ACTIO: Docência em Ciências
ISSN: 2525-8923

http://periodicos.utfpr.edu.br/actio

Teacher Training in mathematical modeling according to participants in different research studies

Adan Santos Martens
adanm9090@gmail.com
orcid.org/0009-0007-3035-1476
Instituto Federal do Paraná (IFPR), Irati, Paraná, Brasil

Tiago Emanuel Klüber
tiagokluber@gmail.com
orcid.org/0000-0003-0971-6016
Universidade Estadual do Oeste do Paraná (UNIOESTE), Cascavel, Paraná, Brasil

ABSTRACT

Mathematical Modeling has been consolidating both nationally and internationally in the field of research. However, the integration of this trend into Basic Education classrooms has not yet occurred extensively. The continuous training of teachers is highlighted in the literature as one of the factors insufficient for the incorporation of this approach in the classroom. This article aims to understand continuous teacher training in Modeling in a research context based on the testimony of seven teachers who experienced the phenomenon under investigation. In this context, a phenomenological-hermeneutic approach to research is adopted, guided by the following research question: What emerges from continuous teacher training in Modeling, developed within the scope of research, according to the participating teachers? From the phenomenological movement of analysis, four categories emerged from the first author's dissertation, under the supervision of the second author, which are described and interpreted. The hermeneutic analysis revealed the need to develop teacher training programs that go beyond the timeframes of master's or doctoral research, as well as the need to overcome training models that are disconnected from school reality and limited to a mere presentation of Modeling to teachers.
KEYWORDS: Research context; Continuing teacher education; Phenomenology.

A formação de professores em modelagem matemática segundo participantes de diferentes pesquisas

RESUMO

A Modelagem Matemática consolida-se tanto no cenário nacional, quanto no internacional, no âmbito da pesquisa. No entanto, a inserção dessa tendência em sala de aula na Educação Básica não ocorre, ainda, de forma extensiva. A formação continuada de professores é apontada na literatura como um dos fatores que não são suficientes à incorporação dessa tendência em sala de aula. Neste artigo, busca-se compreender a formação continuada em Modelagem em contexto de pesquisa a partir do depoimento de sete professores que vivenciaram o fenômeno investigado. Assume-se, nesse contexto, uma postura fenomenológica-hermenêutica de investigação, direcionada pela seguinte interrogação de pesquisa: O que se mostra da formação continuada em Modelagem desenvolvida no âmbito de pesquisas, segundo os professores participantes? Do movimento fenomenológico de análise, quatro categorias emergentes da dissertação do primeiro autor, sob orientação do segundo autor, são descritas e interpretadas. A hermenêutica realizada revelou a necessidade do desenvolvimento de formações para além da temporalidade da pesquisa de mestrado ou doutorado, bem como para a superação de modelos de formação sem relação com a realidade escolar e a simples apresentação da Modelagem aos docentes.
PALAVRAS-CHAVE: Contexto de pesquisa; Formação continuada de professores; Fenomenologia.

INTRODUCTION

Based on the results obtained from the dissertation of the first author, under the supervision of the second, entitled: “Continuous Training in Mathematical Modeling in a Research Context: A Study Based on Participating Teachers,” this study addresses the following research question: What emerges from the continuous training in Modeling developed within research contexts, according to the participating teachers?

The afore mentioned dissertation filled a gap in the literature by addressing, among other findings, aspects of continuous teacher training in Modeling within a research context, based on the analysis of the participating teachers’ testimonies. Here, we understand training in a research context, or within the scope of research, as that in which the participating teachers become research subjects, and the researcher, by offering the training, aims to collect or produce data for a dissertation or thesis (Martens, 2018; Martens & Klüber, 2023).

The investigation of this phenomenon proved to be relevant, and the results deserve to be shared, as they revealed aspects of the incorporation of Modeling in the classroom. These insights suggest important reflections for thinking about environments for teacher training in Mathematical Modeling in a research context, offering arguments that contribute to the theme of this special issue: "The Constitution of Environments for Teacher Training in Mathematical Modeling."

In this regard, even though the number of training programs and research on teacher training has increased in recent decades in Brazil, as noted by Silveira (2007), Biembengut (2009), Araújo (2010), Bicudo and Klüber (2011), and Villa Ochoa, Soares and Alencar (2019), the results of our research contribute to thinking about this research and practice context. It is important to highlight that the incorporation of Modeling in the classroom has not kept pace with this expansion, indicating that Modeling practices still do not occur on a large scale or are weakly correlated with the number of courses, events, and other formative activities directed at in-service teachers, as we infer from the work of Magnus (2012), Martens (2018), Martens and Klüber (2016a), Klüber (2017), Silveira (2007), and Silveira and Caldeira (2012).

It is worth noting that, in this decade of the 2020s, more than 40 years after the first studies demonstrated the potential of Modeling in mathematics teaching and learning, there is a noticeable strengthening of Modeling in the research field. This is evident as research is now more focused on disseminating Modeling, rather than defining or conceptualizing it, as was described in the earlier works of pioneers who were dedicated to promoting this trend in Brazil (Almeida & Dias, 2004; Barbosa, 2001b, 2003, 2004; Bassanezi, 2009; Biembengut, 1999, 2005; Burak, 1987, 1992; Caldeira, 2005). These earlier works also sought to explore the process of how to implement Modeling (Almeida & Vertuan, 2011; Barbosa, 2004) or highlight its potential for teaching (Burak, 2004; Klüber, 2010).

The consolidation of the research field, both nationally and internationally (Ceolim & Caldeira, 2017), reflects the ongoing efforts of a community composed of students, teachers, and researchers in the fields of Mathematics and Mathematics Education.

The strengthening of the field is manifested through the production of articles for conferences and journals, as well as through the organization of specific Modeling events, such as the National Conference on Modeling in Mathematics Education (CNMEM) and the Paranaense Meeting on Mathematical Modeling in Mathematics Education (EPMEM). Furthermore, the recognition of Mathematical Modeling as a research area or line in master's and doctoral programs across various states of Brazil has also contributed to its advancement and recognition, as evidenced by the research conducted by specialists dedicated to investigating and implementing practices from the early years of Elementary Education (Tortola & Silva, 2021; Veronez & Santos, 2023) to Higher Education (Vertuan, Silva & Borssoi, 2017).

This strengthening of Modeling has occurred primarily within the research domain, but its implementation in Basic Education seems to be happening only tentatively (Martens & Klüber, 2023), indicating the need to question, among other aspects, the continuous training of teachers in Mathematical Modeling, a topic that will be discussed in the next section.

CONTINUOUS TEACHER TRAINING IN MATHEMATICAL MODELING IN A RESEARCH CONTEXT

Teacher training in Modeling is considered a priority (Barbosa, 2001a; Barbosa, Araújo & Caldeira, 2009) for its proper implementation and persistence in the classroom. However, merely introducing teachers to this trend through short-term courses or sporadic training is not enough. To implement Modeling in the classroom, it is necessary not only for teachers to have knowledge of it but also to receive support in their practice (Tambarussi & Klüber, 2014). Additionally, appropriate formative approaches must be created or used while dismantling ineffective ones and reconstructing those that are closer to its proper use (Bellei & Klüber, 2018).

Research focused on investigating continuous teacher training activities in Mathematical Modeling in Mathematics Education has revealed, among other aspects, the importance of teachers understanding and experiencing various perspectives of Mathematical Modeling to utilize them in their pedagogical practice, as highlighted by Abreu (2011). In this regard, Dias (2005) reported in his research that teachers were receptive to the relevance of bringing Modeling into the classroom; however, they expressed insecurities about incorporating this trend into the school environment.

Similarly, Machado (2010), Oliveira (2010) and Ceolim (2015) emphasized in their research that while teachers were optimistic about the benefits of Modeling, they expressed feelings of insecurity, resistance, and discomfort when addressing its implementation in the classroom.

Immersed in the community and aware of the need to make practical advances in teacher training in Modeling, the research group IFEM – Phenomenological Investigation in Mathematics Education, based at the State University of Western Paraná (Unioeste) in Cascavel, PR, has been dedicated to research on teacher training in Mathematical Modeling in Mathematics Education since 2012 (Klüber, 2023).

Various dissertations and theses produced within this group have revealed aspects that suggest a shift in perspective when questioning the advancement of Modeling in the classroom, as highlighted by Klüber (2023). The research belonging to the macro-project "Teacher Training in Mathematical Modeling: Understandings and Unveilings" (2012–2023) signaled important aspects regarding the continuous training of teachers in Modeling (Bellei, 2018; Cararo, 2017, 2022; Loureiro, 2022; Martens, 2018; Martins, 2016; Matioli, 2019; Mutti, 2016, 2020; Santos, 2019; Silva, 2017; Souza, 2022). In summary, they revealed the need to focus more strongly on understanding the meaning of human development, beyond the theoretical and practical objectives of Modeling itself or teacher training (Klüber, 2023).

These findings support and expand on discussions in earlier works. Tambarussi and Klüber (2014; 2017) pointed to the need for research investigating teacher training models in Mathematical Modeling. Questioning these models becomes relevant, especially when reflecting on the limited incorporation of Modeling in the classroom by teachers, as noted by Martens (2018). However, the training models and approaches used require reflection and change in light of teachers' misunderstandings about adopting Modeling in their classrooms.

In agreement, other researchers highlight the need for these training sessions to take the specificities of schools as their "starting point," emphasizing a closer connection between universities and schools (Malheiros, Forner & Souza, 2020). This perspective underscores not only the dissemination of Modeling but also the urgency of adapting training to the specific contextual demands of schools.

Nearly a decade ago, Klüber (2016) questioned the absence of independent Modeling practice collectives outside of research projects. This gap underscores the need for permanent projects, programs, and training centers that are independent of research, re-establishing research as an ally, not a temporal determinant, of school practices.

Next, the methodological procedures relevant to this study will be described.

METHODOLOGICAL PROCEDURES

The investigation that led to this article adopted a qualitative approach based on a phenomenological-hermeneutic perspective. According to Bicudo (2011, p. 41), "[...] to proceed phenomenologically, that is, to carry out the very movement of working with meanings and significances that do not reveal themselves immediately, but rather are constituted and unveiled in different ways [...]," which is a significant challenge. It requires transcending initial impressions and preconceptions. In other words, working phenomenologically is the relentless pursuit of transcending naivety through phenomenological reduction (Bicudo, 1999). One of the great tasks of phenomenological reduction is overcoming natural knowledge through a conscious exercise (Galeffi, 2000).

Therefore, assuming a phenomenological approach to research in the field of education involves seeking the meaning and significance of what is done and chosen. In this process, analysis, criticism, and reflection are constant and essential components, making this investigative method suitable for education. It does not impose a pre-established theoretical or ideological truth but instead seeks to work

with lived realities, aiming to understand what is intentionally pursued (Bicudo, 1999).

In this context, the investigation pursued the research question: "What is revealed about continuous teacher training in Mathematical Modeling developed within research contexts, according to the participating teachers?" To clarify this inquiry as much as possible, the significant materials analyzed were open testimonials focused on the lived experiences of training developed as part of master's and doctoral research projects. These teachers resided in different regions of Brazil.

They were identified after conducting a search in the Capes database of theses and dissertations to find those that aimed to collect or produce data through continuous training in Mathematical Modeling. This search provided an understanding of the scope of Modeling training conducted within Brazilian research and consequently identified the authors of dissertations and theses that offered continuous training in Modeling and used this training as a data source. An email was sent to these authors, requesting, if possible, the email addresses of the teachers who participated in the training courses.

In addition to this initial selection of participants, questionnaires were sent to mathematics teachers via regional education centers in the state of Paraná and through lists of participants in continuous training programs provided by researchers who offered such training across Brazil.

The selection criteria for participants are detailed in Martens (2018) and can be summarized as follows: 1) being a participant in continuous training in Modeling in a research context, and 2) accepting the invitation to participate in our research. From this process, seven teachers became the research participants, whose information is presented in Table 1, using codes to protect their identities. The code identifies each teacher by the letter "P" and a respective number, followed by the city and state where the Modeling training course was offered, the level of education in which they teach, and their teaching experience at the time.

Table 1

Identification of participants, cities, states, and teaching background

Code	State where training was offered	Level of Education	Years of Exerience	State of Employment
P1	Camaçari – BH	Final years of Basic Education	12	BH
P2	Campina Grande – PB	Final years of Basic Education and High School	15	PB
P3	Campina Grande – PB	Final years of Basic Education	5	PB
P4	São Paulo – SP	Final years of Basic Education and High School	25	PR
P5	Guarapuava – PR	Final years of Basic Education	14	PR
P6	Guarapuava – PR	Final years of Basic Education	5	PR
P7	Maringá – PR	Final years of Basic Education and High School	20	PR

Source: Adapted from Martens (2018).

These testimonials were recorded in audio only, using the Aiseesoft Screen Recorder® software, which allowed for the recording of calls via the now-discontinued Google Hangouts®. After this procedure and having the recordings in hand, the audios were transcribed and transformed into written language. Once these spoken texts were converted to written form, it was decided to use the Atlas.ti software for organizing and analyzing the material.

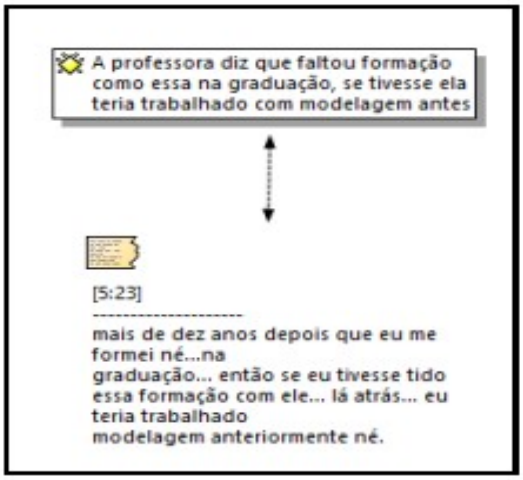
These texts were thoroughly read in their entirety to find a connection with the research question, ultimately resulting in units of meaning. It is important to emphasize that this rigorous process of reading and establishing units of meaning and categories is carried out by the researcher. Atlas.ti is a tool that modifies the visualization and temporality of the analysis; however, the explanation of meanings and interpretations remains the responsibility of the researcher.

Figure 1 illustrates a unit constructed using the Atlas.ti software, established from the original text. At the top of the image is the unit of meaning with its corresponding code, and at the bottom is the fragment of the original text.

The codes for the text excerpts or citations are automatically generated by the software. For example, the code 5:23 indicates the twenty-third citation corresponding to the fifth analyzed testimony. The same citation coding was used for the corresponding unit of meaning.

Figure 1

Unit of Meaning and Corresponding Citation



Source: Own authorship (2024).

In this process, by interpreting convergences among these units of meaning, open categories were established. In Table 2, the four categories are presented along with a brief description of their core ideas. These are represented by the letter "C" followed by a number in ascending order.

Table 2

Open Categories of the Phenomenon of Continuing Education in Mathematical Modeling Developed within the Scope of Research, According to the Participating Teachers

Code	Category	Description
C1	Duration, context of continuing education, and the school	The units of meaning focus on the duration of the training, the setting where it occurs, and how the teachers incorporate Modeling in the school.
C2	Continuing education and the practice of Modeling	These units discuss the training, working with Modeling, and its implementation in the classroom.
C3	Understandings about education	This category presents the teachers' understandings about the training.
C4	Teacher's contact with Modeling	This category relates to the teachers' knowledge of Modeling.

Source: Adapted from Martens (2018).

In the next section, each of the categories is described, followed by their interpretations. The categories are indicated by the letter "C" followed by a number, in ascending order.

It is important to highlight that this study was linked to the research project titled: Teacher Training in Mathematical Modeling in Mathematics Education: Understandings and Unveilings. This project was approved after ethical review by the CEP UNIOESTE – Center for Biological and Health Sciences of the State University of Western Paraná, under process number CAAE 50933215.0.0000.0107.

DESCRIPTION AND INTERPRETATION OF OPEN CATEGORIES

As previously explained, four open categories emerged from the analysis of the testimonies: C1 - Duration, context of continuing education, and the school; C2 - Continuing education and the practice of Modeling; C3 - Understandings about education; and C4 - Teacher's contact with Modeling. Although these categories are distinct from each other, they are interconnected with the phenomenon.

DESCRIPTION OF C1 – DURATION, CONTEXT OF CONTINUING EDUCATION, AND THE SCHOOL

Category C1 is composed of thirty-five units and expresses the duration of the training, its context, and the way Modeling is incorporated by the teachers in the school. The units that make up this category indicate that the training sessions had different time loads: forty hours; two days, morning and afternoon; three months with classes on Saturdays; nine Saturdays; approximately one year; and another lasting two years, with direct involvement from the trainer.

Some trainings were offered to teachers at the University, while others took place remotely. Some were conducted within the University, and others at the

location where the teacher worked, particularly when classroom practices with students were involved.

Regarding how the training developed, the units of meaning indicate that the sessions were divided into theoretical and practical parts. The theoretical part of Modeling was first presented to the teachers, and then the practical part was developed in the classroom, where the teachers worked.

The units indicate that the longer training sessions, lasting about one year and two years, followed a project model executed within the school with the teachers and students, supported by continuous guidance from the trainer. The units also point out that such training fosters a closer relationship between the University and public schools when it involves practical work and takes place in the teachers' work environments.

One of the Modeling training sessions was developed remotely. In this case, all the dialogue and teacher questions were handled using online tools. Teachers had autonomy in how they wanted to work. The training presented how to do Modeling and Modeling problems from different widely recognized authors in the community, including Maria Salett Biembengut, Rodney Carlos Bassanezi, and Jonei Cerqueira Barbosa.

Regarding the implementation of Modeling in the classroom, the category highlights that the training provides a foundation for working with Modeling. However, the teachers' reality in the school does not allow frequent work with this approach. It is expressed that the training is temporary, and the teacher feels the need for further training in Modeling.

The units indicate that the reality of teachers in schools does not allow for planning in the classroom similar to that of the interviewee, who was in training for two years. The extensive workload of teachers prevents them from participating in continuous training. It is evident that current training is insufficient to alter the way the teacher perceives teaching, and it does not change their view of daily school routines. Factors such as the demands of work plans and interactions with others involved in school education may hinder progress in working with Modeling.

Interpretations of C1

This category reveals core ideas of continuous education in Modeling within the scope of the research, according to the participating teachers, such as duration, context, and the school.

Some of the units express that the teacher training sessions in Modeling, within the research context, are mostly one-off, with start and end dates and a predetermined workload. This aspect of the temporality of Modeling training aligns with studies and research already present in the literature (Barbosa, 2001a; Klüber, 2017; Martens & Klüber, 2016a; Martens, Tambarussi & Klüber, 2017; Silveira, 2007; Tambarussi & Klüber, 2014). This temporal issue needs to be overcome through the design, sequencing, and implementation of more extensive, long-term, and institutionally rooted training programs, with closer ties between trainers, researchers, and teachers, as discussed by Martens and Klüber (2024).

The temporal aspect of the training expressed in the units suggests that the Modeling courses offered within the research context only follow the period when the researcher is focused on training, which coincides with the research period that leads to dissertations or theses.

Moreover, as Silveira (2007, p. 92) contributes: "[...] Teachers cannot merely be subjects of research to satisfy the momentary interests of researchers." However, it demonstrates that, even after years of research highlighting the obstacle of one-time, exploratory Modeling training, this profile has not been completely overcome, and researchers continue to return to the field with the intent to offer training for the purpose of investigating it. Nonetheless, there are indications of change regarding this context, as seen in Loureiro (2022), who, by interviewing authors with significant contributions to the Mathematical Modeling community, exposes shifts in understanding regarding the concepts and possibilities of teacher training. This shift is partly attributed to the debate initiated by Barbosa (2001a, b) and more recently by Klüber (2017). It is understood that the teacher training initiated by Klüber et al. (2015) contributed to this resonance between the interviewed researchers.

This category emphasizes the need to develop training beyond its temporality and beyond master's or doctoral research, so that it extends beyond the dissertations or theses. Research-dependent training has largely been restricted to the duration of master's and doctoral programs when it involves fieldwork, as mentioned by Klüber (2017). The training period should be adequate for teachers to implement what they have learned, without depending on external agendas.

It was found that during one of the training sessions attended by the interviewee, the researcher-trainer generally disseminated knowledge about Modeling developed by themselves or the community, so that "teachers" could put it into practice. The training courses the teachers attended tended to follow an "application-based" model of Modeling, centered on itself and not on the problems of the school reality in which the teacher is inserted.

It is inferred that these continuing education sessions had a disciplinary character, similar to that of initial training, where there is a split between theory and practice. This is one of the major problems with teacher training, if not the main one. In this context, it can be said that the training model adopted is, for most teachers, ineffective when it comes to the professional development of their practice, because they are not given the time or opportunity to engage beyond the schedule established by the research.

It is not intended to devalue the researchers' initiatives or their contributions. However, it is understood that the development of know-how—the practical skills—is often sidelined, even in longer training sessions. Regarding these course models, they seem to fall into the category of merely updating training, without deepening, contributing to the lack of implementation of Modeling in the classroom, as the training has little impact on teachers' conceptions of their practice. More recently, Souza (2022) demonstrated the inadequacy of literature studies for the effective practice of Modeling in the classroom, thus clarifying that training that emphasizes reading, discussion, and application, in this sequence, tends to be inappropriate.

In close relation to this, Klüber (2017, p. 8) already stated that "[...] it is no surprise that, in 10 years, we have not managed to achieve the intended or possible progress." Therefore, it is understood that the approach to teacher training needs to change, in other words, "[...] when we think about the tradition of research in master's and doctoral programs, which are short in our country, and we do not have inter-institutional or even interdisciplinary groups, we are left at the mercy of exploratory results that tend to be repeated" (Klüber, 2017, p. 8).

The units that address the moment of implementing Modeling in the classroom express this difficulty. Teachers mention barriers that limit the continuity of working with Modeling in the school after the training. These barriers include heavy workloads that prevent the professional from participating in training, work plans, and pressure from parents, managers, and even other teachers.

Teachers may feel insecure about a possible estrangement and lack of acceptance by other teachers, parents, students, and managers due to a different routine in the classroom. In this sense, it is possible to understand that when training resonates with the school reality experienced by the teacher, it can be potentiated and facilitate the presence of Modeling in the routine of mathematics classes.

As Imbernón (2009, p. 10) states: “We cannot separate training from the work context, or we will deceive ourselves in discourse.” Furthermore, training within the school environment can facilitate teacher participation, as it is possible to schedule training during the period the teacher is already at the institution, avoiding overloading their routine with additional activities.

It is considered that the school should not be seen solely as a space for applying Modeling in training, as it is at least reasonable to admit that, in this space, the teacher will validate, reject, develop, and consolidate theoretical knowledge, (re)signifying their experiences based on their practice in contact with other experiences in the school collective (Tardif, 2002). Thus, the school becomes a space for opportunities to relate theory and practice, so that they move together. Souza’s (2022) dissertation emphasizes that the teacher always takes the literature of Modeling as their comprehension horizon, in their own way, and not as expected by the community.

DESCRIPTION OF CATEGORY C2 – CONTINUOUS TRAINING AND THE PRACTICE OF MODELING

The twenty-six meaning units in the open category focus on training, working with Modeling, and its implementation in the classroom. They reveal that for implementation by teachers in the classroom, it is essential to have the interaction of coworkers, support, and commitment from the management team, teachers, parents, and students.

The units indicate that the work with Modeling does not happen when the teacher takes it on alone, and that applying it in the classroom is a significant step that requires the help of colleagues. Thus, it is clear that the actions of coworkers influence the practice of Modeling, either strengthening or limiting its development, depending on the school.

Regarding the practice of Modeling, specifically in the two-year training, a formative project was developed with the teachers in their practice, with support from the school administration and pedagogues. Other units highlight whether or not teachers continue implementing Modeling in the classroom.

After the longer training sessions, one lasting a year and the other two years, the teacher continues to develop Modeling in the classroom. It was observed that the teacher works with Modeling for a year with the same class, that after the training they are able to put it into practice, completing the stages of Modeling, and that they continue to use Modeling in their lessons after the training.

The units show that Modeling is not consistently developed in lessons, as the teacher applies it only a few times after the training, while another applies the project in just a few classes. Other units highlight that even if the teacher does not work directly with Modeling, the approach to teaching changes. For instance, they start incorporating the knowledge brought by the students. Regarding the training, it was noted that with the development of Modeling in the classroom, the teacher begins to understand "how to do" Modeling.

Additionally, in training developed through practice, some units highlight that the teacher received only initial guidance and then independently developed Modeling. Others carried out the work with Modeling in the classroom without anyone's guidance.

It is evident that in some training sessions, the teacher only receives guidance from the university, but believes that the true experience happens through practice, and that it takes time to start working independently with Modeling.

Other units show that teachers are interested in learning more to try to put Modeling into practice, and that it is easier to apply Modeling in the classroom when the training provides practical demonstrations of how to do it.

Interpretation of Category C2

The practice of modeling, like any other, does not occur effectively in the classroom without support from trainers, the involvement of students' parents, colleagues, and the management team. The lack of support from these perspectives poses a significant obstacle to teacher training in Mathematical Modeling when associated with research development.

It is understood that this organization of training, which is not centered on school problems and does not stem from the lived experiences of teachers, hinders meaningful changes in teaching practices. Teacher training has largely adopted a traditional model, focusing on the transmission and application of Modeling. This underscores the need for trainers to reflect on the purposes of training within a research context.

In this sense, it can be said that such training, where teachers only receive information about Modeling, has little impact on their classroom routines. Teachers continue to perceive their lessons as disconnected from other subjects, which clarifies the observations in the units where teachers state that the actions of colleagues influence their modeling practices at school.

However, this reflects the structure of the training experience as something non-collective, occurring beyond the classroom, school, and colleagues, contributing to the reinforcement rather than the deconstruction of their beliefs. Regarding the practice of Modeling, it is expressed that, in training stemming from research, there is encouragement from trainers, through guidance during training, for teachers to implement Modeling in practice. However, the teachers receive only instructions on how to work with Modeling.

It is understood that the training follows a model of teacher updating, where Modeling is presented to educators as a solution for their practice. However, this will contribute little to its effectiveness in the classroom, as it is believed that "this destructive formative practice has generated more prejudice than benefit" (Imbernón, 2009, p. 105). In this context, it is essential to consider that teachers remain entrenched in a traditional teaching environment (focused on reproducing results without space for autonomy and critique), often instituted by the educational system and validated by school members. In such a context, support for pedagogical innovations is compromised.

There are indications that, in longer training sessions, after a year of practice, teachers continue to use Modeling in their lessons post-training. This leads to the understanding that each teacher requires time to become familiar with and learn how to implement Modeling and to overcome the inherent difficulties of change and learning new methods of interaction in the classroom, such as being open to constant dialogue with students.

In light of this, to promote initiatives for adopting Modeling in teachers' practices, among other stated issues, it is emphasized that training should prioritize the experiences of teachers and the development of practices, opposing approaches with an individualistic character, a point criticized by Mutti (2020). Furthermore, it is understood that overcoming these difficulties is linked to changes in teachers' attitudes, beliefs, and conceptions, which does not happen instantaneously or without their willingness to engage in such a process (Mutti, 2020).

This leads to the necessity for the research community to reflect on training in Modeling within a research context, its purposes, the relationship between theory and practice in Modeling, training linked to collective work as a support strategy for teachers, and its impacts in the medium and long term.

On the other hand, other units show that teachers are optimistic about Modeling during training and try to implement it in the classroom, but end up applying it only a few times after training, as already described by Barbosa (2001a). This reveals a long journey to traverse between the teacher's "sympathy" for Modeling during training and its ongoing implementation in the classroom.

Teachers value training focused on practice, as identified through phenomenological reduction, where the teacher recalls the training in which they participated and received only minimal guidance. However, they believe that experience comes with practice. The teacher is immersed in the tradition of theoretical study followed by practice. However, as Mutti (2020) defended, before establishing theoretical relationships, a teacher's willingness to inhabit Modeling in a Heideggerian sense is necessary before adopting it as their own. Therefore, before constructing an understanding, it is essential to inhabit it.

DESCRIPTION OF CATEGORY C3 – UNDERSTANDINGS ABOUT TRAINING

The third category, composed of eighteen units, highlights the teachers' understandings about training. Some of the units indicate that teachers often participate in training merely for the purpose of accumulating hours, particularly those who have been teaching for a longer period. They sometimes believe that training is primarily for newer teachers who are more interested in professional development.

From the descriptions of the teachers' testimonies, it is indicated that the development of Modeling relies on the teacher's willingness. They express that training is ineffective if there is no desire to implement it in practice. Other units clarify that training in Mathematical Modeling should occur during undergraduate studies, so that teachers would have already engaged with Modeling beforehand.

Most training sessions on Modeling are superficial, and teachers seek guidance on the "how to do" Modeling. Thus, the training provides direction and guidance, helping teachers understand how to implement and work with Modeling.

It is noted that the two-year training model, which does not rush through activities, reduces teachers' anxiety regarding the development of Modeling in the classroom. Another unit refers to the feeling of exclusion experienced by teachers after training, indicating that when the research results from the studies in which they participated are presented to them post-training, they feel less isolated.

Furthermore, it is evident that the training does not adequately encourage teachers to step out of their comfort zones or to fill the gaps in their knowledge about Modeling.

Interpretation of Category C3

The research reveals a gap in the Modeling training experienced by teachers. Two major aspects stand out regarding Modeling training in the context of research. First, there is an incompleteness in the Modeling training concerning its adoption in the classroom, and second, there are the reasons expressed by teachers who show some resistance to the training. The units that comprise this category allow for interpretations about the professionals' understanding of the training processes they participated in.

The broader culture, both of the trainers and the trainees, needs to be reviewed and overcome. It is understood that there is a gap between what is presented in the training and what the teacher considers relevant for their teaching practice. This critique of the training is supported by Tardif (2000), who mentions that to study professional knowledge, researchers need to go directly to the places of teaching.

When teachers approach Modeling, which for most presents itself as something new, they feel uncomfortable. This shock results in difficulties, as teachers are immersed in teaching practices long before they begin working, and often, not even initial training is capable of changing or shaking these practices.

This means that knowledge about the profession begins to be built from experiences lived as students and throughout life, which justifies the need for training processes to take these teachers' knowledge into account. In this sense, we agree with what Imbernón (2009) says:

> It will be necessary to change the training model through institutional plans to open up more intensely to a more inquiry-based and project development model, in which teachers from a given context assume the deserved protagonism and are the ones who plan, execute, and evaluate their own training (Imbernón 2009, p. 107).

In connection with these elements, Tardif (2002) states that professional knowledge manifests itself from various forms of knowledge, meaning the teacher does not have a single conception of their practice, "[...] but several conceptions that they use in their practice, depending at the same time on their daily and biographical reality and on their needs, resources, and limitations." (Tardif, 2002, p. 63)

Other barriers concern the sense of training linked to age, understanding that the application of Modeling depends on the teacher's will and that adopting this trend in the classroom is for the younger, more interested teachers. They highlight that many teachers take courses only to accumulate hours for career advancement.

Teachers are conditioned to a career model that does not contribute to continuous training, to formative advancement without fragmentation. This perspective, that Modeling is only for younger teachers, leads us to interpret that it is not an easy task for teachers to step out of their comfort zone. This aspect reveals two sides of the same "coin," meaning it is the individual who decides whether to pursue training or not. Regardless of age, change can occur for those who move towards something new. These understandings represent the other side of the coin discussed by Cararo (2022), when addressing teachers who develop mathematical modeling in the state of Paraná. In other words, those who decided to pursue training did so not because of modeling itself, but because of the personal drive to move out of their previous position, finding solutions to the problems in their teaching practice.

In this sense, other teachers show curiosity and openness to the introduction of this trend in the classroom, that is, training that meets their needs. It is clear from the units (2:20, 5:23) that longer training, where actions are not "rushed," helps reduce teachers' anxiety about using Modeling in Mathematics classes. This is one of the most relevant aspects for designing formative environments, not only for Modeling but for any subfield of Mathematics Education.

Teachers' understanding of the training provides clues about what needs to be considered in its planning and the type of training disseminated to education professionals. This reveals that teachers, in their discourse, express the structure of the training, which aligns with what they understand as effective training that meets their needs. The motivation to seek further training leads us to understand that the burden of not implementing Modeling cannot be placed solely on the teachers, even though it is ultimately their decision to adopt it or not.

DESCRIPTION OF CATEGORY C4 – TEACHER'S CONTACT WITH MODELING

This open category consists of six units of meaning. These units address the teachers' contact with Modeling. Some express that the teachers had no knowledge of Modeling before the training. Others highlight that they had some prior contact with Modeling before participating in the training. Additionally, one unit (5:26) shows that the teacher was introduced to Modeling during their undergraduate studies but did not understand how to apply it in the classroom.

Interpretation of Category C4

It is evident that the continued training in Modeling within the research context provided teachers with their first exposure to this trend—an initial introduction, so to speak. However, knowing that Modeling exists is not enough to implement it, although it is necessary. Tambarussi and Klüber (2014, p. 53) argue that "[...] training, its methods, and its content itself must be detached from a research project with an expiration date."

The way this introduction is carried out does not contribute to the effective implementation of Mathematical Modeling in the classroom context, as can be inferred from the category. There is a need for continuous training, with ongoing support for participants so that they do not abandon Modeling when applying it in the classroom or perceive the training as mere 'ready-made recipes' to reproduce in their practice.

In this regard, it is essential that,

> [...] much more than just presenting this trend to teachers, continuous training activities need to accompany these professionals in their teaching practice and develop other ways to establish formative processes" (Tambarussi & Klüber 2014, p. 53).

Since teachers have an initial understanding of Modeling, but many do not comprehend its purpose or its practical organization, it is plausible to assert that the courses or programs developed—most of which are short or consist of individual modules within undergraduate teaching degrees focused on readings—fail to address the practical know-how, which is distinct from merely declarative knowledge. This issue points to a training tradition that presents diverse theories but does not allow preservice teachers or in-service teachers to experience or even see how Modeling is applied in classroom situations. This idea was supported by Souza (2022) when investigating the lived experience of in-service teachers who only had exposure to the literature. In the context of teacher education, this was examined more closely by Pereira (2023) in understanding the experience of student teachers working with basic education teachers who adopt and develop modeling in their lessons. The author asserts that a distinct horizon opens up for future teachers, beyond just reading and theory, as they tend to accept that it is possible to integrate modeling practices into the school context.

The four categories outlined and interpreted are interconnected and highlight the meaning of training for teachers in continuous education, which were dependent on research projects. They offer important reflections on the formative

processes that precede Modeling, both in the school environment and those related to the training in Modeling itself.

FINAL CONSIDERATIONS

Considering the phenomenological-hermeneutic approach undertaken and guided by the research question: What is revealed about continuous training in Modeling developed within research, according to the participating teachers? the hermeneutic analysis of what emerged from the testimonials revealed that a number of researchers have developed continuous training initiatives, aiming to bring Modeling to teachers.

However, the training models analyzed, based on the testimonies of the participating teachers and exclusively tied to master's and doctoral research projects, contributed more to the research field than to the practical field and the incorporation of Modeling in the classroom. In other words, the advancement of Mathematical Modeling in the classroom does not have a strong correlation with the research conducted, as it is more closely related to training that is integrated with the teacher, rather than those aimed at disseminating modeling or its contributions to teacher training. This observation, of course, is not limited to Mathematical Modeling but applies to the entirety of Mathematics Education.

Furthermore, the understandings highlighted from the testimonials of basic education teachers indicate the need to rethink the training, going beyond the simple presentation of Modeling. Their lived experiences reveal gaps in the training they participated in, especially regarding the adoption of Modeling, as discussed by Mutti (2020).

In summary, these insights point to the long journey that the community concerned with the effective advancement of Modeling in teachers' practice still has to travel. This is without undermining the training analyzed here and its contributions to the field, as they belonged to a specific moment in production. Therefore, this article invites new investigations and a reconsideration of teacher training in research contexts, so that the field progresses, and the implementation of Modeling advances more effectively in basic education. It also opens up space to study training in other areas of Mathematics Education, such as Problem Solving, French Didactics, and its different branches.

ACKNOWLEDGMENTS

This work was carried out with the support of the Coordination for the Improvement of Higher Education Personnel – Brazil (Capes) – Funding Code 001.

REFERENCES

Abreu, G. O. C. (2011). *A prática de Modelagem Matemática como um cenário de investigação na formação continuada de professores de matemática.* [Dissertação Mestrado Profissionalizante em Educação Matemática, Universidade Federal de Ouro Preto]. Repositório Institucional da UFOP. https://www.repositorio.ufop.br/handle/123456789/2547.

Almeida, L. M. W., & Dias, M. R. (2004). Um estudo sobre o uso de Modelagem Matemática como estratégia de ensino e aprendizagem. *Bolema*, (22), 19-35. https://www.periodicos.rc.biblioteca.unesp.br/index.php/bolema/article/view/10529.

Almeida, L. M. W., & Vertuan, R. E. (2011). Discussões sobre "como fazer" modelagem matemática na sala de aula. In Almeida, L. M. W., Araújo, J. L. & Bisognin, E. (Orgs.). *Práticas de modelagem matemática na educação matemática: relatos de experiências e propostas pedagógicas* (pp. 19-43). Londrina: Ed. da UEL.

Araújo, J. L. (2010). Brazilian research on modelling in mathematics education. *ZDM Mathematics Education*. 42(3-4), 337–348. https://doi.org/10.1007/s11858-010-0238-9.

Barbosa, J. C. (2001a). Modelagem matemática e os professores: a questão da formação. *Bolema*, Rio Claro, (15), 5-23.

Barbosa, J. C. (2001b). *Modelagem na Educação Matemática: contribuições para o debate teórico.* [Apresentação de trabalho]. 24ª Reunião anual da ANPED, Caxambu, Rio Janeiro.

Barbosa, J. C. (2004) Modelagem matemática: O que é? Por quê? Como? *Veritati*, (4), 73-80.

Barbosa, J. C., Araújo, J. de L. & Caldeira, A. D. (2009). GT 10 – *Modelagem Matemática*: *relatório das sessões do GT10 no IV SIPEM*. SBEM. http://www.sbem.com.br/gt10/pdf/relatorio_ivsipem.pdf.

Bassanezi, R. C. (2009). *Ensino-aprendizagem com modelagem matemática: uma nova estratégia*. São Paulo, SP: Contexto.

Bellei, P. (2018). *Gestão escolar e formação de professores em modelagem matemática na educação matemática*: *um olhar*. [Dissertação de Mestrado em Ensino, Universidade Estadual do Oeste do Paraná]. Biblioteca Digital de Teses e Dissertações da Unioeste. https://tede.unioeste.br/handle/tede/3908.

Bellei, P. & Klüber, T. E. (2018). Comunidade escolar e modelagem matemática na educação matemática: uma reflexão. *ACTIO: Docência em Ciências*, *3*(3), 317-335.

Bicudo, M. A. V. (1999) *A contribuição da fenomenologia à educação*. (Cap. 1, pp. 11-51). São Paulo, SP: Olho D'Água.

Bicudo, M. A. V. (2011). *Pesquisa qualitativa segundo a visão fenomenológica*. São Paulo, SP: Cortez.

Bicudo, M. A. V., & Klüber, T. E. (2011) Pesquisa em modelagem matemática no Brasil: a caminho de uma metacompreensão. *Cadernos de Pesquisa*, 41(144), 902- 925. https://doi.org/10.1590/S0100-15742011000300014.

Biembengut, M. S. (1999). *Modelagem matemática & implicações no ensino-aprendizagem de matemática.* Blumenau, SC: Furb.

Biembengut, M. S. (2005). *Modelagem Matemática no Ensino*. São Paulo, SP: Editora Contexto.

Biembengut, M. S. (2009). 30 Anos de Modelagem Matemática na educação brasileira: das propostas primeiras às propostas atuais. *Alexandria Revista de Educação em Ciência e Tecnologia,* 2(2), 7-32. https://periodicos.ufsc.br/index.php/alexandria/article/view/37939.

Burak, D. (1987). *Modelagem matemática: uma alternativa para o ensino de matemática na 5ª série*. [Dissertação de Mestrado, Rio Claro, Unesp]. Repositório da Unesp.

Burak, D. (1992). *Modelagem matemática: ações e interações no processo de ensino aprendizagem*. [Tese de Doutorado, Campinas, Unicamp]. https://www.psiem.fe.unicamp.br/pf-psiem/burak_dionisio_d.pdf.

Burak, D. (2004). *Modelagem Matemática e a Sala de Aula*. [Apresentação de trabalho]. I EPMEM-Encontro Paranaense da Modelagem Na Educação Matemática, Londrina.

Caldeira, A. D. (2005). *A modelagem matemática e suas relações com o currículo*. [Apresentação de trabalho]. IV Conferência Nacional Sobre Modelagem e Educação Matemática – Cnmem. UEFS, Feira de Santana.

Cararo, E. F. F. (2017). *O Sentido da Formação Continuada em Modelagem Matemática na Educação Matemática desde os Professores Participantes*. [Dissertação de Mestrado em Educação, Centro de Educação, Comunicação e Artes, Universidade Estadual do Oeste do Paraná]. Biblioteca Digital Brasileira de Teses e Dissertações. https://tede.unioeste.br/handle/tede/3323.

Cararo, E. F. F. (2022). *O professor que desenvolve modelagem matemática no ensino Básico do estado do Paraná*. [Tese de Doutorado em Educação em Ciências e Educação Matemática, Centro de Ciências Exatas e Tecnológicas,

Universidade Estadual do Oeste do Paraná]. Biblioteca Digital de Teses e Dissertações da Unioeste. https://tede.unioeste.br/handle/tede/5986.

Ceolim, A. J. *Modelagem matemática na educação básica*: obstáculos e dificuldades apontados por professores. Tese (Doutorado em Educação). São Carlos: Universidade Federal de São Carlos, UFSCar.201.

Ceolim, A. J., & Caldeira, A. D. (2017). Obstáculos e Dificuldades Apresentados por Professores de Matemática Recém-Formados ao Utilizarem Modelagem Matemática em suas Aulas na Educação Básica. *Bolema*, 31(58), 760-776. https://doi.org/10.1590/1980-4415v31n58a12.

Dias, M. R. (2005). *Uma Experiência com Modelagem Matemática na Formação Continuada de Professores.* [Dissertação de Mestrado em Ensino de Ciências e Educação Matemática, Universidade Estadual de Londrina]. Repositório do Programa de Pós-Graduação em Ensino de Ciências e Educação Matemática. https://pos.uel.br/pecem/teses-dissertacoes/uma-experiencia-com-modelagem-matematica-na-formacao-continuada-de-professores/.

Galeffi, D. A. (2000). O que é isto – a fenomenologia de Husserl? *Ideação*, (5), 13-36.

Imbernon, F. (2009). *Formação permanente do professorado: novas tendências*. 1a ed. São Paulo, SP: Cortez.

Klüber, T. E. (2010). Modelagem Matemática: revisitando aspectos que justificam a sua utilização no ensino. In Brandt, C. F., Burak, D. & Klüber, T. E. (Orgs.). *Modelagem Matemática: uma perspectiva para a Educação Básica*. (pp. 97-114). Ponta Grossa, PR: Editora UEPG.

Klüber. T. E. (2016). *A pesquisa e a prática em modelagem na Educação Matemática: um debate.* [Apresentação de trabalho]. VII Encontro Paranaense de Modelagem Matemática, Londrina, UEL.

Klüber, T. E. (2017). Formação de professores em Modelagem Matemática na Educação Matemática brasileira: questões emergentes. *Educere et Educare*, 12(24), 1-11. https://e-revista.unioeste.br/index.php/educereeteducare/article/view/15281.

Klüber, T. E. (2023). Metanálise do macroprojeto “formação de professores em modelagem matemática: compreensões e desvelamentos”. *Vidya*, 43(2), 191-206. https://doi.org/10.37781/vidya.v43i2.4614.

Klüber, T. E. et al. (2015). *Projeto de Extensão*: Formação Continuada de Professores em Modelagem Matemática na Educação Matemática. Cascavel, Universidade Estadual do Oeste do Paraná.

Klüber, T. E. & Tambarussi, C. (2017). *A formação de professores em modelagem matemática na educação matemática: uma hermenêutica. Acta Scientiae*

Revista de Ensino de Ciências e Matemática, 19(3), 412-426. http://www.periodicos.ulbra.br/index.php/acta/article/view/3157.

Loureiro, D. Z. (2022). *Sobre a formação de professores em modelagem matemática na educação matemática: do ôntico ao ontológico*. [Tese de Doutorado em Educação em Ciências e Educação Matemática, Centro de Ciências Exatas e Tecnológicas, Universidade Estadual do Oeste do Paraná]. Biblioteca Digital de Teses e Dissertações da Unioeste. https://tede.unioeste.br/handle/tede/6445.

Machado, S. R. C. (2010). *Percepções da Modelagem matemática nos anos iniciais.* [Dissertação de Mestrado em Educação Científica e Tecnológica, Centro de Ciências da Educação, Universidade Federal de Santa Catarina]. http://repositorio.ufsc.br/xmlui/handle/123456789/93484.

Magnus, M. C. M. (2012). *Modelagem Matemática em sala de aula: Principais obstáculos e dificuldades em sua implementação*. [Dissertação de Mestrado em Educação Científica e Tecnológica, Universidade Federal de Santa Catarina]. Biblioteca Digital Brasileira de Teses e Dissertações. http://repositorio.ufsc.br/xmlui/handle/123456789/99480.

Malheiros, A. P. dos S., Forner, R. & Souza, L. B. (2020). Formação de professores em Modelagem e a escola: que caminhos perseguir? *Revista Brasileira de Educação em Ciências e Educação Matemática*, 4(1), 01–22. https://doi.org/10.33238/ReBECEM.2020.v.4.n.1.24566.

Martens, A. S., & Klüber, T. E. (2016). *Práticas de formação de professores em artigos do VI Encontro Paranaense de Modelagem na Educação Matemática*. [Apresentação de trabalho]. VII Encontro Paranaense de Modelagem na Educação Matemática, Londrina, Paraná.

Martens, A. S., Tambarussi, C. M. & Klüber, T. E. (2017). *Formação continuada em Modelagem na Educação Matemática: análise de práticas formativas em contexto de pesquisa*. [Apresentação de trabalho]. XIV Encontro Paranaense de Educação Matemática, Cascavel, Paraná.

Martens, A. S. (2018). *Formação continuada em Modelagem Matemática em contexto de pesquisa: um estudo a partir dos professores participantes.* [Dissertação Mestrado em Educação, Universidade Estadual do Oeste do Paraná]. Biblioteca Digital de Teses e Dissertações da Unioeste. https://tede.unioeste.br/handle/tede/3925.

Martens, A. S., & Klüber, T. E. (2023). Modelagem Matemática e a Sala de Aula: um olhar a partir dos professores participantes de formação continuada. *Revista de Educação em Ciências e Matemáticas*, 19(43), 94-106. https://periodicos.ufpa.br/index.php/revistaamazonia/article/view/14684/10733.

Martens, A. S., & Klüber, T. E. (2024). O formador de professores em contextos de formação continuada em modelagem na educação matemática. *Debates em Educação*, 16(38), e16027-e16027.

Martins, S. R. (2016). *Formação continuada de professores em modelagem matemática na educação matemática: O sentido que os participantes atribuem ao grupo*. [Dissertação de Mestrado em Ensino, Universidade Estadual do Oeste do Paraná]. Biblioteca Digital de Teses e Dissertações da Unioeste. https://tede.unioeste.br/handle/tede/1026.

Matioli, C. E. R. (2019). *Metapesquisa dos referenciais teóricos de textos sobre formação continuada de professores em Modelagem Matemática*. [Dissertação (Mestrado em Educação em Ciências e Educação Matemática, Centro de Ciências Exatas e Tecnológicas, Universidade Estadual do Oeste do Paraná]. Biblioteca Digital de Teses e Dissertações da Unioeste. https://tede.unioeste.br/handle/tede/4718.

Mutti, G. S. L. (2016). *Práticas Pedagógicas da Educação Básica num Contexto de Formação Continuada em Modelagem Matemática na Educação Matemática*. [Dissertação de Mestrado em Ensino, Universidade Estadual do Oeste do Paraná]. Biblioteca Digital Brasileira de Teses e Dissertações. https://tede.unioeste.br/handle/tede/1025.

Mutti, G. S. L. (2020). *Adoção da modelagem matemática para professores em um contexto de formação continuada*. [Tese de Doutorado em Educação em Ciências e Educação Matemática, Centro de Ciências Exatas e Tecnológicas, Universidade Estadual do Oeste do Paraná]. Biblioteca Digital de Teses e Dissertações da Unioeste. http://tede.unioeste.br/handle/tede/5003.

Oliveira, A. M. P. de. (2010). *Modelagem Matemática e as tensões nos discursos dos professores.* [Tese de Doutorado em Ensino, Filosofia e História das Ciências, Universidade Federal da Bahia, Universidade Estadual de Feira de Santana]. https://ppgefhc.ufba.br/sites/ppgefhc.ufba.br/files/andreia_maria_pereira_de_oliveira_tese_2010.pdf.

Pereira, E. (2023). *O estagiário da licenciatura ao estar com o professor regente que assume a modelagem matemática em sala de aula*. [Tese de Doutorado em Educação em Ciências e Educação Matemática, Programa de Pós-Graduação em Educação em Ciências e Educação Matemática, Universidade Estadual do Oeste do Paraná]. Biblioteca Digital de Teses e Dissertações da Unioeste. https://tede.unioeste.br/handle/tede/6836.

Santos, L. A. dos. (2019). *Um olhar sobre a própria prática com Modelagem Matemática na Educação Matemática ao es-tar-com-um-grupo de formação continuada.* [Dissertação de Mestrado em Ensino, Centro de Educação, Letras e Saúde, Universidade Estadual do Oeste do Paraná]. Biblioteca Digital Brasileira de Teses e Dissertações. https://tede.unioeste.br/handle/tede/4644.

Silva, M. V. da. (2017). *Concepções prévias de professores e formação continuada em Modelagem Matemática*. [Dissertação de Mestrado em Educação, Centro de Educação, Comunicação e Artes, Universidade Estadual

do Oeste do Paraná]. Biblioteca Digital de Teses e Dissertações da Unioeste. https://tede.unioeste.br/handle/tede/3370.

Silveira, E. (2007). *Modelagem matemática em educação no Brasil: entendendo o universo de teses e dissertações*. [Dissertação de Mestrado em Educação, Universidade Federal do Paraná]. Biblioteca Digital Brasileira de Teses e Dissertações. https://acervodigital.ufpr.br/handle/1884/11568.

Silveira, E., & Caldeira, A. D. (2012). Modelagem na sala de aula: resistências e obstáculos. *Bolema*, 26(43), 249-275. https://doi.org/10.1590/S0103-636X2012000300012.

Souza, N. F. (2022). *Modos de uma professora compreender modelagem matemática com apoio exclusivo na literatura*. [Dissertação de Mestrado em Educação em Ciências e Educação Matemática, Centro de Ciências Exatas e Tecnológicas, Universidade Estadual do Oeste do Paraná]. Biblioteca Digital de Teses e Dissertações da Unioeste. https://tede.unioeste.br/handle/tede/6163.

Tambarussi, C. M., & Klüber, T. E. (2014). A pesquisa em Modelagem Matemática: sobre as atividades de formação continuada em teses e dissertações. *Revemat*, 9, 38-56. https://doi.org/10.5007/1981-1322.2014v9nespp38.

Tardif, M. (2000). Saberes profissionais dos professores e conhecimentos universitários: elementos para uma epistemologia da prática profissional dos professores e suas conseqüências em relação à formação para o magistério. *Revista Brasileira de Educação*, (13), 5-24. http://educa.fcc.org.br/scielo.php?pid=s1413-24782000000100002&script=sci_abstract.

Tardif, M. (2002). *Saberes docentes e formação profissional*. Petrópolis, RJ: Vozes.

Tortola, E., & Silva, K. A. P. (2021). Sobre modelos matemáticos nos anos iniciais: das pesquisas às práticas. *Em Teia. Revista de Educação Matemática e Tecnológica Iberoamericana*, 12(3), 1-26. https://doi.org/10.51359/2177-9309.2021.250564.

Veronez, M. R. D., & Santos, T. F. dos. (2023). Atribuição de significado em modelagem matemática nos anos iniciais: uma interpretação semiótica acerca dos objetos matemáticos. *Educação Matemática Pesquisa. Revista do Programa de Estudos Pós-Graduados em Educação Matemática*, 25(1), 167-199. https://doi.org/10.23925/1983-3156.2023v25i1p167-199.

Vertuan, R. E., Silva, K. A. P. & Borssoi, A. H. (2017). Modelagem matemática em disciplinas do ensino superior: o que manifestam os estudantes? *Educere et Educare,* 12(24), 1-15. https://e-revista.unioeste.br/index.php/educereeteducare/article/view/15391.

Villa-Ochoa, J. A., Soares, M. R. & Alencar, E. S. de. (2019). A modelagem matemática nos anos iniciais como perspectiva para o ensino de

matemática: um panorama de publicações brasileiras em periódicos (de 2009 a 2018). *Educar em Revista*, 35(78), 47- 64. https://doi.org/10.1590/0104-4060.68974.

Received: July. 1st. 2024
Approved: Nov. 12th,. 2024
DOI: https://doi.org/10.3895/actio.v9n3.18783

How to cite:
Martens, Adan Santos, Klüber, Tiago Emanuel. (2024). Teacher Training in Mathematical Modeling According to Participants in Different Research Studies. **ACTIO**, 9(3), 1-21.
https://doi.org/10.3895/actio.v9n3.18783

Correspondence:
Adan Santos Martens
Rua Doutor Washington Subtil Chueire, n. 333, Jardim Carvalho, Ponta Grossa, Paraná, Brasil.