTEs aware of beliefs by means of reflection on intended action in their PD sessions are analysed (Erens, 2025).



Furthermore, several papers provide analyses of observed PD, workgroup or coaching sessions, planning conversations, post-lesson reflection meetings, or (reflecting) group-discussions (e.g., Bardy et al., 2023; Gibbons & Nieman, 2023; Jarry-Shore et al., 2025). For this purpose, field or observational notes, video recordings, audio recordings, or artefacts such as planning structures or the group's written record of the planning process are used. The analyses focus, for example, on patterns and shifts in facilitators' practices or knowledge by uncovering the principles underpinning their contributions (Munson et al., 2025) or on moves the MTE employed to orchestrate teachers' interactions (Gibbons & Nieman, 2023; McKie et al., 2025). To obtain focused perceptions from MTEs on student thinking or on MTEs' decision-making regarding teachers' ideas about student learning in PD situations, situated multi-part instruments are also being developed (Shure et al., 2025).

Some studies also conduct document analyses, in which researchers examine curriculum materials, assessment tools, or other relevant documents. Specifically, for example, Baumanns et al. (2025) analysed written reflections of MTEs on teaching experiments, revealing their understanding of the principle of conceptual focus—one central principle of the designed PD course.

Whereas the quantitative-oriented study of Montenegro et al. (2025) involved using a questionnaire with 30 items to collect pre- and post-test quantitative data on MTE's professional learning and research disposition, the quantitative part of the study by Moeller et al. 2023 used a pre-survey with 40 different items and a post-survey with 28 different items to investigate MTEs' characteristics and views and experiences with implementing the PD program. In addition, Giadas et al. (2025) include a questionnaire to understand and explore teachers' perceptions of MTEs' knowledge in their qualitative study. Beyond the data types mentioned so far, also reflective journal entries, written statements of MTEs, brief student surveys (Jarry-Shore et al., 2025), observation forms to collect data about the implementation of key workshop elements (Moeller et al., 2023), students' reactions and feedback on the PD course or written planning documents for own PD sessions (Şahin-Gür & Prediger, 2023) are considered.

For data analysis, often a combination of different methods and instruments is used, different types of data are triangulated, and coding systems are developed or adapted based on various theoretical frameworks (such as the facilitator expertise framework of Prediger et al. [2022], or the FOMSC framework of Leufer et al. [2019]) (see Conceptual Frameworks for Researching Mathematics Teacher Educator Expertise section). Further methods used for data analysis include, for example, thematic analysis (Montenegro et al., 2025) and, in several cases, content analysis (e.g., Erens, 2025; McKie et al., 2025), as well as a systematic comparison of cases. In the quantitative study described (Montenegro et al., 2025), the data collected were analysed using descriptive statistics and paired *t*-tests.

In addition to the empirical contributions whose integrated methods have been briefly outlined here, some papers make a substantial conceptual or theoretical contribution; for example, in the form of the development of a framework (Borko et al., 2025) or focus on the development of a data collection instrument (Rojas & Pascual, 2023).

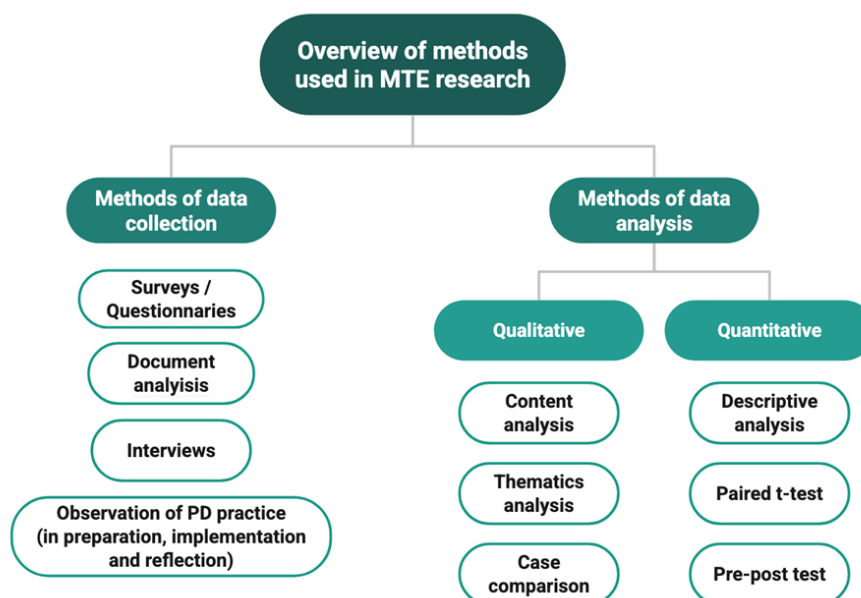


Figure 2. Overview of methods used in MTE research presented in TWG at CERME conferences.

Features of Current Research: Findings

We identified five key research findings across the studies at the last three CERME conferences (see figure 3). First, many studies focus on the impact of contextual factors on MTEs, with institutional policies, student demographics, and available resources significantly influencing their practice. For example, the comparative study of three FPD programs presented by Karsenty et al. (2025) provides a map of structural and institutional characteristics of FPD programmes. According to the authors, this map allows different FPDs to be compared, thereby guiding decisions on creating new ones, e.g., programmes developed in Israel (VIDEO-LM programme: Karsenty & Arcavi, 2017), the United States (Problem-Solving Cycle FPD programme: Borko et al., 2021), and Germany (Mastering Math FPD programme: Prediger et al., 2023).

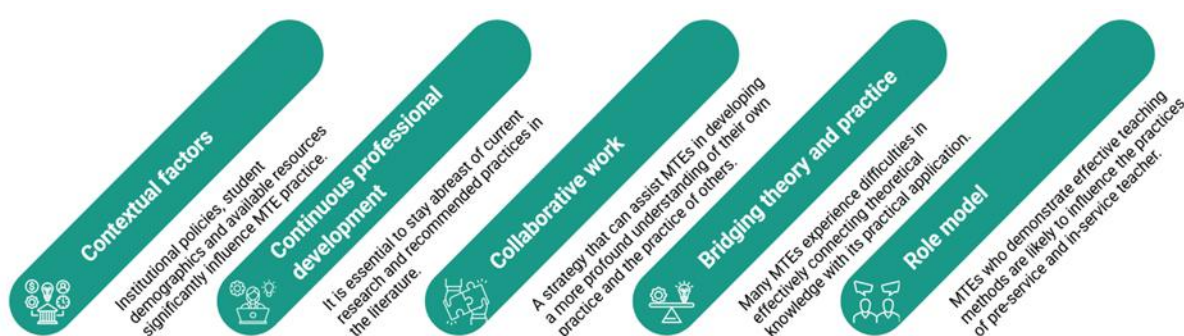


Figure 3. Five key research findings across TWG27 CERME conferences.

Second, MTEs need continuous professional development to stay abreast of current research and recommended practices in the literature. In this sense, mentoring programs have the potential to provide valuable support and guidance for novice and experienced educators and facilitators in pre-service and in-service contexts. For example, Borko et al. (2025) propose a model for designing and analysing the professional development of MTEs in in-service teacher education contexts—the

Learning to Facilitate Framework (LTFF). From a situated learning perspective (Lave & Wenger, 1991), the LTFF is meant for FPD leaders who support facilitators. In pre-service teacher education, studies such as that by Keijzer and Veldhuis (2023) considered which characteristics would be desirable in a professional development trajectory for mathematics teacher educators starting in primary school teacher education. After a study involving three cohorts of teachers, they concluded that these pathways should focus on mathematical knowledge for teaching (MKT; Hill et al., 2008), primary education practice, opportunities for cooperative learning, and the use of practice-based research as a development tool. In this way, these trajectories would contribute to the greater professionalisation of novice MTEs. These are just a few examples of the studies presented at CERME conferences. Many papers, however, describe complex mechanisms that enable MTEs to provide teachers and future teachers with tools that support their professional reflection and foster their professional development.

Third, the authors emphasise the importance of collaborative work as a tool that can assist MTEs in developing a deeper understanding of their own practice and that of others. One of the experiences that highlights collaboration as a key element in the professional development of facilitators is that presented by Jarry-Shore et al. (2023, 2025). In their work, the authors proposed meta-coaching, an approach to facilitators' professional development that emphasises collaboration with expert facilitators. After analysing interviews with coaches and meta-coaches who worked together across several professional development cycles for mathematics teachers, the authors identified emerging themes from the collaboration. However, the themes differed depending on who proposes them. Meta-coaches emphasised that coaches (facilitators) should encourage teachers to change their teaching practices, use different sources of information, analyse their classes, and adapt their teaching to the needs teachers raise. In this last point, meta-coaches agreed with the coaches' view of the essence of their work with teachers. In this collaborative process, it was clear that the coach made significant progress in her knowledge and skills in supporting teachers' professional development. Rojas et al. (2022) proposed a similar collaborative process between an MTE and a critical friend (Schuck & Russell, 2005). In Rojas et al.'s study, an experienced MTE served as a critical friend to explore and discuss the classes taught by a novice MTE. This discussion process was analysed in terms of the different types of questions asked by the critical friend and the novice teacher educator's responses to them, to understand the latter's pedagogical reasoning and teaching practice. This collaboration highlights critical friendship as a means of collaborative professional development, characterising the depth of discussion (descriptive or analytical) and the type of content addressed (professional or educational-mathematical).

Fourth, there is the challenge of bridging theory and practice, as evidenced by the difficulties many MTEs face in effectively connecting theoretical knowledge with its practical application. One experience that linked successfully theory and practice is the QuaMath project (Prediger & Selter, 2024). Developed in Germany, this initiative has enabled the connection of key ideas for professional development in mathematics teaching with the experience of those training to become facilitators. Based on a model that connects what happens in the classroom, in-service teacher training and facilitator training in a nested and aligned manner (Three-Tetrahedron Model: Prediger et al., 2019), various studies were developed and presented at the last CERME conference (for example, Baumanns et al., 2025; Shure et al., 2025; Zastrow et al., 2025). In all of the studies, the facilitators' experiences as classroom teachers were linked to what is expected to be developed in the teacher professional development programme. Another example of professional development experiences for MTEs that attempted to make an explicit connection between theory and practice is the one presented by Montenegro et al. (2025), developed in Chile as part of the RedFID project. In these experiences, educators explored their professional learning by participating in communities of practice and sharing their own experiences and challenges during initial teacher education. This allowed them to develop new tools to investigate their practice, expanding their research knowledge while also enabling them to act in their everyday professional contexts.

Fifth, the studies presented at these conferences highlighted the importance of the MTE role model, also known as teacher modelling. In these studies, MTEs who demonstrated effective teaching methods



were likely to influence the practices of their pre-service and in-service teacher counterparts. In particular, facilitators in in-service contexts model practices for novice or prospective facilitators, while educators in pre-service contexts model practices for student teachers. For example, the study by Alfaro-Vázquez (2025) showed that the different ways in which MTEs explain the reasons for their practice, particularly in algebra and functions classes, have proved to be a key strategy for connecting theory and practice, justifying the working methodologies used and addressing school students' misconceptions. It was observed that the MTEs demonstrated knowledge of the necessary PCK for these content areas and used it to justify their activities.

Emerging Issues and Desiderata

Several key themes emerged from the conference proceedings and discussions, highlighting critical and necessary areas for future research and practice. A significant body of work focused on characterising the practices of MTEs, including planning PD or learning activities for teachers, facilitating productive conversations among teachers (both prospective and practising), and providing effective feedback on their analysis of student work. This was complemented by research exploring the beliefs and orientations of MTEs and how these link to their professional trajectories.

The TWG 27 discussions emphasised that although prior teaching experience is valuable, it is insufficient preparation for the MTE role. Studies emphasised the diversity of MTE roles and the need for specialised preparation and continuous support to develop MTEs' understanding of and skills in reflection, data analysis, and mathematical knowledge for teaching, ultimately leading to pedagogical reasoning. These aspects, however, were deemed insufficient; the most important additional points raised are summarised below. One issue addressed explicitly was the *role of MTEs in bridging the gap between theory and practice*. At CERME 14, the discussion focused particularly on the use of conceptual lenses to analyse corresponding MTE practices. Given the wide range of datasets now available from various projects, a key objective for the community could be to analyse such data from different perspectives. For instance, frameworks could be applied to capture either facilitators' expertise to foster teacher learning or their noticing. This could inform the field and provide an opportunity to connect research projects in different countries. Another issue is the call to make data generated more accessible and valuable in helping MTEs align theoretical aspects with practical relevance.

The TWG 27 discussion at CERME 14 focused on how to efficiently analyse such a large volume of data. This aspect places *data analysis* at the heart of MTE research, balancing macro and micro analyses. Typically, researchers examine MTEs' decisions and practices in detail, favouring a qualitative approach. It is, however, important not to lose sight of the bigger picture in such a detailed analysis. In this respect, the field could benefit from other lines of research, such as studies focusing on the impact of MTE decision-making on teachers and students. Similarly, TWG participants emphasised the potential role of the TWG in advancing the field. As previously mentioned, most of the studies reported in the group were small-scale and qualitative. Therefore, there is an acknowledged need to develop a more comprehensive understanding of the field. For example, areas of research that could benefit from broader studies and a wider range of methodologies could be implemented. This requires larger-scale, more generalisable studies and an understanding of how institutional capacity for teacher learning can be developed during professional development or university studies. This includes identifying the institutional factors that may foster or hinder effectiveness at scale.

Participants added *reflection as a learning mechanism for MTEs* to the discussion. This multifaceted focus primarily concerned the use of reflection to align facilitation practices with teachers' learning during PD courses. The role of reflection was also examined with respect to issues of status and power, and its influence on MTEs' interactions with others, including peers, researchers, and critical friends. This also encompasses the role of criticism and the emotional reactions that emerge during such reflection sessions. The role of emotions, specifically *MTEs' emotional knowledge*, was raised again. This issue of developing MTEs' sensitivity to their (prospective) teachers' needs and specific problems at in-service and pre-service levels was discussed in more detail. Explicit consideration of emotions could



support MTE's learning. In most countries, MTEs are not explicitly prepared for their role, and support with emotional reactions has so far been somewhat neglected.

A key issue that emerged consistently throughout the conference discussions was the importance of *practising specific MTE tasks before actually providing the teacher PD*. For instance, the discussions revealed the importance of facilitating open conversations, a key issue that needs practice before conducting the teacher PD. Alongside this, establishing norms for analysing teaching could help to overcome potential tensions. Using vignettes, videos, rehearsals and other methods to gain an in-depth understanding of potential teacher PD scenarios supports MTEs in this context. As in classrooms, formative assessment tools were discussed for use in the MTE context. Throughout CERME 13, discussions also emerged regarding the crucial role of modelling. In particular, the importance of facilitators serving as role models in PD was examined. In other words, the TWG participants questioned the extent to which MTEs demonstrate the pedagogical practices they advocate. The possible implications of a lack of coherence between the practices MTEs aim to support and their own practices have not yet been explored in detail, nor has this issue been the focus of the articles presented in the TWG at both CERME conferences. As with the aspects above, the triad of educators, pre-service teachers and schools was discussed in depth. In this respect, issues of brokering and tension were also revealed. The need to develop robust strategies to enhance the work of MTEs (including mathematicians teaching pre-service courses) to improve prospective teachers' teaching and learning experiences was undoubtedly emphasised. In particular, the emphasis was on the roles and practices that educators can adopt in their teaching to support pre-service teachers' learning.

As all the emerging issues illustrate, they are related to MTEs, with a particular focus on mathematics. However, these aspects would also apply to other subject areas. TWG participants at CERME 13 and 14 explicitly discussed whether we are losing sight of the content and considered whether we should *pay more attention to mathematics in our MTE research*. While researching MTE practices can be done at a generic level, should we not focus explicitly on the subject matter? Thus, the question of mathematics' role in preparing for and supporting MTEs remains unanswered.

The emerging issues that arose during the conferences, which featured a variety of research projects, highlight areas where MTE research should focus in the coming years. The question, "Where is the mathematics?" is crucial from a content viewpoint. Also, "Have generic aspects received excessive attention to date? Are there any specific aspects of the mathematical content and teachers' learning of mathematics that need to be considered more explicitly, besides integrating current and urgent themes? Do we need more specific frameworks that scrutinise MTEs and teachers' learning from a content perspective?" Another important issue is what can be learned from research at the teacher and student levels. "Which frameworks can be elevated to the MTE level, and which are missing?"

Lastly, we identified an emerging theme: moving beyond what MTEs do to consider how they adapt to *complex contexts and address urgent global issues*. A growing area of research is focused on how MTEs can integrate global challenges, such as climate change, into teacher education. While MTEs recognise the importance of addressing these issues, barriers to curriculum space and assessment regimes limit their ability to do so.

Since MTE research is still developing, qualitative approaches are clearly favoured. However, "When is the right time to advocate for quantitative approaches? How can researchers from different countries and projects collaborate to overcome the inherent limitation of small sample sizes?" MTEs play a crucial role in supporting the education of many (prospective) teachers, but this results in a smaller MTE sample than at the teacher and student levels. Thus, research collaborations could be initiated based on such practical considerations. Given the wide range of topics covered in MTE research, it may be possible to identify a common research goal. At a more granular level, methodological decisions could be informed by the various approaches presented at conferences, offering insight into MTE work. Therefore, plurality could inform common research approaches.

The emerging issues and requirements discussed so far emphasise the strengths of MTE research. The diversity of its approaches provides an opportunity to achieve common goals. The first attempts to characterise MTE approaches have been made (Karsenty et al., 2025), focusing on mapping the



structural characteristics of preparation and support. The next step could be to synthesise these aspects into an open model that can include content-specific and affective-motivational elements, such as emotions on the part of the MTE. The resulting model could then provide a framework for collecting and analysing quantitative data to inform the development of MTE approaches and generate empirical evidence about the role of MTEs in supporting teacher learning.

Summary and Outlook

The research presented in TWG 27 reveals an increasingly vital field focused on MTEs. The work underscores that effective MTEs are not simply strong mathematicians or excellent teachers but professionals who require dedicated preparation, ongoing support, and a deep understanding of teacher learning, pedagogical reasoning, and the complex interplay between context and practice. The analysis reveals a rapidly evolving field grappling with the vital, historically marginalised role of those who prepare and support the next generation of mathematics teachers.

The studies examined across the three CERME conferences illuminate several crucial findings. For example, contextual factors—including institutional policies, school demographics, and resource availability—significantly influence MTE practice. Moreover, the need for continuous professional development for MTEs is paramount, highlighting the value of mentoring programs and ongoing learning opportunities. Collaborative work amongst MTEs is a powerful tool for deepening understanding and improving practice. A persistent challenge lies in bridging the gap between theory and practice; studies emphasising conceptual lenses and practical application are gaining traction. Finally, the importance of MTEs modelling effective teaching strategies and their impact on pre-service and in-service teachers were consistently highlighted.

The emergence of TWG 27 itself reflects a growing recognition of MTEs as a distinct research domain. The field evolved from its roots in broader teacher research, spurred by growing awareness of the specific skills and knowledge required for effective teacher preparation. Research on MTEs draws upon diverse theoretical frameworks, including situated learning and communities of practice, sociocultural theory, and activity theory. These frameworks emphasise the importance of understanding MTE work within its context and recognising the role of social interaction in shaping knowledge and practice. Reflective practice and action research provide methodologies for continuous improvement and self-evaluation. More recently, critical theory has begun to inform investigations into challenging the status quo and promoting equity in mathematics education.

Qualitative research predominates within the field, with studies employing interviews, observations, document analysis, and case studies. While providing rich, in-depth understandings, this often results in smaller sample sizes and limits generalisability. Video recordings, vignettes, and rehearsals are increasingly common for providing concrete examples of practice and facilitating analysis.

The TWG 27 discussions identified several key areas for future research. A central question concerns the role of mathematical content knowledge in MTE preparation and practice. While research often focuses on pedagogical approaches, the need to explicitly address the specialised knowledge required for teaching mathematics was repeatedly highlighted. There is a call to develop more robust frameworks for analysing MTE practice that incorporate content-specific and socio-emotional dimensions. Other emerging issues include the importance of reflection as a learning mechanism for MTEs and the role of emotions in their work. Further research is needed to understand how MTEs can effectively navigate complex contexts and address urgent global issues within teacher education. Developing strategies to bridge the gap between research and practice, including accessible resources and practical tools, is critical. Finally, exploring the triad of educators, pre-service teachers, and schools—examining educators' roles and practices during teaching practice and how to support pre-service teacher learning—represents a promising avenue for future investigation.

The field of MTE research is ready for continued growth. Addressing the emerging issues identified through TWG 27 requires a multi-faceted approach. Collaboration among researchers across countries



and institutions is essential to address issues of sample size and generalisability. The development of robust, mixed-methods methodologies will be crucial. A stronger focus on the specialised content knowledge of MTEs and on integrating emotional considerations will be critical for improving the quality of teacher preparation and, ultimately, mathematics education for all learners. The map of the field presented here serves as a starting point for ongoing dialogue and collaborative inquiry, contributing to the development of a more robust evidence base and the continued professionalisation of this vital, yet often unseen, role in the educational ecosystem. The need to move beyond what MTEs do, to examine how they adapt to complex contexts, and to assess the impact of their practices on teacher learning represents a significant opportunity for future research and a vital step in supporting the success of the next generation of mathematics educators. Looking forward, research must continue to explore how best to prepare and support MTEs as they navigate their complex role. This requires continued collaborative inquiry and a commitment to building a strong, research-based foundation for the mathematics teacher education profession.

Corresponding author

Stefan Zehetmeier
University of Klagenfurt
Sterneckstraße 15
9020 Klagenfurt, Austria
stefan.zehetmeier@aau.at

Competing interests

The authors declare there are no competing interests.

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