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A study about the education of mathematics teachers in public schools in the region of Formiga (MG)

Um estudo sobre a formação de professores de Matemática de escolas públicas da região de Formiga – MG

Estudio sobre la formación de profesores de Matemáticas en escuelas públicas de la región de Formiga – MG

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Abstract
The education of mathematics teachers who teach in public schools in the region of Formiga (MG) was investigated, together with the perception of a group of teachers regarding the need for specific training. Data from the State Department of Education were used, and a questionnaire was developed and administered to participating professionals. The demand for teachers in the region has grown more than the number of teachers working since 2014. The average number of professionals licensed in the subject has been higher than the national average for elementary education but lower than the average for high school. Finally, teachers consider knowledge and specific training in mathematics essential for working in basic education and adapting content to official curricula and for the quality of the teaching and learning process.
Keywords: Teacher education. Mathematics teaching. Teacher perception. Teaching and learning.

Resumo
Foi investigada a formação de professores de Matemática de escolas públicas da região de Formiga – MG, bem como a percepção de um grupo docente quanto à necessidade de formação específica. Foram utilizados dados da Secretaria Estadual de Educação e também desenvolvido e aplicado um questionário aos profissionais participantes. A demanda por professores na região cresceu mais que o número de docentes atuantes desde 2014. A média de profissionais licenciados na disciplina tem sido maior que a média nacional para o Ensino Fundamental, porém é menor que a média para o Ensino Médio. Por fim, os docentes consideram conhecimentos e formação específica em Matemática essenciais para a atuação na Educação Básica, bem como para a adequação dos conteúdos aos currículos oficiais e para a qualidade do processo de ensino e aprendizado.
Palavras-chave: Formação de professores. Ensino de Matemática. Percepção docente. Ensino e aprendizagem.

Resumen
Se investigó la formación de profesores de Matemáticas en escuelas públicas de la región de Formiga – MG, así como la percepción de un grupo docente sobre la necesidad de formación específica. Se utilizaron datos del Departamento de Educación del Estado y cada participante respondió un cuestionario. La demanda de docentes ha crecido más que el número de docentes activos desde 2014. El número promedio de profesionales licenciados en la materia ha sido superior al promedio nacional para la Educación Primaria, pero es inferior en la Secundaria. Finalmente, los docentes consideran imprescindible el conocimiento y la formación específica para el desempeño de la Educación Básica, así

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como para la adaptación de contenidos a los planes de estudio oficiales y para la calidad del proceso de enseñanza y aprendizaje.
Palabras clave: Formación de profesores. Enseñanza de Matemáticas. Percepción del profesor. Enseñando y aprendiendo.

1. Introduction

Higher education for teachers is mandatory in Brazil, following the Brazilian Basic Education Guidelines and Bases Law. Studies prove a direct correlation between the quality of teaching and the teacher's specific training in the content they teach (DARLING-HAMMOND, 2014; RODRIGUES, LIMA, & VIANA, 2017).

However, a commission established by the Ministry of Education (MEC) prepared a report in 2007 about the lack of teachers in high school (HS), including intervention proposals, bringing a compilation of data released by the National Institute of Educational Studies and Research Anísio Teixeira (Instituto Nacional de Estudos e Pesquisas Educacionais Anísio Teixeira–INEP). The document, fruit of summaries and arguments carried out in the context of the Basic Education Chamber of the National Education Council (Câmara de Educação Básica do Conselho Nacional de Educação), also highlighted a worrying reality of teacher education, showing a rate of approximately 50% of students who drop out of teaching degree courses, especially in physics, chemistry, and mathematics (RUIZ; RAMOS; HINGEL, 2007; DIAS & DA COSTA, 2015).

According to the Basic Education School Census, the supply and demand for teaching degree courses have increased in recent years. However, there is still a shortage of basic education (BE) teachers. The 2022 Census shows that 7.7% of mathematics teachers who worked in the final years of elementary school (ES) and 2.9% of those who worked at high school (HS) that year did not have higher education. Only 65.3% of professionals in the final years of ES and 79.0% of HS, respectively, had adequate teaching education (teaching or research degree with pedagogical complementation in the area).

Given this reality, one of the objectives of this work was to map the education of teachers who teach mathematics in HS and the final years of ES in state schools in the cities of Arcos, Campo Belo, Candeias, and Formiga, also aiming to understand teachers' perceptions of the importance of specific education. The research is characterized as quantitative, and the results are discussed from the point of view of descriptive statistics.

Mapping the education of mathematics teachers in the region is important from an academic and practical point of view. Educational institutions can use knowledge of demand to define strategies and actions for specific education, outline methods to combat dropout rates, develop practices and curricula that guarantee that teachers without specific education can qualify, and make decisions about new teaching degrees and/or complementary formative courses.

Regarding perception, knowing how teachers recognize the need for specific education is important. This survey can also guide educational institutions in the region in training teachers in basic education teaching practices.

2. Literature Review

One of the most significant historical challenges of Brazilian education concerns educating and attracting teachers to basic education (TANURI, 2000; GATTI, 2010, 2014; MOREIRA & FERREIRA, 2021). Law 9.394 of 1996 (LDB) established the guidelines and bases of education at the national level, a relevant step toward the qualification and improvement of teaching and learning by raising the minimum education required from a teacher of the initial grades. However, even today, public and private education systems face difficulties in attracting and retaining specialized professionals on their staff.

Saviani (2009) assertively states that issues involving teacher education and retaining professionals in activity cannot be separated from discussions about working conditions. It is necessary to balance the evident disparity between low salaries and long working hours, which affects most Brazilian teachers. It is essential to adjust political decisions to provide the necessary financial resources for education –which has been exalted in speeches about its importance for establishing our "knowledge society"– to stop being guided by traditional cost reductions and systematic investment cuts. The author concludes that by choosing education as the highest priority and financing it as one of the pillars of a country's development project, we will concisely and simultaneously face other problems, such as violence, health, public safety, unemployment, poverty, transport infrastructure, energy, supply, and environment, among others.

A low demand for different teaching degree courses appears as a reflection of insufficient investment in education and, associated with high school dropout and retention rates, culminates in a much greater number of new entrants than graduates, which fuels the current large deficit of teachers with specific education (DIAS & DA COSTA, 2015). Still, many qualified teachers prefer to dedicate themselves to other occupations. According to Barreto (2015), the low attractiveness of the profession means that many teachers seek more profitable employment opportunities in the labor market, outside the classroom. On the other hand, it is also quite common for professionals with qualifications other than undergraduate teaching degrees, who are unemployed or have difficulties in professional relocation, to seek teaching as a temporary opportunity or to supplement their income, being inserted into the school context without due preparation, which impacts negatively on the teaching and learning process (SCHWERZ, 2020). Due to its scope and complexity, the problem cannot be resolved only through specific actions in the field of education; effective public policies are needed to mitigate it (SAVIANI, 2009).

Another major adversity imposed on the advancement of education concerns the historical adoption of practices that emphasize reproductive aspects by teacher education institutions. Until the last decades of the 20th century and the beginning of the 21st, colleges and universities, to a large extent, contributed to the technical education of teachers focused on content, who reproduced traditional teaching methodologies and techniques that stood out due to the centrality and protagonism of the teacher, the supposed "transmitter of knowledge" (DEMO, 2010). On the other hand, reflective practice (FREIRE, 1996) is opposed to the reproductivist practice and aims for a new education that is not merely a copy of existing ones, allowing the construction of a model that serves as a basis for society, incorporating new alternatives and, mainly, including historically excluded subjects, converging towards the formation of critical, reflective citizens who are aware of the formative process, as well as their social roles. In recent decades, formative institutions and

educational guidelines have been increasingly concerned with breaking with the content-based model, seeking to forge teachers capable of reflecting on their practices and actions before, during, and after executions while incorporating into their curricula new teaching tools and modern teaching methodologies that give students leading positions and co-responsibility for learning.

According to Demo (2010), many active professionals have been trained in institutions where reproducing content was valued. As a result of schools strongly supported by instructionalism, many teachers are not used to studying and getting updated in their profession. Thus, even though current qualification curricula point to research as the leading source of building, improving, and recycling knowledge, many teachers do not continue their studies and restrict their practices to day-to-day life and classroom experiences.

Once the challenges were identified, among others specific to different areas of knowledge, teacher education became the object of research in recent decades and was consolidated as a critical guiding aspect of educational policies (KUENZER, 2011; DINIZ-PEREIRA, 2013; JORGE, 2018; MOREIRA & FERREIRA, 2021). Specific guidelines for undergraduate courses have been implemented to consolidate the education of specialized professionals in different areas and also to dissociate the education between an educator and a research-degree professional who, despite coinciding in several aspects, are essentially different (REIS, DE ANDRE & PASSOS, 2020).

The reality of mathematics teachers' education and the historical challenges imposed on the process do not differ from those faced by education in general (GOMES, 2016a, 2016b). Despite the growing number in recent years of face-to-face and distance learning (DL) courses and qualification institutions (universities, colleges, and federal institutes of education, science, and technology), in addition to actions to strengthen teaching degree courses -particularly the Higher Education Improvement Coordination (Coordenação de Aperfeiçoamento de Pessoal de Nível Superior–CAPES): Program for the Consolidation of Teaching Degrees (Prodocência), Institutional Program of Teaching Initiation Scholarships (Programa Institucional de Bolsa de Iniciação à Docência -PIBID) and Pedagogical Residency Program (Residência Pedagógica), the country still lacks teachers (Gomes, 2016a; Schwerz, 2020). According to Beltrão and Mandarino (2014), based on data from the National Institute of Educational Studies and Research (Instituto Nacional de Estudos e Pesquisas Educacionais–INEP) and the Brazilian Institute of Geography and Statistics (Instituto Brasileiro de Geografia e Estatística–IBGE), the increase in mathematics courses between 1995 and 2010 did not increase the number of qualified teachers. Most recent data from the basic education school census have shown that reality has not changed. It is still commonplace to find in-service teachers qualified in other areas without a teaching degree or specific teaching qualification (ARAÚJO & VIANNA, 2011; CRUZ & BAYER, 2017).

Just as happened with teacher education in general, until the last decades of the 20th century, mathematics teaching degree courses in the country had purely technical characteristics, causing problems such as a neutral, universal, and solely scientific treatment of curriculum components; a considerable distance between the studied theory and practice; a marked fragmentation of general qualification subjects and an evident disassociation between social and school realities (TANURI, 2000; FREIRE, 1996; GOMES, 2016a, 2016b). From the beginning of the 21st century, the concern with reflective teacher education brought gradual changes to the curriculum structure of the

courses, culminating in the qualification of teachers who are more capable of contextualizing their practices and seeing the teaching and learning process from students' standpoint, incorporating social and human aspects into traditional technical education (GOMES, 2016a, 2016b).

If, on the one hand, there is a shortage of teachers duly qualified in mathematics, even though it is a legal requirement for teaching classes on the subject, research shows that the quality of the teaching and learning process tends to increase when teachers of each curriculum component have specific training in their areas of expertise (COSTA, BRITO & WALTERBERG, 2020; DARLING-HAMMOND, 2014; PEREZ et al., 2013; RODRIGUES, LIMA & VIANA, 2017). Teachers who are prepared to teach tend to be more successful and confident with students than those who do not have a teaching qualification (LIMA, 2017). Research and data analyses also indicate that changes in teacher education, which created programs that integrate extensive practical education intertwined with courses on teaching and learning and innovative teaching methodologies, tend to produce more efficient teachers who enter and remain in the teaching career. A noteworthy contribution of specific training is that it can develop skills so that teachers understand teaching from students' perspective and can integrate different experiences, methodologies, and references into daily school life, which increases the chances of success and/or student approval and leads to better results in the teaching and learning process (DARLING-HAMMOND, 2014; FREIRE, 1996; LIMA, 2017; SIMÕES, 2013). Finally, professionals qualified in teaching tend to be better prepared to contribute to the discussion about mathematics necessary for school teaching practice in basic education that must be present in initial and/or continuing education courses (MOREIRA & FERREIRA, 2021).

Despite the efforts spent on teacher education, the basic education census and the realities of elementary and secondary education schools have demonstrated that there is still an evident lack of specialized professionals in all regions of Brazil, on a greater or lesser scale. The most worrying cases are those related to poor communities and those far from large urban and/or qualification centers (GOMES, 2016a, 2016b). Therefore, it is natural that there is an interest in mapping the qualification of teachers in a region to identify potential qualification gaps and generate knowledge to design strategies and actions that can be used to remedy them.

3. Methodology

Information on teacher education was obtained from the State Department of Education of Minas Gerais (Secretaria de Estado de Educação de Minas Gerais–SEE/MG) since the schools in the four investigated cities (Arcos, Campo Belo, Candeias, and Formiga) are subordinate to three different regional superintendencies of education. In this study, we analyzed 2014, 2018, and 2022 data to investigate whether the average professional's education has significantly changed over those years. SEE/MG information is confidential and does not allow teachers to be identified.

The following criteria were considered for the processing of qualification data for teachers in HS and the final years of ES: i) classification of professionals into mathematics teaching-degree graduates, mathematics research-degree graduates or with other qualifications; ii) among professionals who do not have specific education in mathematics, analysis of the percentage of teachers with a postgraduate degree at any level (*lato sensu* or *stricto sensu*) in mathematics, education, or teaching and iii) the percentage of effective and recruited mathematics teachers each year.

We studied teachers' perception of the importance of a specific qualification to work in basic education guided by a questionnaire developed and applied anonymously to teachers working in 2022 in nine neighboring cities. Assessing a group's perception is complex because of subjectivity and the variety of perceptions that can coexist (DALMORO & VIEIRA, 2013). To this end, we used the multi-item measurement Likert scale, developed by Rensis Likert (1932), with five levels of agreement for evaluating an assertion: 1) totally disagree; 2) partially disagree; 3) my arguments for disagreeing and agreeing are equivalent; 4) I partially agree and 5) I totally agree.

The questionnaire was created with four constructs. Here, we will present an extract of three constructs: Construct 1- the importance of qualification in mathematics (a research degree or a teaching degree) for the mathematics teacher (two statements); Construct 2- the relevance of teacher education in a teaching degree in mathematics (six statements), and Construct 3- the public school and its relationship with the teaching degree in mathematics (two statements).

The questionnaire was handed out in person in print and online via Google Forms. With the possibility of remote participation, 56 teachers from the following cities in Minas Gerais collaborated: Arcos, Campo Belo, Cana Verde, Candeias, Cristais, Formiga, Iguatama, Lagoa da Prata, and Piumhi, characterizing a convenience sampling of the researched region, meaning that teachers gave voluntary answers. Also, this is the most usual sample in opinion polls. The questionnaires were distributed between September and November 2022, and the answers were analyzed using descriptive statistics, which defined the research as quantitative.

According to resolution 510/2016 of the National Health Council, there is no need for approval of the work by an ethics committee, as it is an opinion survey with unidentified participants.

4. Results and Discussion

Table 1 presents the results of the data analysis of the qualification of mathematics teachers in state schools of HS and the final years of ES in the cities of Arcos, Candeias, Campo Belo, and Formiga for 2014, 2018, and 2022. The number of vacancies differs from the number of teachers because a single teacher can occupy more than one vacancy in different schools.

Table 1- Mathematics teachers' qualifications in Arcos, Candeias, Campo Belo, and Formiga.

Year	Vacancies for mathematics teachers	Mathematics teachers (HS and final years of ES)	Teachers with a proper qualification in mathematics	Vacancies occupied by permanent teachers
2014	122	92	66 (71.7%)	88 (72.1%)
2018	170	120	91 (75.8%)	128 (75.3%)
2022	218	123	87 (70.7%)	154 (70.6%)

Source: Prepared by the authors.

The number of jobs increased from 122 in 2014 to 218 in 2022, a growth of 78.7%, indicating a large expansion in demand in state schools in the region. In the same period, the number of active teachers grew from 92 to 123, an increase of just 33.7%. The percentage growth in demand for mathematics teachers was 2.3 times greater than the growth in the total number of teachers in the classroom during the period, revealing the need to expand recruitment and teacher education in

the region. This result reveals a local mismatch between demand and available labor, in line with results obtained in other contexts and regions (BARRETO, 2015; DIAS & DA COSTA, 2015; GATTI, 2010, 2014; GOMES, 2016a; KUENZER, 2011; MOREIRA & FERREIRA, 2021).

The 2018 School Census clarified that, between 2014 and 2018, the average national percentage of teachers with an adequate qualification in mathematics (teachers with a teaching degree or a research degree with pedagogical complementation in the area) was 56.3% in the final years of ES and 73.9% in HS. The 2022 Census presented higher percentages of professionals in the same conditions for that year: 65.3% in the final years of the ES and 79.0% in the HS. The results obtained for the group of teachers in the region reveal that the qualification adjustments are, in a first approximation, higher in percentage compared to the national qualification adjustments for the final years of ES. However, they are lower than the national averages for HS, demonstrating a lack of professionals in the field. Thus, a relatively fragile regional reality is observed in relation to the adequate qualification of mathematics teachers, showing that teachers trained in other areas teach the subject, according to results obtained by Araújo and Viana (2011) and Cruz and Bayer (2017).

Among the teachers in the region who did not have adequate training to work in BE, many completed postgraduate studies (*lato sensu* or *stricto sensu*) in mathematics, education and/or teaching, which reveals professional maturity and concern with continuing education and adaptation to the job market. The percentage of professionals without adequate qualifications but with postgraduate degrees in these areas was 84.2% in 2014, 61.5% in 2018, and 27.3% in 2022.

In the years investigated, permanent teachers filled at most 75.3% (in 2018) of the vacancies in the region. In 2014, the percentage was 72.1%, and in 2022, 70.6%. Recently, the Education Committee of the Chamber of Deputies approved Bill 5717/19, which requires states, municipalities, and the Federal District to ensure that permanent professionals fill at least 90% of public school teaching positions. The adjustment must be made gradually over up to five years. Thus, the rates of effective mathematics teachers in the region reveal great fragility, indicating the need to qualify a considerably higher number of teachers to comply with the legislation. An auxiliary measure would be to attract graduates who are dedicated to different professional activities to the teaching profession.

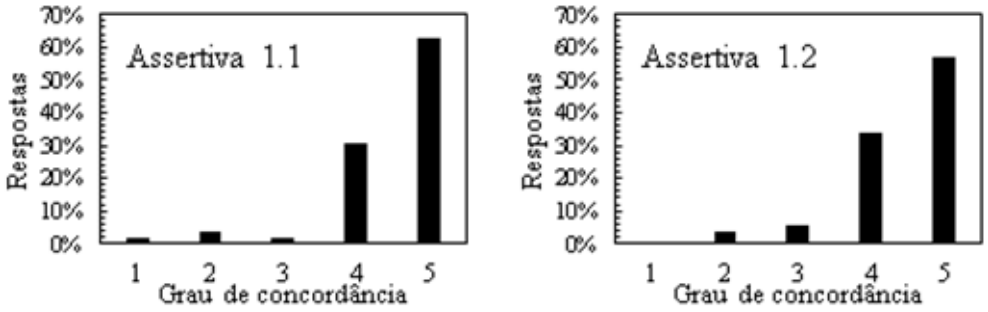
As discussed by Saviani (2009), the qualification and conservation of teachers in the classroom go beyond localized actions in the field of education and are also directly related to the professionals' working conditions and pay. The growth in demand at a level much greater than the growth in the number of teachers, as well as the lag in adequate training revealed in this work, are probably closely related, among other things, to the historical indifference with which the Government of the State of Minas Gerais has handled education –the state is known for not paying the minimum salary to its teachers. For decades, there have been conflicts between the state government and representatives of the category, who seek better professional working conditions and pay and a more solid structuring of the teaching career.

Regarding teachers' perceptions, the questionnaire was applied to 56 teachers from the cities of Arcos, Campo Belo, Cana Verde, Candeias, Cristais, Formiga, Iguatama, Lagoa da Prata, and Piumhi, with five levels of agreement for each statement: 1) completely disagree; 2) partially disagree; 3) my arguments for disagreeing and agreeing are equivalent; 4) I partially agree and 5) I totally agree. Of the respondents, 30.4% had a higher education degree as their maximum degree, 62.5%

had a specialization, and 7.1% had a master's degree. Furthermore, 94.6% have degrees in mathematics, which guarantees a significant sample of professionals with adequate training to work in BE.

The first construct of the questionnaire is "The importance of a qualification in mathematics (teaching or research degree) for the mathematics teacher," and contains two statements. The results are shown in Figure 1.

Figure 1- Results for the first construct of the questionnaire, "The importance of a qualification in mathematics (teaching or research degree) for the mathematics teacher."



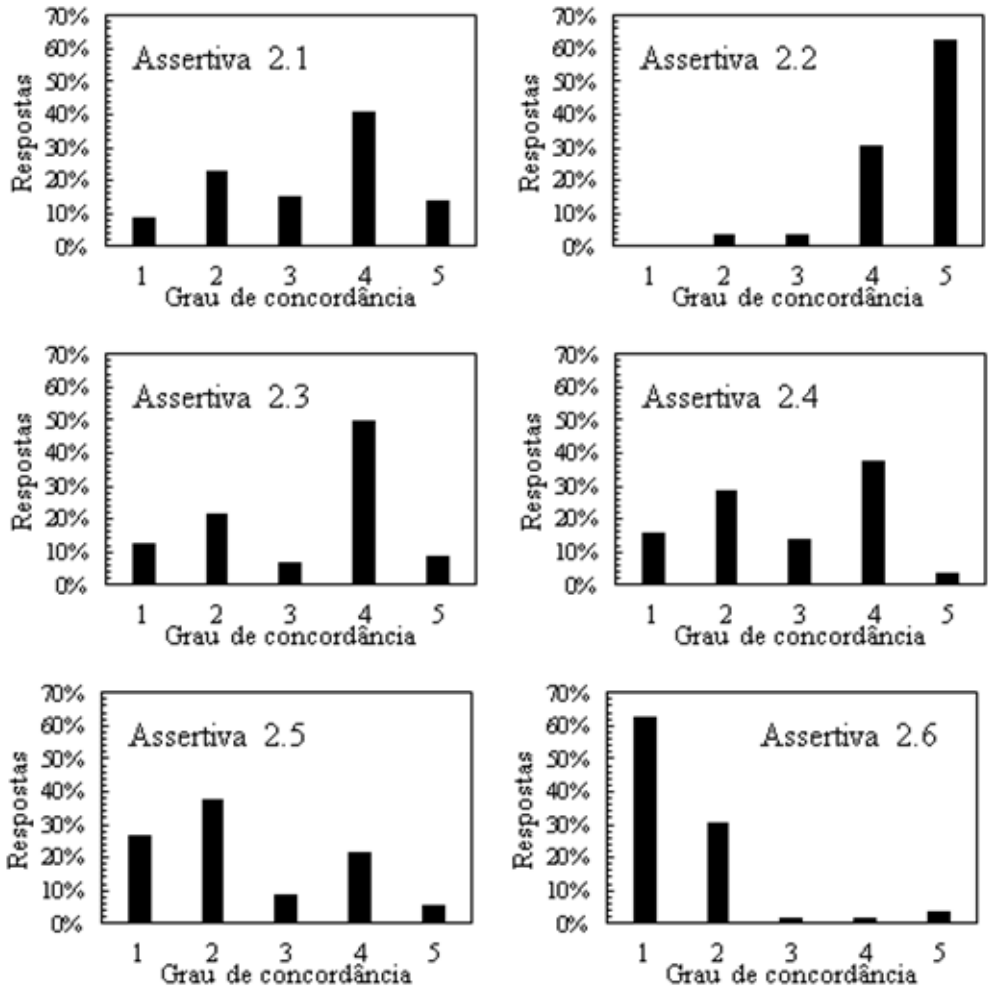
Source: Prepared by the authors.

The degree of global agreement (partial agreement and total agreement) of the respondents with statement 1.1, "A teacher trained in mathematics can obtain more satisfactory results in the classroom than a teacher without training in the area," is 92.9%, with 62.5% of total agreement and 30.4% partial agreement. This demonstrates that teachers recognize the need for specific knowledge in the area to work in BE.

The second statement of the construct (1.2) analyzes whether "The absence of specific qualification in mathematics may compromise the adaptation to the Curriculum Guidelines or the Common Curriculum Bases." Again, the degrees of agreement were high, 57.1% total agreement and 33.9% partial agreement. Moreover, no teacher totally disagreed with the statement, which demonstrates that teachers strongly associate the need for qualification in the area with the implementation of BE curricula in the classroom.

The second construct is "The relevance of teacher education in mathematics teaching degree," and aims to investigate the perception regarding the need for a specific qualification as a teacher in the subject. Furthermore, it investigates the full capacity of professionals with different backgrounds to teach in BE. It has six assertions, and the results are presented in Figure 2.

Figure 2- Results for the second construct of the questionnaire, "The relevance of teacher education in mathematics teaching degree."



Source: Prepared by the authors.

The first construct statement 2.1 is "The teacher who does not hold a teaching degree but has a research degree in mathematics is fully capable of teaching the subject for basic education." Overall agreement is only 55.4%, while 32.1% totally or partially disagree, which is solid evidence that participants recognize the differences in training between research degree and teaching degree holders and their implications for working in BE. This corroboration leads us to reflect on which mathematics is necessary for school teaching practice, as highlighted by Moreira and Ferreira (2021).

"The teacher with a teaching degree in mathematics is fully capable of teaching the subject in basic education" is statement 2.2. The high degree of global agreement of 92.9% (30.4% partial and 62.5% total) aligns with the results of statement 2.1, clearly demonstrating understanding regarding the need for adequate teacher qualification for the teaching process and learning in BE.

The subsequent four statements investigate the participants' perception of the possibility of teachers with teaching degrees in other subjects taking on mathematics classes in BE: "2.3- A teacher licensed in physics is fully capable of teaching the subject of mathematics in basic education"; "2.4- A teacher licensed in chemistry is fully capable of teaching the mathematics subject in basic education"; "2.5- A teacher licensed in biology (biological sciences) is fully capable of teaching

the subject mathematics in basic education," and "2.6- A teacher licensed in other areas (different from those mentioned previously) is fully capable of teaching the subject mathematics in basic education".

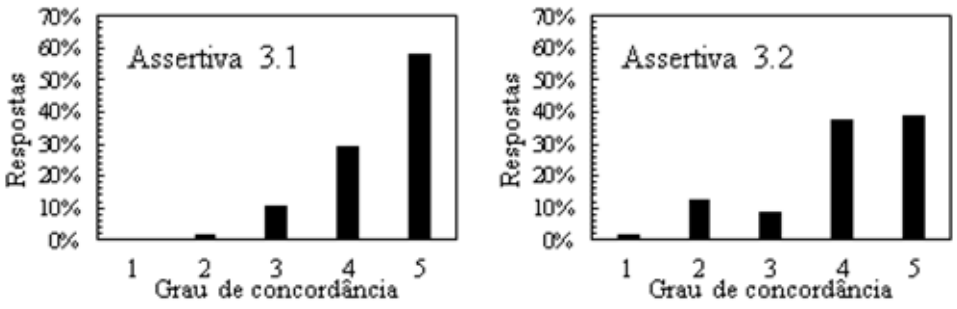
The highest overall agreement rate was found for physics graduates imparting mathematics classes, with 58.9% (50% partial and 8.9% total). Even though the agreement for physics is higher, the overall percentage is due mainly to declarations of partial agreement only. Furthermore, there is a considerably high percentage of global disagreement (partial disagreement and total disagreement combined), 33.9%. In other words, approximately one-third of respondents think that physics graduates cannot teach mathematics classes. These results, again, demonstrate that teachers clearly see the need for specific qualifications for BE professionals in this area.

The overall agreement rates drop considerably in statements 2.4- Chemistry (41.1%), 2.5- Biology (Biological Sciences) (26.8%), and 2.6- Other Areas (5.4%), compared to statement 2.3- Physics (58.9%). The descending order for the degrees of agreement (Physics > Chemistry > Biology >Other Areas) seems to echo the Brazilian teaching degree curricula in recent decades.

Physics degree courses have historically included mathematics subjects such as Calculus (I, II, III, and IV), Numerical Calculus, Introduction to Linear Algebra, Analytical Geometry, Mathematical Methods of Theoretical Physics, Statistics and Probability, Ordinary and/or Partial Differential Equations, among others. On a smaller scale, chemistry teacher education courses also have a relatively high mathematics workload. Although present, the workload in biology/biological sciences courses is considerably smaller since quantitative and statistical methods are important for qualifying teachers in the area. Teachers trained in other areas tend to have much less contact with mathematics–if any- during their initial education.

Finally, the third construct has two statements and investigates the topic: "The public school and its relationship with the teacher degree in mathematics." The results are shown in Figure 3.

Figure 3- Results for the third construct of the questionnaire, "The public school and its relationship with the teacher degree in mathematics."



Source: Prepared by the authors.

Statement 3.1 investigates whether "The school management understands that specific qualification in mathematics is important for teachers who will teach mathematics." Specifically, the sample space for the statement was 55 teachers, as one of the participants did not respond. The overall degree of agreement was 87.3% (29.1% partial and 58.2% total). The state school network requires permanent teachers –admitted through public examination to have a teaching degree in

mathematics. On the other hand, temporary teachers– are hired under much less restrictive hiring policies than the rules that apply to permanent teachers. Thus, although school principals cannot require a teaching degree since, in the absence of licensed teachers, other professionals, and even students, can temporarily fill the vacancies, the results indicate that the school managers of the participating teachers recognize the importance of specific training.

Finally, statement 3.2 seeks to understand whether "The school community (parents, teachers, students, etc.) understands that specific qualification in mathematics is important for teachers who will teach mathematics." Overall agreement was 76.8% (37.5% partial and 39.3% total). Again, the high degree of agreement demonstrates that not only principals but also the wider school community tends to value that mathematics classes are imparted by teachers duly licensed in the area, which corroborates the analyzed studies that state that the quality of the teaching and learning tends to increase when teachers have specific training in their areas of expertise (COSTA, BRITTO & WALTENBERG, 2020; DARLING-HAMMOND, 2014; PERES et al., 2013; RODRIGUES; LIMA & VIANA, 2017).

5. Conclusions

This study focused on the qualification of mathematics teachers who teach in high school and the final years of elementary school in public schools in four cities in the Formiga (MG) neighboring region, working in 2014, 2018, and 2022. We sought to understand the perception of 56 teachers from nine cities in the region, working in 2022, of the need for specific training in mathematics for work in basic education.

Regarding teachers' qualifications in the region, the data revealed that the percentage increase in the demand for teachers was 2.3 times greater than the increase in the number of teachers working between 2014 and 2022, which demonstrates a situation that could become unsustainable in the medium and long term, culminating in a severe professional shortage. Furthermore, we found that the average of adequacy of regional training between 2014 and 2022 was higher than that of national training for professionals who worked in the final years of elementary school (ES) in the same period. However, it was lower than the national average for high school (HS).

As the growth rate of regional demand was higher than that of the number of working professionals, and the regional average of adequate training was below the national average for high school teachers, an alert signal must be activated, and alternatives must be found. Expanding the number of courses and education institutions and creating programs to strengthen teaching degrees (Prodocência [Proteaching], PIBID, and Pedagogical Residency) in the last decade was vital to minimize the problem of the lack of teachers in the country. Nonetheless, it did not resolve it. Teacher education institutions in the region must seek alternatives to attract more students, offering better conditions for retention and qualification, reducing dropout rates, and increasing the ratio between graduated and incoming students. By ensuring satisfactory conditions for education and proper professional qualification, an important step can be taken so that teachers with training in the area take on more and more classes in basic education, which is highlighted in several works as essential for enriching teaching and learning (COSTA, BRITTO & WALTENBERG, 2020; DARLING-HAMMOND, 2014; PERES *et al*., 2013; RODRIGUES, LIMA & VIANA, 2017).

On the other hand, it has become increasingly evident that isolated efforts by training institutions and development agencies have not been sufficient, especially given the recent legal obligation that permanent professionals occupy at least 90% of public school teaching positions. It is known that the lack of financial attractiveness and the lack of prestige of the profession (SAVIANI, 2009), especially in post-truth times, are preponderant factors that lead teachers to seek a professional replacement in other areas (BARRETO, 2015; SCHWERZ, 2020). Thus, there is also an urgency for robust and effective public policies to value teachers, which are capable of impacting the number of students who are interested in the area and which can make teaching attractive to those subjects who are qualified and who are not professionally dedicated to teaching.

As for perception, the results revealed a high degree of awareness regarding the importance of specific knowledge of mathematics, both for obtaining better results in the classroom and for adapting the content covered to the Curriculum Guidelines or Common Curriculum Bases. Furthermore, it was evidenced that, despite considering that the mathematics research degree is partially capable of teaching the subject in basic education (BE), the results showed that the graduates qualified in teaching are more capable and prepared for the situation, demonstrating knowledge and clarity about the difference in qualification and performance between the two professionals and the need for teaching training.

We also investigated whether teachers duly licensed in physics, chemistry, biology/biological sciences, and other areas would be fully capable of leading mathematics classes in BE. The group of teachers considers that the licensed in physics are the most skilled among those not specifically trained in mathematics. To a lesser extent, they also consider chemistry licensees capable of imparting mathematics classes. On the other hand, the majority believe that graduates in biology or other areas are unprepared. This sequence seems to be directly stimulated by the greater workload of mathematics subjects in the curriculum of physics teacher education courses in recent decades.

Finally, according to the teachers' perception, both principals and people in their school communities tend, for the most part, to value the specific education of mathematics licensees. Recognizing this is important, as it reveals that managers and the school community know the specificities and differences between teaching-based and research-based education and the contributions of a teacher educated in the area.

The perception results were obtained from a group of teachers who, although predominantly made up of mathematics teaching-degree holders (94.6%), include individuals with different postgraduate profiles, social, emotional, and economic experiences, and different age groups. Therefore, despite indicating a trend in teaching perception, the results cannot be directly extrapolated beyond the participants' context.

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