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► **To cite this version:**

Helena Montenegro, Francisco Rojas, Salomé Martínez. Mathematics teacher educators professional learning: Evidence from inquiry into their own practice. Proceedings of the Fourteenth Congress of the European Society for Research in Mathematics Education (CERME14), ERME; Free University of Bozen-Bolzano, Feb 2025, Bozen-Bolzano, Italy. <hal-05305187>

HAL Id: hal-05305187

<https://hal.science/hal-05305187v1>

Submitted on 9 Oct 2025

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Mathematics teacher educators professional learning: Evidence from inquiry into their own practice

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Mathematics teacher educators play a crucial role in teacher education, and examining the opportunities that facilitate their professional learning is imperative. In this study, we report how inquiry into one's own practice can be a suitable strategy for this, characterizing the improvements that mathematics teacher educators identify when participating in an e-learning self-instructional course and workshops on inquiry into their own practice. We employed a quasi-experimental, mixed methods, pre-post design; data were collected through an online questionnaire and focus groups. Findings evidence that participants in this professional learning experience perceived they developed new research skills and expanded their knowledge and positioning about research, highlighting that inquiry into one's own practice is a valid genre of research that allows them to improve their prospective teachers' learning. Finally, the implications of these findings are discussed.

Keywords: Professional learning, mathematics teacher educator, inquiry, practice-based research.

Introduction

Teacher educators are seen as crucial agents of change in preparing teachers for increasingly complex and uncertain educational contexts. They ought to model effective teaching practices, engage in research, and navigate multiple roles as researchers, mentors, and career curriculum managers (Lunenberg et al., 2014). In addition, they are responsible for implementing educational policies, reforms, and quality teaching and learning experiences inside preservice teacher education programs (Cochran-Smith et al., 2020). Considering their crucial role in educating teachers, several studies have reported the relevance of supporting teacher educators' professional learning (Kelchtermans et al., 2018; Ping et al., 2018; Tack et al., 2018).

One way to improve teacher educators' professional learning is by developing their inquiry stance and development as scholars and researchers (Cochran-Smith et al., 2020; Murray et al., 2020). According to Willemsse and Boei (2013), teacher educators' research is seen as a means to achieve professional development, improve their classroom practices, and contribute to the body of their knowledge. In terms of mathematics teacher educators doing research, there has been much interest in practice-based research (such as action research, narrative inquiry, and self-studies) to develop a deep understanding of their practice to enhance it (Chapman et al., 2020). When mathematics teacher educators inquire into their own practice, they can develop an inquiring mind, maintaining research-informed teaching and building awareness about the complex task of teaching future teachers (Cochran-Smith et al., 2020; Murray et al., 2020). In other words, practice-based research allows mathematics teacher educators to scrutinize their own practice and, therefore, to support their own growth and professional development.

The RedFID project is an original model of professional learning and development for Chilean mathematics teacher educators. It offers a comprehensive support system, featuring a technological platform with three distinct digital environments: Professional Learning, Communities, and Resources (<https://www.redfid.cl/>). These environments provide mathematics teacher educators with access to a self-instructional professional development course, synchronous workshops, various communities of practice, and a digital library of resources.

This proposal reports the professional development outcomes related to two activities of the Professional Learning environment: the e-learning self-instructional “Inquiry into teaching practice” course and six synchronous workshops to strengthen different teaching and research skills to inquire about their teaching practices. The following research question guides this study: What are the main gains of professional learning in mathematics teacher educators who participate in a formal program to improve their abilities to inquire into their own practice? The research on this topic becomes relevant because it will allow us to systematize the improvements mathematics teacher educators gain by participating in professional learning opportunities focused on strengthening their professional development as teacher educators.

Conceptual Framework

Professional learning for teacher educators

Professional learning for teacher educators encompasses a range of activities and processes designed to enhance their knowledge, beliefs, skills, and practices (Ping et al., 2018; Tack et al., 2018) and is essential for teacher educators to maintain and enhance their teaching practices, research skills, and overall professional growth. Several authors have identified various strategies for improving professional learning among teacher educators: participation in communities of practice that share common interests and goals (Ping et al., 2018), engagement in collaborative learning and reflective practice with other teacher educators (Tack et al., 2018), and conducting research on one’s own teaching practices through practitioner research and self-study (Kelchtermans et al., 2018; Tack et al., 2018). Professional learning is more effective when it is participatory, situated in the workplace, and contextually relevant (Murray et al., 2020; Ping et al., 2018).

Furthermore, the professional learning needs of teacher educators are diverse, reflecting the multifaceted and complex nature of their roles. First, it is crucial to develop specific knowledge and skills related to their dual roles as teacher educators and researchers (Ping et al., 2018) and research skills associated with conducting research and integrating research into their teaching practices (Czerniawski et al., 2017). It is also essential to build a strong professional identity and confidence in their roles as teacher educators (Tack et al., 2018). Finally, staying updated with current research in mathematics education and understanding how to apply these findings to their teaching, ensures they are well-informed and knowledgeable in their field (Martignone et al., 2022).

Inquiry own practice as professional learning

Teacher educators’ engagement in conducting research is a fundamental aspect of their professional development. Ping et al. (2018) in their study point out that many teacher educators highly value research knowledge as essential for their work. This ability to conduct research includes formulating

theoretical frameworks, developing research designs, selecting research methods, and publishing results. However, despite recognizing research's importance for professional development, teacher educators face several challenges. These challenges include a lack of time and insufficient support, knowledge, and skills necessary for undertaking research (Czerniawski et al., 2017; Lunenberg et al., 2014). On the other hand, Lunenberg et al. (2014) highlight another challenge: while institutions expect teacher educators to engage in research, many feel ambivalent about this role. Indeed, they often identify more with their role as educators of future teachers and tend to show greater confidence in this aspect of their work than in their research role (Lunenberg et al., 2014).

Self-study is highlighted as an essential type of practitioner research that enables teacher educators to reflect on and improve their teaching practices, helping them better understand the relationship between teaching and learning in substantive ways (Loughran, 2014; Tack et al., 2018). The outcomes of such inquiries often highlight the role of reframing taken-for-granted practices to become more informed and knowledgeable about teaching and teacher education. Similarly, Murray et al. (2020) discuss how researching one's own practice can lead to transformative practice changes and a renewed sense of agency. This expansive learning involves creating new professional knowledge through research-informed practices, leading to new insights and changes in their professional identities and practices. Through reflection on their own practice and engagement in self-study, teacher educators develop the capacity to examine their teaching practices critically, enhancing their teaching and research skills (Kelchtermans et al., 2018; Loughran, 2014).

Methods

To identify gains in mathematics teacher educators' professional learning, we adopted a quasi-experimental, mixed methods, pre-post design (Creswell, 2014). The sample comprised 28 mathematics teacher educators from 14 Chilean universities, 19 (67.9%) females and nine males (32.1%). The average age of the sample is 47 years, ranging from 33 to 75, and the number of years of professional experience in this group ranged between 1 and 50 years, with a mean of 11 years. Regarding professional and academic qualifications, 16 (57.1%) were mathematics secondary school teachers, 7 (25%) were primary school teachers, 5 (17.9%) had a bachelor's degree in mathematics, and 18 (64.3%) had a master's degree and 10 (35.7%) had a doctorate. Concerning their affiliation with a teacher education program, 13 (46.4%) taught math courses in primary programs, 12 (42.9%) taught math courses in secondary programs, and 3 (10.7%) taught math courses in both primary and secondary programs. Each participant was assigned an identification number (MTE1–MTE28), replacing their names. All participants signed a consent form that followed national ethical standards.

Participants completed an approximately 20-hour online self-instructional course. The course is divided into three modules. In the first module, titled "Why investigate your own practice?" participants explore the concept of teaching practice and the challenges that may arise within it through a case. Each participant must identify and describe a problem of practice based on their experiences educating future teachers. The second module, titled "Approaches to innovate or investigate one's own practice," continues the case discussion by presenting a dilemma: whether to follow an innovation or research approach to address an identified problem of practice. This module clarifies the definitions of researching and innovating in one's practice and analyzes how these

approaches can complement each other when tackling a problem. Each participant is also tasked with proposing an approach to address the problem of practice they identified in the first module. In the third module, “Generating an inquiry proposal,” participants are introduced to key aspects of establishing a clear purpose and analyzing the feasibility of developing an inquiry project. By working on their identified problem of practice, participants create a proposal that includes the problem they wish to address, the purpose of their inquiry, the chosen approach, and an analysis of how feasible it is to implement their proposal. After completing the course, mathematics teacher educators participated in 6 synchronous workshops to strengthen different research skills. These workshops allowed participants to complement the knowledge and skills gained from the online course in a practical setting. Figure 1 summarizes the course and workshops in which mathematics teacher educators participated.



Figure 1: The course and workshops that mathematics teacher educators participated in

The research strategy used for collecting pre and post–test quantitative data was a questionnaire, whereas focus groups were used for collecting pre and post–test qualitative data. The questionnaire contained 30 items rated on a 5–point scale, from “I fully disagree” to “I fully agree”. The items were adapted from the survey on teacher educators’ professional learning developed by Ping et al. (2020) and the teacher educators’ researcherly disposition scale developed by Tack and Vanderlinde (2016). The questionnaire has five scales: disposition to research (6 items), appraisal to research practice (5 items), appraisal to innovation practice (5 items), teaching for teacher education (8 items), and research for teacher education (6 items). The pre–test questionnaire data were collected at the beginning of the course in January 2023, and the post–test data a year later in January 2024. Descriptive statistics and paired t–tests were applied to analyze the data gathered.

The focus groups were organized to be conducted during two National Seminars of Mathematics Teacher Educators held by RedFID. Pre–test focus groups were conducted with participants who would take the course in December 2022 (n=31), and post–test focus groups were performed with participants who finished the course and actively participated in the different workshops in December 2023 (n=28). In pre–test and post–test focus groups, questions focused on how participants view professional learning and what they consider crucial topics and opportunities for strengthening mathematics teacher educators’ professional development. A thematic analysis was done to identify recurring themes in the data (Clarke & Braun, 2017). While analyzing the data, two research team members cross–verified the coding of answers and jointly refined the different codes and categories

of analysis wherever necessary. That way, a high degree of consensus was achieved in the coding strategy, increasing the validity and trustworthiness of the data analysis (O'Connor & Joffe, 2020).

Findings

Quantitative results

The results of the questionnaire show relevant findings. First, as indicated in Table 1, the average scores in the post-test measurement increase in all the scales that measure aspects related to skills and interest in research. Second, only in the “Appraisal to research practice” scale the t-test was statistically significant ($t=2.372$; $df\ 27$; $p<0.05$). Third, we estimated the t-test of the pre-test and post-test scores of all the questionnaire items, finding statistically significant differences in only five items from three scales. From disposition to research scale item 5 “I am familiar with the results of recent research on teacher education” ($t=2.458$; $df\ 27$; $p=0.021$); from appraisal to research practice item 13 “I have experience in developing research on my teaching practice” ($t=3.400$; $df\ 27$; $p=0.002$), and item 14 “I have the methodological knowledge necessary to research my teaching practice” ($t=2.073$; $df\ 27$; $p=0.048$). And from research for teacher education scale item 11 “I have learned how to research my own practice” ($t=3.777$; $df\ 27$; $p=0.001$); and item 12 “I have learned the role of the mathematics teacher educator as a researcher” ($t=2.105$; $df\ 27$; $p=0.045$). These results evidence that participants in this professional learning experience perceived developing new research skills, especially related to researching their own practice.

Table 1: Results of the t-test on the different scales of the questionnaire

Scale	Pre-test score	Post-test score	t	df	p value
Disposition to research	3.77	3.88	0.837	27	0.410
Appraisal to research practice	3.97	4.20	2.372	27	0.025
Appraisal to innovation practice	4.13	4.23	0.699	27	0.491
Teaching for teacher education	3.60	3.42	-0.904	27	0.374
Research for teacher education	3.36	3.58	1.027	27	0.314

n=28

Qualitative results

Mathematics teacher educators highlighted some key features of professional learning and some interesting changes in their approach to practice from the focus group analysis. Participants in the pre-test focus group mentioned two key issues regarding professional learning. On the one hand, mathematics teacher educators emphasise that professional learning allows the construction of different types of knowledge, such as disciplinary (mathematical), pedagogical, and socio emotional. However, it is noteworthy that the professional learning needs expressed by the mathematics teacher educators did not include those related to research and even less so to the research of their own practice: “Professional learning is not only disciplinary, but it has to do with competencies, skills, characteristics and everything that involves my job...” (MTE8, female, 22 years as a mathematics

teacher educator, pre-test FG3). Moreover, professional learning through research is associated with academic research and carried out by a privileged group of teacher educators who have the funds and protected time to conduct it: “With the privileged conditions of the assigned time, the teacher educator can devote himself to research. If these conditions do not exist in an institution, research should be forgotten” (MTE1, male, 40 years as a mathematics teacher educator, pre-test FG2).

On the other hand, since mathematics teacher educators have been involved in this professional learning instance, two main advances have been observed that we consider relevant to highlight. At the beginning (pre-test focus group), the mathematics teacher educators emphasised the need for constant reflection on their practice without necessarily specifying how this would be translated into concrete actions or a working methodology: “I think this is a very practical reflection, to look at oneself and questioning Wow, this year did not work so well for me, what happened? or What should I do?” (MTE21, female, 15 years as a mathematics teacher educator, pre-test FG4). In contrast, in the post-test focus group, participants emphasised not only the reflection of the practice but also that they had already acquired the necessary tools to engage in the process of inquiry into their own practice: “[RedFID] gave me skills, especially related to inquiry one’s practice, knowing yourself, and the knowledge you have [...] I really developed skills that I did not think I had” (MTE10, female, 4 years as a mathematics teacher educator, post-test FG3).

A second advance that is deemed significant pertains to the notion of research as mathematics teacher educators conceptualise it. In the beginning, in the pre-test focus group, several participants realized that research was something foreign to them, of an academic nature, or that it was not directly related to their teaching practice: “We are stuck with academic research... we do not do practitioner research that contributes more to teaching” (MTE11, male, 12 years as a mathematics teacher educator, pre-test FG3). Conversely, a year later, the participants considered research more broadly and recognised its value in fostering their academic careers: “I have broadened what I understood by research, what research was. It has changed my paradigms... Now, I can also investigate myself [...]. It has allowed me to understand that there are other ways of doing research.” (MTE18, female, 15 years as a mathematics teacher educator, post-test FG2). In addition, researching one’s own practice is seen as an option not only to improve teaching practices but also to impact student learning: “Another thing that I learned is that much evidence of our practice allows us to inquire about our own practice, and this is going to have implications in our way of teaching and, obviously, it has an impact on the outcomes of our prospective teachers” (MTE23, female, 4 years as a mathematics teacher educator, post-test FG4).

Conclusions

The present study aimed to investigate the professional learning of mathematics teacher educators who participated in the “Inquiry into teaching practice” course and six workshops as part of the RedFID’s Professional Learning digital environment during a year. We adopted a quasi-experimental, mixed method, pre-post design, collecting quantitative and qualitative data. We found that participants scored significantly higher in their perceptions of gains related to research on teacher education and methodological knowledge and skills for researching their own practice. Furthermore, they expressed new insights about the research practice, emphasizing that researching their practice

as a teacher educator contributes to their own and prospective teachers' learning, evidencing participants expanded their knowledge about doing research and inquiry into one's practice.

These findings are in line with Willemse and Boei (2013), who state that research allows teacher educators to achieve professional development, improve classroom practices, and contribute to the knowledge base of the teacher profession. In addition, these results, despite being in line with the discussion about the research on one's practice as a means to improve the professional learning of teacher educators (Kelchtermans et al., 2018; Loughran, 2014; Murray et al., 2020; Ping et al., 2018), provide new insights of the challenges in doing this genre of research due to the necessity to acquire methodological knowledge and research skills to be able to do it. However, it is relevant to point out that, in general terms, the interest of investigating one's practice in participants has a greater focus on generic pedagogical issues rather than didactic or disciplinary issues associated with the teaching and learning of mathematics. It would be interesting to encourage research into one's own practice linked to disciplinary issues in teaching and learning mathematics to generate bodies of knowledge linked to the teaching of this discipline.

In sum, the present study provides new insights into professional learning in mathematics teacher educators through practice-based research and inquiry into one's practice. However, we must acknowledge the limitations and scope of the results obtained. For instance, the small number of participants in a specific context (Chile) limits the generalizability of the findings to a broader group of mathematics teacher educators. Moreover, this study relied solely on data gathered from questionnaires and focus groups. Incorporating additional qualitative data (such as in-depth interviews and reflective journals) could have offered a more comprehensive examination of the participants' learning experiences.

Despite these limitations, the findings of this study have the potential to contribute new knowledge and practical suggestions for the field of professional learning in teacher educators. We recommend continuing the study of the professional learning of mathematics teacher education through formal professional development programs situated in the workplace and focused on research and inquiry-based learning (Murray et al., 2020; Ping et al., 2018). It is essential to begin systematizing the results of initiatives and professional development programs for teacher educators, identifying good practices and relevant results that strengthen the professional learning of mathematics teacher educators.

Acknowledgment

Basal funding FB210005, Fondef ID21I10067, Fondecyt Regular 1212067, and UNESCO Chair "Preparing teachers to teach mathematics in the XXI century." This study is also supported by GIPEAM–Grup d'Investigació sobre Pràctica Educativa i Activitat Matemàtica (2021SGR–00159).

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