

# Profiles of Pre-service Secondary Mathematics Teachers' Self-perceptions of Professional Competencies and the Opportunities for Development

M. Victoria Martínez Videla  
*Universidad de O'Higgins*

Josefa Perdomo-Díaz  
*Universidad de la Laguna*

Valentina Giaconi  
*Universidad de O'Higgins*

Felipe Ruz  
*Pontificia Universidad Católica de Valparaíso*

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The study reported in this article examined pre-service secondary mathematics teachers' perceptions about the development of their professional competencies and the opportunities offered by their university teacher education program to develop these competencies. Three competence components are considered: mathematical competencies, competencies for teaching mathematics, and pedagogical competencies. The research was conducted at a recently established public university, with a questionnaire designed based on the professional competencies stated in its Mathematics Teacher Education Program. Participants were 78 pre-service teachers from different academic years. Most participants perceived that they reached a medium or high level of development of their competencies and that the program offered them several or many opportunities for such development. A cluster analysis identified three profiles characterised by high (41%), medium (41%) and low (18%) levels of perceived competence development and opportunities. Bivariate analysis showed significant relationships among these profiles, the number of completed study years, and the participants' levels of academic commitment. The implications for evaluating pre-service teacher education programs, the study's limitations and directions for future research are discussed.

**Keywords** • mathematics teacher education • pre-service teacher education • professional competence • teacher professional competencies • self-perception •

## Introduction

The quality of teacher education has become a topic of particular interest in recent years, given that research has provided evidence of teachers' relevance for students' learning (Blömeke et al., 2022; Tatto et al., 2025). As a result, the evaluation of teacher education programs has been incorporated into the work agenda of researchers, teacher educators and policy makers (Zlatkin-Troitschanskaia et al., 2025). The results of different investigations have provided frameworks for evaluating teacher training proposals. Regarding pre-service teacher education programs, various ways to assess them have been proposed. At the international level, there are large-scale antecedents, such as the comparative study Teacher Education and Development Study in Mathematics (TEDS-M), which investigated pre-service primary and secondary teachers' education in 17 countries (Tatto et al., 2008). The TEDS-M study focused on three elements: educational policy and sociocultural context; pre-service teaching curricula; and future teachers' knowledge and beliefs about mathematics, its teaching and learning. The comparative nature of the TEDS-M study makes it possible to identify the characteristics of each teacher education program, its emphasis, and the elements that are in common in various initial teacher training proposals.

In Chile, the TEDS-M findings have contributed to the development of pre-service teacher education standards as part of the development of public policies aimed at strengthening pre-service teacher education. This process began in 2010. The standards range from pre-service teacher preparation to the



definition of a professional teaching career (Law N° 20.903). Thus, in pre-service teacher education two assessment instances have been implemented: one at the beginning of a program and another at the end of a program. For the beginning of the program, several assessment proposals have been developed using diagnostic evaluations. At the end of a program, an evaluation aligned with the standards is applied one year prior to graduation. The objectives of this evaluation are twofold: to inform those participating in the program about the pre-service teachers' graduation profiles, and to inform pre-service teachers about their development in relation to the program's training processes (Martínez Videla et al., 2019; Rodríguez Alveal et al., 2019). Through the implementation of these assessment strategies, Chile's education system established a quality assurance structure for pre-service teacher education programs that reflects the three key elements proposed by Ingvarson and Rowley (2017): (1) ensuring quality in the recruitment and selection of those that enter pre-service teacher education programs; (2) monitoring and ensuring the quality of these programs; and (3) possessing certification policies for teachers who graduate from these teacher education programs.

In Chile, the monitoring and quality assurance of teacher education programs is done mostly through an accreditation process, which is overseen by the National Accreditation Commission (Comisión Nacional de Acreditación, CNA), a public body whose mission is ensuring quality in higher education. In the case of pre-service teacher education programs, CNA bases the certification of quality on the purposes and criteria stated by each training program. Indeed, this accreditation system covers a broad and complex area of work. Furthermore, in recent decades, the increasing demand for school and professional education has shifted focus toward, considering the definition of study programs and graduation profiles in terms of competence development. The shift has brought about the need to develop assessment and monitoring procedures that can attest to the development of competencies across various educational areas and levels, including pre-service teacher education. Thus, a requirement such as the one made by the accreditation system in Chile, implies that pre-service teacher education programs must implement various assessment strategies to determine the level of achievement of competence development in terms of graduation profiles.

Competence assessment has required the design and construction of diverse instruments and approaches, which depend not only on the assessment context but also on the definition of competence used in the program being evaluated. For example, one of the first definitions by McClelland (1973) stated that success does not depend on an individual's intelligence, but on the competencies expressed through behaviour, including personality traits such as communication skills, patience, and goal setting. A more contemporary approach is that of Jevšček (2016), who considered competencies as a set of skills, self-image, and values that individuals can use in the context and environment of certain situations. According to this view, when these aspects (skill set, self-image, and values) are placed in the social and physical environment where an individual has a certain role or task, whether that individual is competent or incompetent becomes apparent.

In this sense, competence evaluation is closely related with what individuals know, can do, and with how they perceive their capabilities. In other words, people need to perceive that they can behave in a certain manner, before showing that behaviour effectively (Rodgers et al., 2014). In the case of professional teaching competencies, this idea translates into teachers needing to perceive that they have developed such competencies before showing their competence in their teaching practice. In terms of a mathematics pre-service teacher education program, this distinction is particularly relevant since there is evidence of the specificity of teachers' professional knowledge (Ball et al., 2008; Blömeke et al., 2015) and the differentiation of teaching-specific knowledge (Shulman, 1986). Thus, teachers must not only develop mathematical competencies and know about their ability to use them (e.g., when solving mathematical problems), but must also be able to teach these competencies effectively (e.g., teach students to solve problems). Consequently, it is important to assess the degree of professional competence development achieved by pre-service teachers, their perceptions of such development, and the value they attribute to opportunities they have had to develop that professional competence throughout their teacher preparation program.

The study reported here analyses competence development in a Chilean Mathematics Teacher Education Program from the perspective of pre-service teachers to understand how the program adds



value to their professional growth in terms of competency development. This research facilitates a comprehensive assessment from the perspective of the learner, a fundamental stakeholder in the evaluation processes (Banta & Palomba, 2014). The following section presents a review of the literature on professional teaching competencies and competency development opportunities, from which the theoretical elements that support the research are drawn.

## Theoretical Framework

### *Mathematics Teachers' Professional Competence*

Research on professional teaching competencies has increased in recent years; even so, there is still a lack of consensus on the meaning of those competencies. From a conceptual standpoint, the literature distinguishes between two main perspectives (Blömeke et al., 2015). The first perspective conceptualises competence as a set of cognitive and affective-motivational attributes. The second perspective incorporates the observable behaviours within specific contexts, defining competence as a combination of cognitive skills and motivational states that evolve as individuals face diverse situations within a specific field. These conceptualisations have led to the development of two main types of competence models: cognitive models and situated models (Santagata & Yeh, 2016).

An example of a cognitive model can be found in the *Tuning Educational Structures in Europe* project, for which competencies represent "a dynamic combination of cognitive and metacognitive skills, knowledge and understanding, interpersonal, intellectual and practical skills, and ethical values" (Tuning Subject Area Group of Education [Tuning], 2009, p. 11). That project defined a set of general competencies applicable to any study area and a set of specific competencies for each area, including education. These general and specific competencies have been the starting points for defining elements of higher education programs in Europe under the Bologna Plan (Tuning, 2009).

From a situated perspective, Baumert and Kunter (2013) pointed out that a competence is "the personal capacity to face a situation's specific demands" (p. 27) and noted that four aspects contribute to its development: knowledge, beliefs, motivation, and self-regulation. Thus, a professional competence would have a cognitive component (knowledge and beliefs) and an affective-motivational component (self-regulation and motivation) that are essential to develop the disposition to act. Those cognitive and non-cognitive elements combine to attend to specific demands in concrete situations. Along the same line, Blömeke et al. (2015) and later applications of their model (see Metsäpelto et al., 2022), conceptualised competencies as a continuum that begins with cognitive and affective dispositions, which include some degree of motivation, progresses through the achievement of specific skills to apply in a situation, which results in way of acting or observable behaviour (see Figure 1).



Figure 1. Model of competence as a continuum

All these models consider that performance, in the diverse situations it can occur, is supported by a complex structure, including cognitive and motivational aspects. The cognitive aspect includes a set of teachers' professional knowledge. Numerous models have been developed to identify, characterise, and organise the different types of knowledge that a teacher needs to develop for their professional competencies. Other models have also generated knowledge about how to generate effective mathematics teaching and learning situations. The common origin of those models came from the work

of Shulman (1986; 1987), who emphasised the need to consider the characteristics of the content or subject to be taught in the formulation of knowledge types required by a teacher. Thus, a teacher knowledge model arises which includes the following: general pedagogical knowledge, content knowledge, pedagogical content knowledge, and curriculum knowledge (Shulman, 1986). Later, Shulman (1987) added three types of knowledge: knowledge of learners, knowledge of educational contexts, and knowledge of education's philosophical and historical aims.

Based on Shulman's model (1986; 1987), various models have emerged, with different foci. For example, Ball et al., (2008) proposed the concept of Mathematical Knowledge for Teaching (MKT), which gives the model its name, to refer to the mathematical knowledge necessary to attend to specific tasks arising during the teaching of mathematics. MKT is a theoretical model based on practice that arises from the analysis of the tasks involved in teaching and the mathematical demands associated with those tasks. The authors of the model proposed a restructuring and precision of Shulman's model (1986; 1987) in two main dimensions: content knowledge and pedagogical content knowledge. The main contribution of the MKT model is the characterisation of the mathematical knowledge that the teacher needs to develop, distinguishing three types: common content knowledge, specialised content knowledge, and horizon content knowledge. According to this model, common content knowledge refers to knowledge that is not exclusive to the task of mathematics teaching but shared with other professions. Specialised content knowledge refers to mathematical knowledge and skills that are only necessary for teaching mathematics; horizon content knowledge considers making connections among common knowledge and more advanced mathematics.

The program Cognitive Activation in the Mathematics Classroom and Professional Competence of Teachers (COACTIV) also used Shulman's proposal (1986; 1987) to create a model that characterises mathematics teacher's professional knowledge, which contributes to the development of their professional competencies. This model identifies five domains of teachers' professional knowledge (Baumert & Kunter, 2013): content knowledge, pedagogical content knowledge, pedagogical-psychological knowledge, organisational knowledge, and counselling knowledge. Each of these domains includes different knowledge aspects. The model does not align with the MKT model directly, but there are some common points. For example, content knowledge refers to a deep understanding of mathematical content marked by secondary education's mathematics curriculum, which agrees with the common content knowledge defined by the MKT model.

Both MKT and COACTIV include sub-domains that refer to knowledge that is not exclusive to teachers: content knowledge in the case of the COACTIV model, and common content knowledge in the case of the MKT model. In contrast, the Mathematical Teacher Specialized Knowledge (MTSK) model considers as specialised knowledge, all the knowledge teachers possess (Carrillo et al., 2013). This model distinguishes two main domains in the mathematics teacher knowledge, one related to mathematics and another related to pedagogical content knowledge. The former includes knowledge of topics, knowledge of the structure of mathematics, knowledge of practices in mathematics, while the latter includes knowledge of features of learning mathematics, knowledge of mathematics teaching, and knowledge of mathematics learning standards.

Although there is no complete consensus about the models, common aspects can indeed be observed, such as the need of knowledge linked to mathematics, one related to pedagogical aspects, and mathematics-specific teaching knowledge. In this study, the professional competencies of secondary education mathematics teachers are considered in relation to these three types of knowledge:

1. Mathematical content knowledge in relation to the MTSK model, which extends the common content knowledge perspective defined by MTK.
2. Knowledge of mathematics teaching, which includes aspects related to MKT's pedagogical content knowledge, MTSK's pedagogical content knowledge, and the COACTIV model.
3. Pedagogical knowledge in the general sense defined by Shulman (1986).

Choosing these theoretical constructs allows for the analysis of the structure of the mathematics teacher education program based on the specialised literature in the field. At the same time, it is important to



consider how the development of teachers' professional competencies can be observed. In this study, the focus is on pre-service teachers' perceptions of their professional competence development. The self-perception of competence development, or perceived competence, understood as "a person's perception of their basic capability of carrying out a behaviour" (Rodgers et al., 2014, p. 538), is one of the components belonging to the affective-motivational dimension, and it is essential for two main reasons. First, according to self-determination theory, perceived competence is a necessary psychological condition to generate the motivation leading to an action, which can contribute to the increase in intrinsic motivation if it is accompanied by commitment for the effective development of such competence (Deci & Ryan, 2000). Consequently, competence self-perception contributes to the achievement of objectives, promoting the development of behaviours that favour the commitment to the acquisition of learning and the necessary abilities to reach such objectives (Rodgers et al., 2014). Competence self-perception can then be considered part of the affective dispositions required to initiate the development of professional competencies (Blömeke et al., 2015; Metsäpelto et al., 2022).

Second, pre-service teachers' self-perceptions should be investigated to fully understand the implementation of pre-service teacher education programs. This is because pre-service teachers should be able to identify an intentional development of competencies and provide a complementary view to that of other stakeholders who may hold different views or be subject to social desirability bias (Struyven & Meyst, 2010).

### *Pre-service Secondary Mathematics Teachers' Opportunities to Develop Professional Competencies*

The concept of Opportunity to Learn (OTL) emerged in the context of a series of studies conducted by the International Association for the Evaluation of Educational Achievement (IEA) to address the need to define indicators that would enable the comparison of the results obtained by different countries in studies about mathematics performance. The interpretation of the OLT has evolved over time. Both McDonnell (1995) and Schmidt and Maier (2009) presented a broad and detailed summary of the origin and evolution of this concept. They found OTL indicators were used to measure if students had been given the opportunity to study specific topics or learn about problem solving strategies included in assessment tasks. This early perspective, which focused on curricular content, was later extended to incorporate other aspects of performance, such as how that content was taught. Over time, OTL became a reference indicator for the development of public policies aimed at achieving equal education opportunities and monitoring the progress of curricular reforms.

Investigation of pre-service teacher education programs has shown that OTL indicators influence the performance of future teachers in standardised tests, such as TEDS-M. Schmidt et al. (2011; 2014) observed differences between the OTL of pre-service mathematics teachers in the United States and those of the countries with the best results in that evaluation. The researchers proposed the OTL indicators as "the content to which future teachers are exposed as a part of their teacher preparation programs" (p. 140). The differences in exposure were larger for future secondary education teachers than for those studying primary education. These results were obtained from a questionnaire that asked the future teachers to choose the type of content or topic that had been discussed in their courses during their pre-service teaching program, including, mathematics, the teaching of mathematics, or general pedagogy.

In recent years, there have been numerous and diverse curricular changes internationally, which have affected the study of mathematics at various educational levels. One of the modifications has been the shift from a teaching model focused on mathematical content and procedures to a competence perspective, where the emphasis is on the development of mathematical literacy. Mathematical literacy concerns the development of mathematical skills that enable the application of a series of mathematical processes in diverse contexts (OECD, 2019). These changes have influenced pre-service teacher education programs, many of which have undergone reforms aimed at developing professional competencies.



How each pre-service teacher education program interprets the professional competencies to be developed affects the selection and organisation of the content and learning activities included in the program. That selection and organisation define the set of OTL provided for the pre-service teachers in that program, and it also define the series of opportunities to develop professional competencies (OTDPC). In coherence with the meaning and sense of teachers' professional competencies (Baumert & Kunter, 2013; Blömeke et al., 2015), in this research OTDPCs are defined as the opportunities that future teachers have had to acquire the knowledge and skills needed to respond to situations specific to mathematics teaching. Furthermore, the necessary affective and motivational factors teachers require development in to be able to respond to the specific demands of the teaching profession are also outlined.

Like the developments in OTL, OTDPC can be measured in several ways. For example, this can be done by counting the number of courses in which the study program states its contribution to the development of each of the professional teaching competencies, analysing the results of future teachers from the various evaluations applied, or consulting instructors in the program. In this study, the perception that pre-service teachers have of the opportunities provided by the education program to develop each stated professional teaching competence was used as an indicator of OTDPC. This indicator provides relevant information for future teachers, since as Carrinus et al. (2019) suggested, pre-service teachers' perceptions of the learning they receive affect their academic results and how they get involved in their learning experience. Furthermore, OTDPCs also offer useful information to evaluate the study program, which complements the information given by educators because "the impact [on candidates] is often different from what instructors or teaching supervisor may imagine or wish" (Clift & Brady, 2005, p. 331).

## Research Objectives

Considering the theoretical perspective, the present study aims to analyse the perception of future Chilean secondary mathematics teachers on the development of their professional competencies, the teaching and learning of mathematics, and the opportunities offered by their teacher education program to develop those competencies. To achieve this aim, the study focuses on three objectives:

- (1) To describe the perceptions of pre-service teachers in the Mathematics Teaching Program on the development of their competencies and the opportunities offered by the program to develop them, across three components: mathematical competencies, competencies for the teaching of mathematics, and pedagogical competencies.
- (2) To determine pre-service teacher profiles according to their perception on competency development and the opportunities offered by their study program in relation to the three components addressed in (1).
- (3) To examine the relationships among the pre-service teacher profiles, by cohort and commitment.

## Method

This research follows a quantitative design, and it is exploratory and descriptive in nature (Hernández-Sampieri & Torres, 2018). The research was conducted at a public Chilean university founded in 2015, for which the first student intake was in 2017.

### *Participants and Research Context*

The sample comprised of 78 pre-service teachers enrolled in the Mathematics Pedagogy Program of a public Chilean university. The participants were enrolled in various courses (typically one semester), from Year 2 to Year 5. Data collection was carried out at the beginning of the courses, so, for the purpose of this article, the interest is in associating the results of the study to the courses the pre-service teachers



had already finished. Thus, the participants were distributed from Year 1 to Year 4 in the following manner: 21, 30, 12, and 15, respectively.

The Mathematics Pedagogy Program curricular proposal is organised by four main study areas, each of which contributes a percentage of the professional teaching competencies to be developed throughout the program: Teaching and learning of mathematics (48.6%); Learning, development, and diversity in childhood and adolescence (6.6%); Educational system and educational community (6.3%); and Practice, reflection and research (29.3%). The remainder of the program focused on English courses and general-topic courses.

In this research, the focus is on the area of teaching and learning of mathematics, which constitutes half of the program's academic workload and encompasses the specialised competencies required of a teacher of mathematics. This disciplinary field is structured around three competence components:

- *Mathematical Competencies* (MC): These are related to mathematical knowledge and skills, for example, being able to master mathematical language.
- *Competencies for the Teaching of Mathematics* (TMC): These involve competencies that integrate pedagogical and disciplinary aspects, for example, using concrete and specific material for the teaching of mathematics to support the teaching and learning process.
- *Pedagogical Competencies* (PC): These refer to pedagogical aspects that are not exclusive for the teaching of mathematics, for example, efficient time management and use of space during teaching activities.

Table 1 presents the percentage of competencies associated with each component in the teacher education program, which are addressed throughout every year of the teacher education program. For example, 90% of the mathematical competencies are developed in Year 1, and 85% in Year 3. A general review of the table indicates that most of the mathematical competencies are developed the early years of the program, while pedagogical competencies are developed more gradually, with a greater presence towards the later years. Competencies for teaching mathematics are developed across courses throughout the program. It should be noted that Year 5 is dedicated to the professional practicum, during which it is assumed that the competencies associated with these components have already been acquired and will be applied in a professional context. For this reason, Year 5 was neither included in the analysis or in Table 1.

Table 1

*Percentage of Competencies Developed for Each Component of the Teaching Program, per Year, in the Area of Teaching and Learning of Mathematics*

Competence Component	Year in the Study Program			
	1	2	3	4
Mathematical Competencies	90%	90%	85%	80%
Competencies for the Teaching of Mathematics	79%	79%	100%	100%
Pedagogical Competencies	36%	55%	36%	73%

## *Instrument and Variables*

The instrument consists of a three-part questionnaire:

Part 1. Questions about participants' general information (identification and year of enrolment in the program).

Part 2. A set of items associated with the academic commitment variable. It consists of eight items, each of which presents a statement about different key activities related to each participant's learning. Each statement is answered through a Likert-type scale: 1 = Never, 2 = Occasionally, 3 = Frequently, 4 = Very frequently. An example item is: "You took detailed notes or recorded the class to complete them." The Cronbach's alpha coefficient for this variable was 0.66 ( $N = 8$ ).



Part 3. A set of items associated with six variables, reflecting the perceptions of pre-service teacher competence development (OTDPC), for each of the competence components: perception of development of mathematical competence (D-MC), perception of the opportunities to develop mathematical competence (OTD-MC), perception of development of the competence to teach mathematics (D-TMC), perception of the opportunities to develop the competence to teach mathematics (OTD-TMC), perception of the development of the pedagogical competence (D-PC), perception of the opportunities to develop the pedagogical competence (OTD-PC). This part of the instrument was listed each of the competencies stated in the program, accompanied by two Likert-type scales: one associated with competence development (1 = Null, 2 = Low, 3 = Medium and 4 = High) and another associated with the perception of the opportunities offered to develop those competencies (1 = None, 2 = Few, 3 = Several, 4 = Any). Figure 2 shows an example corresponding to an item of the D-MC variable and the OTD-MC variable.

Competence	Degree of development reached				Opportunities provided for its development			
	1	2	3	4	1	2	3	4
Understand, interpret, and manipulate symbolic expressions, algorithms, properties, and mathematical constructions in mathematical contexts.								

Figure 2. Example item from Part 3 of the questionnaire.

Data were collected through an online questionnaire developed in the Survey Monkey platform, during March and April 2021 (start of academic year in Chile). The questionnaire was shared via participants' emails and the university's learning management platform. Table 2 shows the number of items associated with each of the six variables, an example of competence asked about within each of the variables, and the reliability index of the variables.

Table 2  
*Variables and Their Characteristics*

Variable	Number of items	Example of the competence asked about	Cronbach's alpha
D-MC	22	Understand, interpret, and manipulate symbolic expressions, algorithms, properties, and mathematical constructions in mathematical contexts.	0.91
OTD-MC	22		0.93
D-TMC	15	Identify and use students' mathematical contributions constructively for the teaching of mathematics, both correct and incorrect ones.	0.91
OTD-TMC	15		0.94
D-PC	11	Design, adapt, and apply diverse types of evaluation instruments according to their students' level and context, considering learning outcomes.	0.95
OTD-PC	11		0.96

## Analysis

In this study, eight variables were considered. Six variables reflect pre-service teachers' perception of competence development (D-MC, D-TMC, and D-PC) and perceptions of the opportunities given by the program to develop these competencies (OTD-MC, OTD-TMC, and OTD-PC); An additional variable corresponds to the cohort, defined as the last year of coursework completed by participants (Year 1-Year 4). The final variable represents academic commitment. To describe the participants' perception of

competence development and OTDPC (first specific objective), descriptive statistics and stacked bar graphs for each variable illustrate the distribution of each variable (see Table 2).

To identify pre-service teacher profiles according to their perceptions of competence development and OTDPC (second specific objective), a cluster analysis was conducted using the six variables described in Table 2. The goal of this analysis was to group individuals into homogeneous groups according to their perceptions of competence development and OTDPC during their teacher education program. A hierarchical cluster analysis was performed using Ward's linkage method with squared Euclidean distance as the measure of similarity. The dendrogram, generated using Ward's method with a maximum distance of approximately 5, was used to determine the number of clusters to be extracted. To examine whether significant differences existed among the resulting clusters, analyses of variance (ANOVA) were applied to compare cluster means, and chi-square tests were employed to analyse differences in the distribution of categorical variables. A significance level of 5% was adopted for all statistical tests.

Finally, to study the relationships among the pre-service teacher profiles, the cohort, and academic commitment (third specific objective), bivariate analyses were conducted. A contingency table was used to explore the relationship between the profiles and the cohort. To explore the relationship between the profiles and academic commitment, means ( $M$ ) and standard deviations ( $SD$ ) of academic commitment were calculated for each profile. All the analyses were performed with *R* (4.0.4) and *SPSS* (v.25) software.

## Results

### *Self-Perceptions of Professional Competencies and the Opportunities for Development*

Overall, the results indicate distribution across three ascending levels of perception of competence development and OTDPC. Level 1 corresponds to average scores of 1 and 2 on each scale and reflects pre-service teachers who largely disagreed with having developed the competencies or having been given the opportunity to develop them. Level 2, defined by average scores between 2 and 3, represents individuals with a mixed or neutral perception. Finally, Level 3 comprising average scores between 3 and 4, included participants who tended to agree that they have developed the competencies and had opportunities to do so. Figure 3 shows the percentage of people in each level, for each of the six variables that capture the participants' perception.

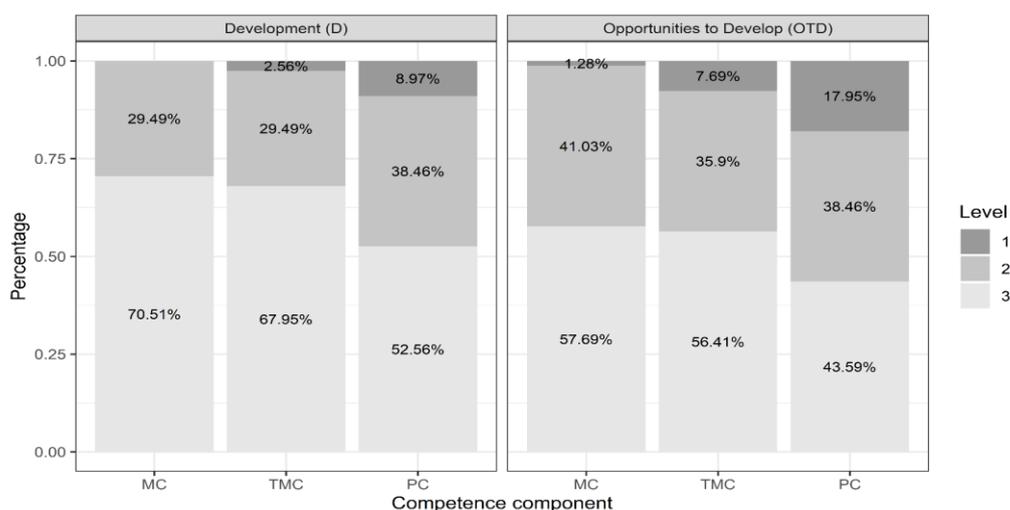


Figure 3. Participant percentages at the various levels.

Across all components, most of the participants were in Level 3, except for the perception of opportunities to develop pedagogical competencies (OTD-PC). Thus, that result implies that most of the participants had a positive perception about the development of their professional competencies and the opportunities given by their program to develop them. Differences, however, were observed between competence components. Participants perceived themselves as more competent in mathematical competencies and felt they had more opportunities for the development of those competencies, while they perceived fewer opportunities were experienced for the development of pedagogical competencies. Furthermore, there was a higher frequency of pre-service teachers in Levels 2 and 3 for the perception of competence development than there was for the perception of competence development opportunities.

Results on each competence component were as follows. In Mathematics Competencies, mean scores were very close for both perspectives considered and showed a tendency towards agreement ( $M = 3.18$ ,  $SD = 0.41$ , for development and  $M = 3.13$ ,  $SD = 0.45$ , for opportunities). The lowest mean scores were recorded in the competence "Understand and use knowledge of differential and integral calculus, and linear algebra," for both perspectives ( $M = 2.59$  for development and  $M = 2.57$  for opportunities). The highest mean scores were observed in different competencies in each perspective. For the perception of opportunities for development, the highest average score was in the competence "Understand and represent numeral systems, their meanings, operations, and the relations between them" ( $M = 3.55$ ).

For the perception of opportunities to develop pedagogical competencies, the highest score was also found in the competence "Use precise mathematical language" ( $M = 3.50$ ). This indicated that participants considered themselves to have developed and received more opportunities to master content related to numeral systems and precise mathematical language than for calculus and linear algebra.

Regarding Competencies for the Teaching of Mathematics, average scores were higher for competence development and showed a tendency towards agreement ( $M = 3.12$ ,  $SD = 0.51$ , for development and  $M = 3.00$ ,  $SD = 0.62$  for opportunities). The lowest values were again found in the competence "Connect knowledge of differential and integral calculus, and linear algebra with contents present in the school curriculum," with a mean of 2.51 for development and 2.44 for opportunities. The highest mean scores were found in different competencies. In relation to competence development, the highest mean score was for "Promoting the understanding, use and transit between multiple mathematical representations, procedures, and solution methods to tackle a problem or situation, according to a mathematical objective and the student's knowledge level," with a mean of 3.40. Regarding opportunities for competence development, the highest mean score was for "Knowing the current school curriculum of the discipline to teach it" with a mean of 3.46. These results indicate that the participants felt competent using various mathematical representations and problem-solving procedures and perceived a high level of opportunity to become familiar with the current school curriculum. Conversely, the participants felt less competent and perceived fewer opportunities when it comes to connecting knowledge of differential calculus and linear algebra with the school curriculum. This aligns with the component, in which participants stated a lower perception of competencies in those areas of mathematics.

Finally, the results for Pedagogical Competencies in terms of competence development and development opportunities demonstrated a mixed trend, characterised by higher standard deviations and greater dispersion within this component ( $M = 2.89$ ,  $SD = 0.71$  for development and  $M = 2.69$ ,  $SD = 0.78$  for opportunities). The lowest mean scores were recorded in the competence, "Select, interpret, and use information from external evaluations to set short- and long-term learning outcomes" with mean scores of 2.67 for competence development and 2.49 for opportunities for competence development. The competencies with the highest mean scores were "Establishing norms and habits and use strategies that promote the development of communication and thinking skills in an environment based on respect, equality, and dialogue" ( $M = 3.18$ ) for competence development. and "Establish and lead work or discussions, in small groups or the full class, distinguishing the relevant use of each of these forms of interaction" ( $M = 2.90$ ) for opportunities for competence development. These results



suggest that the participants felt competent and perceived competence development opportunities were provided in relation to establishing appropriate communication in their classrooms. They reported, however, that they felt less competent and perceived that fewer opportunities were given to use external evaluations for planning learning.

### *Self-perception Profiles on Competence Development and Competence Development Opportunities*

The cluster analysis revealed three distinct clusters based on both the perception of competence development and the perception of OTDPCs. Each cluster represented a specific student profile. The three profiles are characterised in Table 3. The table further differentiates these profiles according to the three components of the professional competencies of mathematics teachers examined in this study: mathematics (MC) competencies for the teaching of mathematics (TMC), and pedagogical competencies (PC). The first and second profiles, including both perspectives, group 32 future teachers (41.03% each), while the third profile groups the 14 remaining participants (17.94%). These results contributed to defining the three profiles of future mathematics teachers identified.

Table 3

*Statistics per Profile According to Self-perception of Participants' Professional Competencies*

	Competence Component	Profile 1	Profile 2	Profile 3
		<i>n</i> = 32 <i>M</i> ( <i>SD</i> )	<i>n</i> = 32 <i>M</i> ( <i>SD</i> )	<i>n</i> = 14 <i>M</i> ( <i>SD</i> )
Development (D)	MC	3.45 (0.29)	2.99 (0.37)	3.00 (0.38)
	TMC	3.50 (0.31)	2.98 (0.36)	2.57 (0.49)
	PC	3.43 (0.36)	2.84 (0.39)	1.79 (0.53)
Opportunities to develop (OTD)	MC	3.47 (0.31)	2.93 (0.32)	2.78 (0.44)
	TMC	3.52 (0.35)	2.78 (0.36)	2.30 (0.57)
	PC	3.34 (0.38)	2.58 (0.42)	1.46 (0.38)

*Profile 1* represents the group of pre-service teachers who perceived both a high level of competence development and a high level of competence development opportunities. All means were between 3 and 4, which implies this group perceived their competence development as being between medium and high, and recognised receiving several to many opportunities for competence development.

*Profile 2* represents the intermediate group, which showed moderate perceptions of both competence development and opportunities for development. For all the variables considered, the means of this group fell within the (2, 3) range, suggesting perceptions of competence development were close to low and medium levels, as well as a perception of competence development opportunities that ranged from few to several.

*Profile 3* represents the group of pre-service teachers who perceived low levels of competence development and fewer competence development opportunities in comparison to the other profiles. This group recorded the lowest mean scores across all scales, except in the MC component, where there was a small difference with Profile 2. Although this is the profile with the fewest participants ( $n = 14$ ), it accounts for a substantial percentage of the sample (18%) and was considered a critical group. For example, in the Pedagogical Competence (PC) component, participants reported perceiving competence development levels as close to null and low, and development opportunity levels as close to none and few. In the other components, the mean scores were also relatively low compared to the other groups, indicating a tendency toward low or medium perceptions of competence development. Regarding the perception of competence development opportunities, the tendency was close to few and several.

The profiles were defined by the overall level of perceived competence development and competence development opportunities across the three study program components. This suggested the existence of relationships among components and between perceptions of competence development and competence development opportunities. In other words, pre-service teachers that perceived themselves as competent in one component tended to report similar perceptions in the other components. Moreover, higher levels of competence development perception were associated with higher perceptions of competence development opportunities.

### *Relationships Among Participant Profiles According to Cohort and Commitment*

Table 4 presents the mean scores of the academic commitment variable for each of the three profiles identified in the preceding section. The mean differences between profiles were statistically significant ( $F[2;34.11] = 6.29, p = .004$ ) with a moderate effect size, indicating meaningful differences in academic commitment across profiles.

Table 4

#### *Statistics per Profile According to Cohort and Participants' Academic Commitment*

	Profile 1 <i>n</i> = 32	Profile 2 <i>n</i> = 32	Profile 3 <i>n</i> = 14	Total
Academic Commitment* <i>M</i> ( <i>SD</i> )	3.04 (0.45)	2.76 (0.32)	3.13 (0.42)	
Completed Study Year (cohort)**	1° Year	8 (38.10%)	8 (38.10%)	21 (100%)
	2° Year	14 (46.67%)	11 (36.67%)	30 (100%)
	3° Year	4 (33.33%)	8 (66.67%)	12 (100%)
	4° Year	9 (60.00%)	5 (33.33%)	15 (100%)

\*The differences are statistically significant between the profiles with  $p < .05$

\*\*The relation between completed study year and the profiles is statistically significant with  $p < .05$

It was observed that the group that reported perceiving the lowest competence development and competence development opportunities (Profile 3), exhibited the highest academic commitment. In contrast, the profile perceiving the highest competence development and competence development opportunities (Profile 2) demonstrated intermediate perception of academic commitment. This is due to a characteristic of the sample, namely that academic commitment was not equally distributed across the cohorts. Specifically, the means of level of academic commitment cores by cohort were  $M = 2.93$  ( $SD = 0.32$ ) for first year,  $M = 3.02$  ( $SD = 0.43$ ) for second year,  $M = 2.58$  ( $SD = 0.35$ ) for third year, and  $M = 3.08$  ( $SD = 0.44$ ) for fourth year. there are significant differences per year according to An ANOVA indicated significant differences in academic commitment across cohorts ( $F[3; 33.34] = 4.6, p = .008$ ) with a moderate effect size, suggesting meaningful differences between cohorts.

Regarding the relationship between profile and cohort, a chi-square test indicated significant association between the two variables  $\chi^2(df = 6, N = 78) = 13.55, p = .03$  (see Table 4). Many of the fourth-year pre-service teachers (60%) perceived that they had achieved a high level of professional competence development and that their program had provided them with ample opportunities for its development (Profile 1). A further 33% perceived a medium level for both dimensions (Profile 2), and only one student in this cohort considered achieving low levels of pedagogical competence and receiving limited opportunities for its development (Profile 3).

Third-year pre-service teachers were distributed between the first and second profile, with approximately twice as many participants classified in the second profile compared to the first. Second-year pre-service teachers showed a distribution similar to that of fourth-year pre-service teachers, with 47% classified in Profile 1, 37% in Profile 2, and 17% in Profile 3. Lastly, nearly a quarter of first-year pre-service teachers (24%) perceived a high level of competence development and ample development opportunities by their program (Profile 1); 38% reported medium levels of competence development



and opportunities level (Profile 2); while 38% perceived a medium level in MC and TMC components, but low levels for the PC component (Profile 3).

These results indicate positive relationships among competence development, competence development opportunities, and completed years of study. These relationships explain the mean scores observed for Profile 3 across the different competence components (Table 3), as most of the pre-service teachers belonging to the profile were at the early stage their studies (all except one had finished only their first or second year; see Table 4). Nevertheless, the relationships do not explain fully the means observed, as this profile included one fourth-year pre-service teacher who had reported low perceptions of both competence development and the program's opportunities for competence development.

## Discussion

The first objective of this study was to describe the perception of pre-service teachers enrolled in the Pedagogy in Mathematics program regarding their professional competence development and about the opportunities the program offered them to develop these competencies. The results indicated that more than half of the participants perceived they had reached a high level of development in the three components of professional teaching competence considered in this study: mathematical competence, pedagogical competence, and competence for the teaching of mathematics (Figure 3).

The proportion of teachers who perceived having reached a high level of pedagogical competence is (53%), which is lower than the corresponding proportions for components for competence for the teaching of mathematics (68%) and mathematical competence (71%). With respect to perceptions of opportunities provided by the program to develop professional competencies (OTDPCs), most of the participants reported having many opportunities to develop mathematical competencies and competencies for the teaching of mathematics (Figure 3). In contrast, a higher percentage of pre-service teachers considered that the program had provided few or no opportunities to develop pedagogical competence when compared with the other two components. Across the three components of professional development, the participants' perceptions of the program's opportunities for competence development were consistently lower than their perceptions of the level of competence they developed.

Given these results, further research is warranted, as several factors may explain the results observed. One likely explanation relates to the pre-service teacher program structure, in which the first two years have a strong emphasis on of courses aimed at developing mathematical competence, while courses focused on pedagogical competence are introduced gradually as pre-service teacher progress through the program (Table 1). In addition, more than half of the participants had completed their first and second year of study, which may have influenced their perceptions of competence development and development opportunities.

The differences observed across the three components reinforce the idea that there are distinct types of knowledge and skills involved in the development of professional competence of mathematics teachers, similar to what is reflected in the theoretical models in the literature (Ball et al., 2008; Blömeke et al., 2015; Carrillo et al., 2013; Shulman, 1986). At the same time, the results raise new questions. From the pre-service teachers' perspective, what or who is primarily responsible for their perceived level of competence development? In the case of mathematical competence development, do pre-service teachers attribute their development to prior school experiences? To what do they attribute development of pedagogical competence or competence for teaching mathematics? More broadly, how do pre-service teachers perceive that these competencies are developed throughout their training?

Regarding the second objective of the study, the cluster analysis identified three distinct profiles between pre-service teachers, based on their perception of level attained in each professional teaching competence and the perception of opportunities provided by their program to develop the competencies. The first profile, which included over 40% of participants, is made up of pre-service teachers who perceived that they attained a high level of development of the three professional teaching competence components and had ample opportunities for competency development by their program. The second profile, which included similar proportions of participants as the Profile 1, consisted of pre-service teachers who perceived a medium level of development of the three



professional teaching competence components, and that they were provided with several opportunities for competence development during their program. The third profile, accounting for approximately 18% of the participants, included pre-service teachers who perceived medium level of development of the mathematical competence and the competence for the teaching of mathematics, alongside several opportunities to develop them, but also perceived low levels of pedagogical competence and few opportunities to develop the competencies. Paradoxically, the participants in this third profile exhibited the highest level of academic commitment (second part of the third study objective), followed by those in the first profile (Table 4).

These results are consistent with the findings of Muñiz-Rodríguez et al. (2020), who identified three profiles of future mathematics teachers according to their competence perception: high-, medium-, and low-perception levels. The study also found that those participants perceived themselves as less competent in the pedagogical domain compared to mathematics and the teaching of mathematics. The current study, however, expands these findings in two ways: first, by examining a teacher education program that differs from the Spanish context, and second, by linking explicitly the perception of competencies with the perception of opportunities for competence development, thereby offering insight into possible explanations for those differences.

With respect to the third objective, the analysis of the relationship between the profile membership and the cohort revealed that most pre-service teachers in second, third, and fourth year belonged to the first or second profile, whereas most of the first-year pre-service teachers were classified in the second or third profile (Table 4). These patterns were expected, given that first-year pre-service teachers have completed a quarter of their teacher training program, and that competencies are distributed unevenly throughout the program (Table 1). More importantly, this finding suggests that the teacher education program impacts cumulatively because pre-service teachers who progress through their studies tend to perceive higher levels of development and greater opportunities to develop the competencies.

Another result that emerged was that approximately one quarter of first-year participants were classified in Profile 1, perceiving both high levels of competence development and ample opportunities to develop all three competence components. Although this corresponds to a small number of participants, it raises additional questions: Why do some pre-service teachers perceive such high levels of competence development after only one year of study? One possible explanation is that these pre-service teachers had achieved high grades in first-year courses and interpreted those outcomes as evidence of strong professional competence development. Another possible reason is that they considered that they did not need specific training to become teachers, or they may have viewed the type of mathematics activity experienced at university was very different from the type experienced when in school; thus, mathematics activities at the university level was perceived just as "another way to teach." These questions show the need to delve into the aspects that intervene in the participants' perceptions, since as Clift and Brady (2005 as cited in Canrinus et al., 2019) suggested, student perceptions frequently differ from those of teachers or researchers.

Regarding the second part of the third specific objective, the analysis of the relationships among the profiles identified and participants' academic commitment showed that future teachers' higher levels of academic commitment are those who perceive lower levels of professional competence development and fewer opportunities to develop those competencies (Profile 3). This finding may be explained by the notion that more committed individuals tend to be more demanding or self-critical. This is a relationship, however, was not explored in depth in this study. Academic commitment is understood as a motivational construct (Baumert & Kunter, 2013) that influences competence development. Considering these results, alternative approaches to measuring this variable should be developed, to assess it more precisely.

## Conclusion

Several limitations of this study were identified. Some relate to the nature of the construct studied—perceptions—while others were related to instrument design, which was based on the competencies



defined either by a specific teacher education program or by the participants themselves. Nevertheless, these limitations may also be viewed as opportunities for further research. For example, while this study focused on the perceptions of pre-service teachers, other studies could focus on the perception of teacher educators, particularly how they design and implement opportunities to develop professional competencies (OTDPCs). In this regard, Fu and Kartal (2023) identified specific practices that influenced pre-service teachers' self-efficacy and growth mindset in mathematics teaching.

Another limitation concerns the timing of the administration of the questionnaire, which took place during a public health emergency due to the COVID-19 pandemic. Therefore, under different circumstances, a higher response rate might be obtained. Moreover, it would be possible to examine potential differences associated with a change in format from digital paper-based questionnaires.

This study involved the collection and analysis of valuable information during the implementation of a new pre-service teacher education program. It offers opportunities to rethink how the implementation of a teacher education plan is evaluated, shifting the focus towards process-orientated approaches that incorporate multiple perspectives—particularly those of pre-service teachers. In this context, two main models of teacher education can be distinguished: the concurrent (or simultaneous) model, which integrates general and professional training within a single curriculum, and the consecutive model, in which pre-service teachers first receive subject-specific training followed by pedagogical and didactic preparation. Different countries adopt one model or a combination of both. For instance, several Southern European countries, such as Spain, Portugal, France, and Italy have adopted the consecutive model, whereas few countries rely exclusively on the concurrent model for teacher preparation (EURYDICE, 2013). In Chile, both models coexist, and studies such as this one contribute to a better understanding of teacher education by identifying similarities and differences across programs.

These findings highlight the importance of proposing monitoring systems as an alternative to isolated evaluations, as such systems facilitate the integration of relevant information over time. In this vein, existing guidelines—such as those by Baartman et al. (2007)—emphasise the use of Competence Assessment Programs (CAPs), which combine traditional assessment methods with innovative summative and formative evaluation approaches, including self-assessment.

Finally, it is essential to evaluate how teacher education programs foster the competencies that prepare pre-service teachers to be prepared for the professional tasks they will encounter, as argued by Canrinus et al. (2019). Accordingly, there is a pressing need to identify new ways to operationalise the tools provided by educational systems and public policy for institutions offering pre-service teacher education programs, such as the Pre-Service Teacher Education Guidelines and the definition of the Teaching Career in the Chilean context.

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### *Corresponding authors*

María Victoria Martínez Videla  
*Universidad de O'Higgins*  
Alameda 611, Rancagua, Chile  
mariavictoria.martinez@uoh.cl

Felipe Ruz  
*Pontificia Universidad Católica de Valparaíso*  
Errázuriz 2734, Valparaíso, Chile  
felipe.ruz.a@pucv.cl

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### *Ethical approval*

Ethical approval for the research was granted by the O'Higgins University, and informed consent was given by all participants for their data to be published.

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### *Competing interests*

The authors declare there are no competing interests.

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## References

- Baartman, L. K., Bastiaens, T. J., Kirschner, P. A., & Van der Vleuten, C. P. (2007). Evaluating assessment quality in competence-based education: A qualitative comparison of two frameworks. *Educational Research Review*, 2(2), 114–129. <https://doi.org/10.1016/j.edurev.2007.06.001>
- Ball, D. L., Thames, M. H., & Phelps, G. (2008). Content knowledge for teaching: What makes it special? *Journal of Teacher Education*, 59(5), 389–407. <https://doi.org/10.1177/0022487108324554>
- Banta, T. W., & Palomba, C. A. (2014). *Assessment essentials: Planning, implementing, and improving assessment in higher education*. John Wiley & Sons.
- Baumert, J., & Kunter, M. (2013). The COACTIV model of teachers' professional competence. In M. Kunter, J. Baumert, W. Blum, U. Klusmann, S. Krauss, & M. Neubrand (Eds.), *Cognitive activation in the mathematics classroom and professional competence of teachers, mathematics teacher education*, (pp. 25–48). Springer. [https://doi.org/10.1007/978-1-4614-5149-5\\_2](https://doi.org/10.1007/978-1-4614-5149-5_2)
- Blömeke, S., Gustafsson, J. E., & Shavelson, R. J. (2015). Beyond dichotomies. Competence viewed as a continuum. *Zeitschrift für Psychologie*, 223(1), 3–13. <https://doi.org/10.1027/2151-2604/a000194>
- Blömeke, S., Jentsch, A., Ross, N., Kaiser, G., & König, J. (2022). Opening up the black box: Teacher competence, instructional quality, and students' learning progression. *Learning and Instruction*, 79, Article 101600. <https://doi.org/10.1016/j.learninstruc.2022.101600>
- Canrinus, E. T., Klette, K., & Hammerness, K. (2019). Diversity in coherence: Strengths and opportunities of three programs. *Journal of Teacher Education*, 70(3), 192–205. <https://doi.org/10.1177/0022487117737305>
- Carrillo, J., Climent, N., Contreras, L. C., & Muñoz-Catalán, C. (2013). Determining specialised knowledge for mathematics teaching. In B. Ubuz, C. Haser & M. A. Mariotti (Eds.), *Proceedings of the VIII CERME* (pp. 2985–2994). ERME.
- Clift R. T., & Brady P. (2005). Research on methods courses and field experiences. In M. Cochran-Smith & K. M. Zeichner (Eds.), *Studying teacher education* (pp. 309–424). Lawrence Erlbaum.
- Deci, E. L., & Ryan, M. R. (2000). The "what" and "why" of goal pursuits: Human needs and the self-determination of behavior. *Psychological Inquiry: An International Journal for the Advancement of Psychological Theory*, 11(4), 227–268. [https://doi.org/10.1207/S15327965PLI1104\\_01](https://doi.org/10.1207/S15327965PLI1104_01)
- EURYDICE. (2013). *Cifras clave del profesorado y la dirección de centros educativos en Europa*. [Key figures on teachers and school leadership in Europe]. [https://www.libreria.educacion.gob.es/libro/cifras-clave-del-profesorado-y-la-direccion-de-centros-educativos-en-europa-edicion-2013\\_172474/](https://www.libreria.educacion.gob.es/libro/cifras-clave-del-profesorado-y-la-direccion-de-centros-educativos-en-europa-edicion-2013_172474/)
- Fu, Y., & Kartal, O. (2023). Developing preservice teachers' self-efficacy and growth mindset for teaching Mathematics: Practices from a mathematics methods course. *Mathematics Teacher Education and Development*, 25(2), Article 4.
- Hernández-Sampieri, R., & Torres, C. P. M. (2018). *Metodología de la investigación: las rutas cuantitativa, cualitativa y mixta* [Research methodology: Quantitative, qualitative and mixed routes]. McGraw-Hill Interamericana.
- Ingvarson, L., & Rowley, G. (2017). Quality assurance in teacher education and outcomes: A study of 17 countries. *Educational Researcher*, 46(4), 177–193. <https://doi.org/10.3102/0013189X17711900>



- Jevšček, M. (2016). Competencies assessment using fuzzy logic. *Journal of Universal Excellence (JUE)/Revija za Univerzalno Odličnost (RUO)*, 5(2), 187–202.
- Law N° 20.903. (2016). *Diario Oficial de la República de Chile* [Official Gazette of the Republic of Chile], Santiago, Chile, 1ero Abril, 2016. <https://www.leychile.cl/Navegar?idNorma=1087343&idParte=>
- Martínez Videla, M. V., Rojas Sateler, F., Ulloa, R., Chandía, E., Ortíz, A., & Perdomo Díaz, J. (2019). Beliefs and mathematical school knowledge at the beginning of pre-service primary teacher education. *Pensamiento Educativo, Revista de Investigación Latinoamericana (PEL)*, 56(2), 1–19. <https://doi.org/10.7764/PEL.56.2.2019.9>
- McClelland, D. C. (1973). Testing for competence rather than for "intelligence." *American Psychologist*, 28(1), 1–14. <https://doi.org/10.1037/h0034092>
- McDonnell, L. M. (1995). Opportunity to learn as a research concept and a policy instrument. *Educational Evaluation and Policy Analysis*, 17(3), 305–322. <https://doi.org/10.3102/01623737017003305>
- Metsäpelto, R. L., Poikkeus, A. M., Heikkilä, M., Husu, J., Laine, A., Lappalainen, K., & Suvilehto, P. (2022). A multidimensional adapted process model of teaching. *Educational Assessment, Evaluation and Accountability*, 34, 143–172. <https://doi.org/10.1007/s11092-021-09373-9>
- Muñiz-Rodríguez, L., Aguilar-González, Á., & Rodríguez-Muñiz, L. J. (2020). Perfiles del futuro profesorado de matemáticas a partir de sus competencias profesionales [Profiles of future mathematics teachers based on their professional skills]. *Enseñanza de las Ciencias*, 38(2), 141–161. <https://doi.org/10.5565/rev/ensciencias.3161>
- OECD. (2019). *PISA 2018 assessment and analytical framework*. OECD Publishing. <https://doi.org/10.1787/13c8a22c-en>
- Rodgers, W. M., Markland, D., Selzler, A. M., Murray, T. C. & Wilson, P. M. (2014). Distinguishing perceived competence and self-efficacy: An example from exercise. *Research Quarterly for Exercise and Sport*, 85(4), 527–539. <https://doi.org/10.1080/02701367.2014.961050>
- Rodríguez Alveal, F., Vásquez Ortiz, C., & Rojas Sateler, F. (2019). Formación inicial docente en profesores de matemática: Una mirada desde la evaluación nacional diagnóstica [Initial teacher training in mathematics teachers: A look from the national diagnostic evaluation]. *Estudios Pedagógicos*, 45(2), 141–153. <https://doi.org/10.4067/S0718-07052019000200141>
- Santagata, R., & Yeh, C. (2016). The role of perception, interpretation, and decision making in the development of beginning teachers' competence. *ZDM Mathematics Education*, 48, 153–165. <https://doi.org/10.1007/s11858-015-0737-9>
- Schmidt, W. H., & Maier, A. (2009). Opportunity to learn. In G. Sykes, B. L. Schneider, & D. N. Plank (Eds.), *Handbook of education policy research*. (pp. 541–549). Routledge.
- Schmidt, W. H., Cogan, L., & Houang, R. (2011). The role of opportunity to learn in teacher preparation: An international context. *Journal of Teacher Education*, 62(2), 138–153. <https://doi.org/10.1177/0022487110391987>
- Schmidt, W. H., Cogan, L., & Houang, R. (2014). Emphasis and balance among the components of teacher preparation: The case of lower-secondary school mathematics teacher education. In S. Blömeke, F. J. Hsieh, G. Kaiser, & W. Schmidt (Eds.), *International perspectives on teacher knowledge, beliefs and opportunities to learn* (pp. 371–392). Springer. [https://doi.org/10.1007/978-94-007-6437-8\\_17](https://doi.org/10.1007/978-94-007-6437-8_17)
- Shulman, L. (1986). Those who understand: Knowledge growth in teaching. *Educational Researcher*, 15(2), 4–14. <https://doi.org/10.2307/1175860>
- Shulman, L. (1987). Knowledge and teaching: Foundations of the new reform. *Harvard Educational Review*, 57(1), 1–22.
- Struyven, K., & De Meyst, M. (2010). Competence-based teacher education: Illusion or reality? An assessment of the implementation status in Flanders from teachers' and students' points of view. *Teaching and Teacher Education*, 26(8), 1495–1510. <https://doi.org/10.1016/j.tate.2010.05.006>
- Tatto, M. T., Chen, Z., & Hernandez, A. S. (2025). Enhancing mathematics education: Regional insights on formative instructional practices. *ZDM Mathematics Education*, 57(6), 1207–1221. <https://doi.org/10.1007/s11858-025-01711-1>
- Tatto, M. T., Schwille, J., Senk, S., Ingvarson, L., Peck, R., & Rowley, G. (2008). *Teacher Education and Development Study in Mathematics (TEDS-M): Policy, practice, and readiness to teach primary and secondary mathematics. Conceptual framework*. Teacher Education and Development International Study Center, College of Education, Michigan State University.
- Tuning Subject Area Group of Education. (2009). *Tuning educational structures in Europe. Reference points for the design and delivery of degree programmes in education*. Publicaciones de la Universidad de Deusto. [http://www.unideusto.org/tuningeu/images/stories/Publications/Education\\_brochure.pdf](http://www.unideusto.org/tuningeu/images/stories/Publications/Education_brochure.pdf)

Zlatkin-Troitschanskaia, O., Shavelson, R. J., & Bartnik, T. N. (2025). What have we learned about modelling and assessing mathematics teachers' competence? Insights from a literature review. *ZDM Mathematics Education*, 57(6), 1093–1108. <https://doi.org/10.1007/s11858-025-01689-w>

