

Prominent themes in Profmat: An approach via a semantic network of cliques

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ABSTRACT

Background: Profmat is a professional master's program in mathematics in the semi-presential modality, coordinated by the SBM with support from IMPA. There is a gap in the literature regarding the identification of prominent themes in Profmat. **Objectives:** Identify the prominent themes present in Profmat's dissertations. **Design:** The research employs network science methods to analyse and interpret the data. **Data collection and analysis:** We collect the titles of dissertations corresponding to the first ten years of defences held in Profmat. A weighted, connected semantic network of cliques nominated as the Profmat network was constructed, where vertices represent words with intrinsic meaning from dissertation titles. Two words are adjacent if both belong to the same title. The prominent themes were identified through an evaluation of word importance from the perspective of centrality and its relationships, as indicated by the weighted edges. **Results:** The research identified 19 prominent themes, of which 4 have a direct connection with mathematics teachers' classroom practice. **Conclusions:** Regarding the program's objectives, the results revealed that the set of Profmat dissertations highly adhered to mathematics teaching in secondary school and in-depth mathematical education. On the other hand, the research identified a lower predominance of themes related to the teachers' classroom practice, suggesting that the set of dissertations adhered little to the Profmat's guidelines.

Keywords: Mathematic teaching; semantic network of cliques; random cliques; centralities.

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Temáticas proeminentes no Profmat: uma abordagem via rede semântica de cliques

RESUMO

Contexto: O Profmat é um programa de mestrado profissional em Matemática na modalidade semipresencial, coordenado pela SBM com apoio do IMPA. Existe uma lacuna na literatura quanto à identificação de temáticas proeminentes no Profmat. **Objetivos:** Identificar as temáticas proeminentes presentes nas dissertações do Profmat. **Design:** A pesquisa utiliza métodos da Ciência das Redes para tratar e analisar os dados. **Coleta e análise de dados:** Coletamos os títulos de dissertações que correspondem aos dez primeiros anos de defesas realizadas no Profmat. Uma rede semântica de cliques ponderada conectada denominada de rede Profmat foi construída, onde os vértices representam as palavras com significado intrínseco dos títulos das dissertações. Duas palavras são adjacentes se ambas pertencem a um mesmo título. As temáticas proeminentes foram identificadas a partir da avaliação da importância das palavras sob a perspectiva de centralidades e de suas relações por meio de arestas ponderadas. **Resultados:** A pesquisa identificou 19 temáticas proeminentes, das quais 4 possuem uma aproximação direta com a prática do professor de Matemática na sala de aula. **Conclusões:** Quanto aos objetivos do programa, os resultados revelaram alta aderência do conjunto de dissertações do Profmat, com foco no ensino de Matemática no Ensino Médio e em uma formação matemática aprofundada. Por outro lado, a pesquisa identificou uma menor predominância de temas relacionados à prática do professor na sala de aula, sugerindo uma aderência reduzida do conjunto de dissertações às diretrizes do Profmat.

Palavras-chave: Ensino de Matemática; redes semânticas de cliques; cliques aleatórias; centralidades.

INTRODUCTION

The Professional Master's Degree in National Network in Mathematics (Profmat) is a blended program coordinated by the Brazilian Mathematical Society (SBM) with support from the Institute of Pure and Applied Mathematics (IMPA). The result of an initiative by the Coordination for the Improvement of Higher Education Personnel Foundation (Capes) and coordinated by SBM together with the scientific community in the field of mathematics, Profmat's target audience is mathematics teachers working in basic education. Profmat contributes to the fulfilment of Goal 16 of the National Education Plan (PNE) (Brasil, 2014): to qualify, by 2024, at the postgraduate level, 50% of basic education teachers in their respective areas of activity. According to Article 3 of its regulations, Profmat aims to provide in-depth mathematical training relevant to teaching in basic education, thereby enabling graduates to obtain certified qualifications to practice as mathematics teachers (Profmat, 2024).

Since offering the first class in 2011, Profmat has obtained a score of 5, the highest for master's programs. SBM commissioned technical reports (Profmat, 2013a, 2013b, 2017, 2020, 2024) from consulting agencies to obtain external assessments of Profmat. Such reports present quantitative analyses of the program, aiming to identify Profmat's contributions to improving mathematics teaching. The evaluations contained in the reports present expectations about the possibilities of positive interventions in the classroom resulting from Profmat's contributions to the education of its students. In Profmat (2013b, p. 63), students and teachers' expectations of a "change for the better in teaching practice in mathematics in basic education as a result of Profmat's teachings" are evident. According to Profmat (2017, p. 53), "Profmat contributes to improving the posture of its graduates, advancing their careers, their professional performance, learning new techniques and tools, generating an impact in the classroom." According to Profmat (2020, p. 27), "the effectiveness of the program is not restricted solely to its scope and number of places, as it is also evident in the qualification of the graduating student and the progress that this can bring inside and outside the classroom." The results of the Profmat report (2024, p. 28) indicate high levels of satisfaction with the program among students (91%), graduates (96%), teachers (88.2%), and coordinators (93.5%).

In the literature, we found several studies that analysed Profmat's contributions to basic education. The literature has pointed out that although the program provides a deeper understanding of mathematical content, there is a gap between the teacher's practice in class and the theoretical discussions in Profmat (Caldatto, Pavanello, & Fiorentini, 2016; Breda et al., 2017; Farias & Vilela, 2017; Caldatto, Fiorentini, & Pavanello, 2018; Santana, Grilo, & Barbosa, 2020; Caldatto, Martins, & Yanez, 2023). Furthermore, Profmat has dropout and failure rates that seem contradictory for a postgraduate program that aims to improve mathematics teaching. Since its inception, Profmat has trained 7,842 master's students, which is equivalent to 36.1% of the total 21,733 vacancies offered (Profmat, 2024). Data made available on the Sucupira Platform indicate that, during the 2021-2024 four-year period, Profmat qualified a total of 2,147 graduates, equivalent to approximately 18% of the total 3,996 enrolled students. If we consider only the data from the 2021-2022 biennium, we see that Profmat graduated only 20% of the 5,167 enrolled students.

Giacomazzo (2015a) developed a quantitative-qualitative study to evaluate the presence of distance learning (DL) devices in Profmat. The organisational principles of Profmat were investigated by Giacomazzo (2015b)

through an analysis of documents (e.g., regulations, notices, official letters, syllabi) present on the program's website. Caldatto, Pavanello, and Fiorentini (2016) and Caldatto, Fiorentini, and Pavanello (2018) analysed the Profmat curriculum. A qualitative research was carried out by Vicente and Resende (2016) to investigate the coherence between Profmat and teacher education policies. The authors applied questionnaires and conducted interviews with students at the Profmat centre in Uberaba, Minas Gerais. Breda and Rosário (2016) conducted a case study to investigate the characteristics of the didactic analysis by Profmat teachers. Breda et al. (2017) analysed the use of scientific contexts in Profmat dissertations.

The Profmat curriculum matrix was analysed by Farias and Vilela (2017) in light of Pierre Bourdieu's theory. Szewczyk and Loguercio (2018) mapped Profmat dissertations with themes focused on the field of descriptive statistics. Using the descriptor "Estatística" [statistics] and, based on inclusion/exclusion criteria, the authors analysed 19 dissertation abstracts. Drawing on Michel Foucault's concepts of discourse and governability, Szewczyk and Loguercio (2019) analysed statistical knowledge present in Profmat dissertations. Through quantitative surveys, Arvelos and Brighenti (2019) performed a descriptive statistical analysis to assess the average course completion time of Profmat students at the Federal University of São João del-Rei (UFSJ) who entered between 2011 and 2016.

Oliveira (2019) conducted qualitative research based on the conception of semantic fields presented by Rômulo Campos Lins to investigate the notion of derivative present in Profmat dissertations. The influence of the Profmat centre at the Federal University of Alagoas (UFAL) on the pedagogical practices of its graduates was investigated by Farias and Cândido (2019), who evaluated the use of playful teaching and pedagogical materials in their classes. Gaspar et al. (2019) evaluated the relationships between DL and Profmat, through documentary analysis and interviews, from the perspective of Agnes Heller's theory. Pierre Bourdieu's concepts were applied by Farias and Vilela (2019) to outline the mathematics field, analysing the relationships between mathematicians who prioritise research, members of IMPA, and those dedicated to teacher education, working at Profmat.

Carvalho and Carvalho (2021) conducted an investigative and qualitative study to explore the conceptions of Profmat student teachers regarding mathematical demonstrations. The authors collected data from an activity applied to ten teachers who had taken the History of Mathematics course at Profmat at the State University of Londrina (UEL). Classroom data

were collected by Santana, Grilo, and Barbosa (2020) to analyse how the teacher educator who is part of Profmat deals with the tensions between the pedagogical discourse of the master's program and the texts mobilised from school mathematics by basic education teachers. Using quantitative and qualitative methods, Almeida, Musmanno, and Sousa (2020) mapped dissertations addressing mathematical modelling in Profmat.

Aparecida and Leivas (2021) mapped master's dissertations focused on spherical geometry, in the areas of education, mathematics education, mathematics teaching and science and mathematics teaching. A systematic literature review was carried out by Oinhas and Zanon (2021) to understand how Profmat dissertations from 2016 to 2020 contributed to solving combinatorial analysis problems mediated by digital technologies in basic education. Nunes and Pagani (2021) conducted qualitative research to map Profmat dissertations on financial education in basic education by reading abstracts, introductions, and conclusions. The questions that made up the Profmat National Qualification Exam [Exame Nacional de Qualificação] from 2012 to 2019 were analysed by Caldatto, Martins, and Yanez (2023), from the theoretical perspective of mathematics teachers' specialised knowledge (MTSK). Silva and Sousa (2024) investigated Profmat dissertations that dealt with the topic "mathematical modelling." Paula and Ferreira (2024) identified the influence of the curriculum components "Discrete Mathematics" and "Real Numbers and Functions" on the academic performance of Profmat students (UFOB centre) in the subject "Problem Solving".

The studies presented indicate the existence of a gap in identifying prominent themes in Profmat. The studies draw on diverse data sources, including official Profmat documents, interviews with graduates, abstracts, introductions, and conclusions of dissertations. The objective of this research is to identify the prominent themes present in Profmat dissertations. We constructed a weighted semantic network of cliques based on dissertation titles, referred to as the Profmat network, applying the science of network methods to analyse the data. The identification of themes combines the assessment of the importance of: 1) words with the highest degree, weighted degree, betweenness, Laplacian, and proximity centralities; 2) the relationships between words based on the weight of their edges. To determine the number of words with the highest centralities to be analysed, we used a criterion based on random networks of cliques (RNoCs). In the next section, we describe the methodological procedures adopted in the research to analyse the Profmat network. Next, we identified the prominent themes present in the titles of Profmat dissertations. Finally, we make some considerations.

METHODOLOGICAL PROCEDURES

This research uses network science methods to analyse the Profmat semantic network of cliques constructed from dissertation titles. In this section, we report on the data collection and processing procedure, as well as the process of constructing the Profmat semantic network of cliques. We discuss the meanings of the centralities used in this research and the criteria for determining the number of vertices with the highest centralities to be evaluated based on the RNoCs. Next, we discuss the procedure for identifying prominent themes.

Construction of the Profmat Network

The titles of Profmat master's dissertations were collected from the catalogue available at <www.profmatsbm.org.br/dissertacoes>, in January 2023. We collected the titles of dissertations from the period 2013 to 2022, which corresponds to the first ten years of defences held at Profmat. Following the techniques by Caldeira et al. (2006) and Fadigas et al. (2009), we applied a manual treatment that consisted of: 1) correcting typos; 2) eliminating punctuation marks; 3) writing acronyms in full; 4) translating words in a foreign language into Portuguese; 5) inspecting the first character of each title to ensure that each title begins with a capital letter; 6) replacing symbols and mathematical terms with words recognised by the computational tool for generating semantic networks of cliques. The titles treated were organised in a text file. We used the computational tool NetPal, developed by Caldeira et al. (2006), to build the Profmat semantic network of cliques.

According to Grilo et al.'s (2017) definition, a semantic network is a knowledge representation system based on graphs, composed of vertices that represent words, concepts, or entities with semantic meaning, of edges that correspond to their relationships, and imbued with the intention of functionality established by the context. Thus, the Profmat network was constructed by assigning vertices to words with intrinsic meaning present in the dissertation titles. All words with intrinsic meaning present in the same title connect, forming a clique. The number of titles in which two words are present simultaneously is signalled in the network by the weight of the edge between them. We applied the NetPal computational tool to the text file with the manually

processed titles to exclude words without intrinsic meaning and transform words with intrinsic meaning into a canonical form. At the end of the process, we obtained the Profmat network, a weighted semantic network of cliques.

Centralities

To capture the importance of words in the process of identifying prominent themes, we used five centralities: degree ($C_G(v)$), weighted degree ($C_{GP}(v)$), betweenness ($C_I(v)$), Laplacian ($C_L(v)$) and proximity ($C_P(v)$). The degree centrality (Freeman, 1979; Wasserman & Faust, 1997) of a word measures the number of neighbouring words, capturing the diversity of relationships established by a word. Therefore, the higher the degree centrality of a word, the greater the diversity of themes in which the word is involved. The weighted degree centrality (Wasserman & Faust, 1997) of a word measures the sum of the weights of the edges that affect the word. The greater the weighted degree centrality of a word, the greater the intensity of the presence of the relationships established by a word in the dissertation titles, indicating how much a word is involved in themes that are (re)discussed. Betweenness centrality (Freeman, 1979; Wasserman & Faust, 1997) of a word in the context of the Profmat network measures the number of shortest paths that cross the word. The greater the betweenness centrality of a word, the greater its presence in shortest paths between pairs of words that do not appear in the same title, indicating how much a word is involved in themes that contain words not present in the same title.

Laplacian centrality measures the importance of a word from its removal from the network (Qi et al., 2013). The greater the Laplacian centrality of a word, the greater its importance from the perspective of the impact of its removal on neighbouring words and the network. Laplacian centrality indicates how the absence of a word decisively affects the themes in which it is present. The closeness centrality (Freeman, 1979; Wasserman & Faust, 1997) of a word, as the name suggests, measures its proximity to other words in the network. The greater the closeness centrality of a word, the smaller its distance from other words in the network, indicating how much a word is involved in themes made up of words close to it.

Number of words with the highest centralities

In the literature, we found works (Quintella et al., 2009; Rodrigues et al., 2017; Nascimento, Pereira & Moret, 2018; Santos & Grilo, 2020; Andrade et al., 2022) that analysed various amounts of major centralities to investigate the importance of vertices in a network. The percentage of the highest centralities evaluated ranges from 0.5% to 76.9%, indicating no relationship with the network size. Therefore, what percentage of vertices should be considered to evaluate the largest centralities in a network? In this research, we defined the number of vertices with higher centralities to be analysed based on a comparison with a random semantic network of cliques (Grilo & Fadigas, 2024), equivalent to the original semantic network of cliques. To determine the number of vertices v with greater centralities to be analysed in a network of cliques, we use the criterion established in Expression 1:

$$C_G(v)^{Profmat} \geq \langle k \rangle^{ProfmatCLA} + 2\sigma^{ProfmatCLA} \quad (1)$$

In Expression 1, $\langle k \rangle^{ProfmatCLA}$ denotes the average degree, that is, the arithmetic mean of the degree centralities of the *ProfmatCLA* network vertices; σ denotes the standard deviation of the average degree of the *ProfmatCLA* network. Expression 1 differs from the criterion established by Cunha et al. (2020) for hubs (vertices of very high degrees), as the authors used the average degree of the original network for comparison purposes. The comparison established by Expression 1 has the advantage of being made with a neutral structure (the random network) and not with the network itself.

Identification of prominent themes

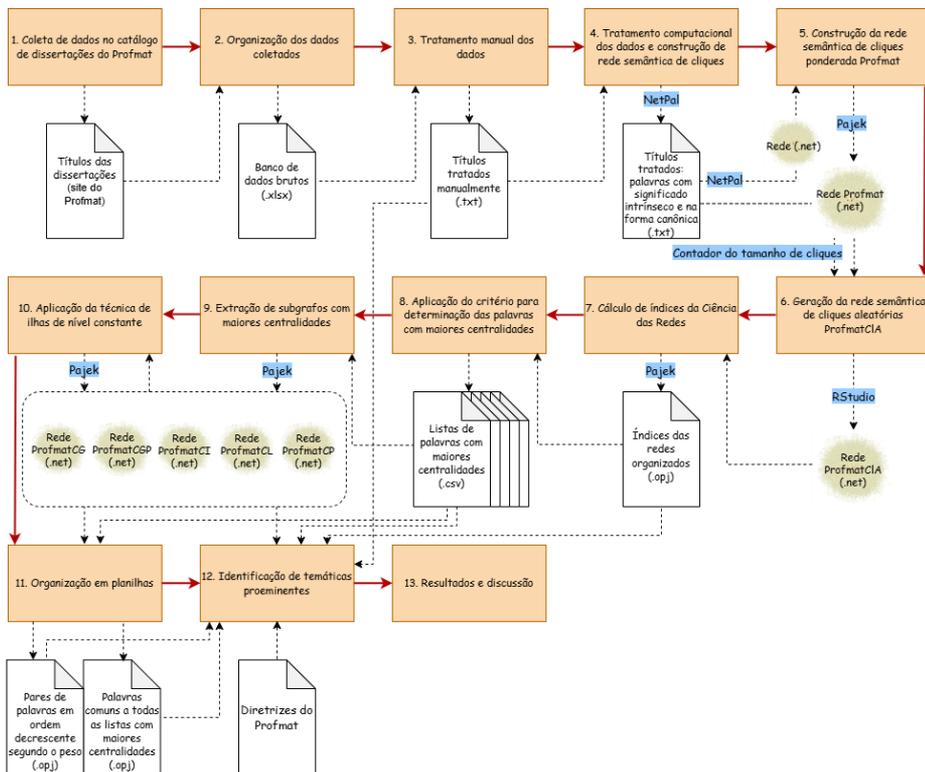
The process of identifying prominent themes considered the importance of vertices from the perspective of centralities and edges from the perspective of their weights. Therefore, the identification of prominent themes considers the importance of words from the perspective of centralities and the intensity of their relationships as reflected in their presence in the dissertation titles. We present in Figure 1 a view of the method for identifying prominent themes.

Steps 1 through 4 were described in Section “Construction of the Profmat Network.” The network generated in step 5 was obtained from

6,720 titles, comprising 3,609 vertices. We used Pajek (Batagelj & Mrvar, 1998) to compute the edge weight from the generated multiple edges. The value calculated for each edge indicates the number of times a pair of words appears together in a title. The largest component of the disconnected network, extracted using Pajek, comprises 3,605 nodes (99.89% of the network), which we refer to as the Profmat network. To perform step 6, we use the .dlf file from the Profmat connected network, generated by Netpal, which separates the words with intrinsic meaning and in canonical form for each title. The .dlf file enables us to obtain the sequence of clique sizes of the Profmat network in its initial configuration. We then use a script written in R to generate random networks of cliques.

Figure 1

Process of identifying prominent themes



In step 7, we calculate the network science indices described in the “Centralities” section. We then organise the indices into spreadsheets. In step 8, we applied the criterion for determining the words with the highest centralities (Section “Number of Words with the Highest Centralities”) and found 192 vertices. With this quantity, we created five lists comprising the 192 vertices with the highest degree, weighted degree, betweenness, Laplacian, and proximity centralities.

In step 9, using Pajek, we utilised the lists to extract subgraphs containing the 192 vertices with the highest centralities from the Profmat network, resulting in five subgraphs. In step 10, we applied the island method to constant-level networks (Batagelj & Zaveršnik, 2004) to eliminate low edge weights, provided that the subgraph does not become disconnected. The weight of an edge between two words reflects the presence of both in the titles of Profmat dissertations. The greater the weight of an edge, the greater the presence of two words simultaneously in the titles, contributing to the emergence of prominent themes. Therefore, the application of the island method in constant-level networks allows for the cleaning of relationships between less relevant words, improving their visualisation and favouring the identification of the prominence of themes.

Thus, we obtained five networks: *ProfmatCG*, with the 192 words with the highest degree centralities; *ProfmatCGP*, with the 192 words with the highest weighted degree centralities; *ProfmatCI*, with the 192 words with the highest betweenness centralities; *ProfmatCL*, with the 192 words with the highest Laplacian centralities; and *ProfmatCP*, with the 192 words with the highest proximity centralities. In step 11, we identified the common words in the five lists with the highest centralities and organised the edges, along with their respective weights, in spreadsheets.

In step 12, the process of identifying prominent themes involved analysing the words common to the five networks with the highest centralities, the edge weights and the Profmat guidelines. We compared the five lists with the highest centralities and identified 149 words that were common to all lists. Our analysis focused on these 149 words and the edges with the highest weights between them. Specifically, the

identification of prominent themes considered: the five lists with the highest centralities and their combinations to facilitate comparisons; the spreadsheets containing the words common to the five lists with the highest centralities and the weight of the edges of the Profmat network; the visualisation of the *ProfmatCG*, *ProfmatCGP*, *ProfmatCI*, *ProfmatCL* and *ProfmatCP* networks; *Profmat* network indices; the titles of Profmat dissertations; and the Profmat regulations.

RESULTS AND DISCUSSION

In this section, we present a topological characterisation of the Profmat network and the prominent themes identified. For data analysis, in light of Grilo et al.'s (2017) definition of semantic networks, we assumed that the choice of title words is influenced by the author's intention to: present the theme of their dissertation in the title; and to explain the dissertation theme's adherence to the Profmat guidelines. Therefore, the choice of words for titles is not random, implying that certain groups of words are more requested than others due to the theme that covers the dissertation topic. Figure 2 shows the visualisations of the ProfmatCG (Figure 2a), ProfmatCGP (Figure 2b), ProfmatCI (Figure 2c), ProfmatCL (Figure 2d) and ProfmatCP (Figure 2e) networks.

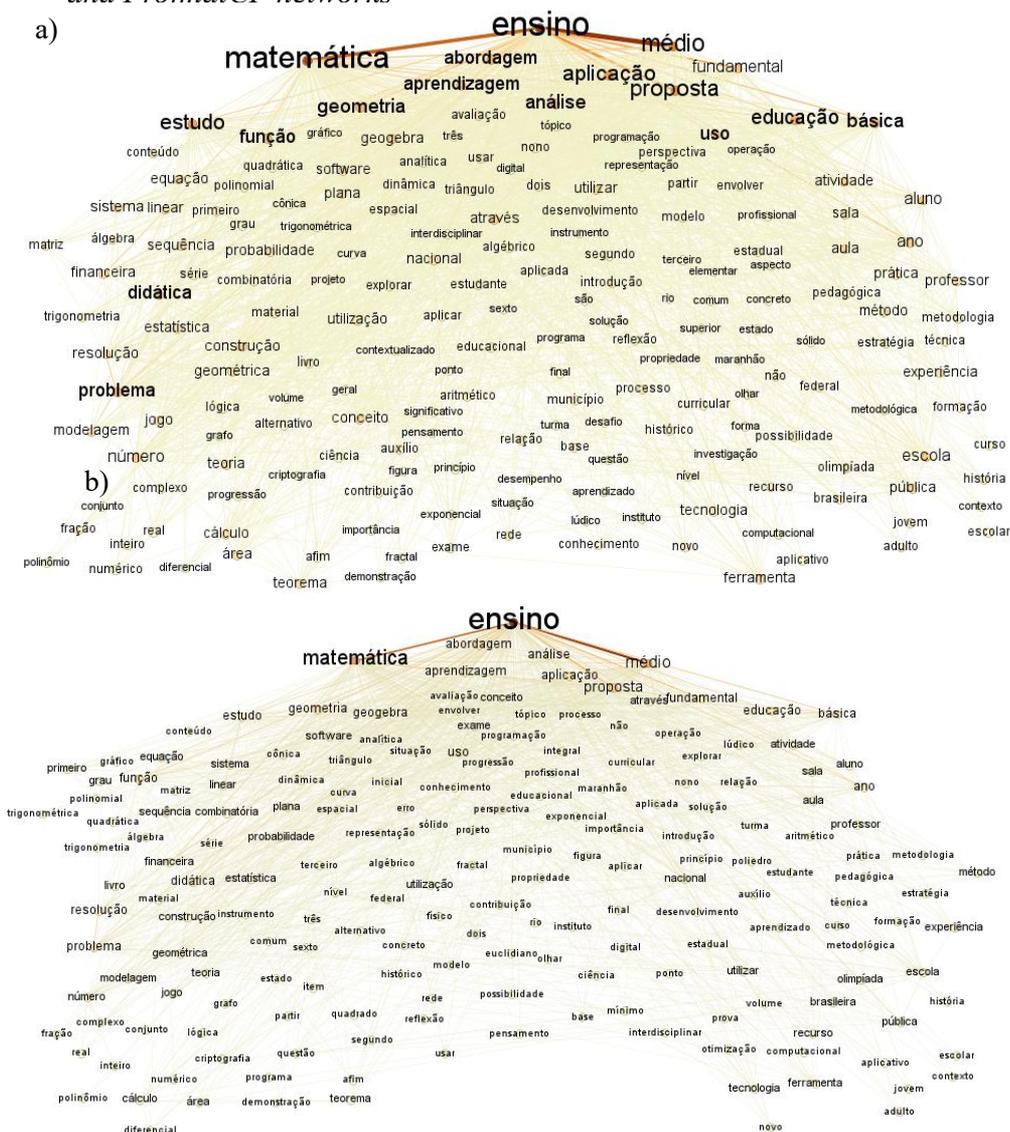
The words *ensino* [teaching] and *matemática* [mathematics] occupy, respectively, the first and second positions of the highest centrality, except from the perspective of betweenness centrality, in which the positions are reversed. Considering that the edge between the two has the second-highest weight in the network, we can state that *ensino de matemática* [mathematics teaching] has prominence in the titles, indicating an adherence to the general objective of Profmat. The word *médio* [average] occupies the third position of the highest centrality, except from the perspective of betweenness centrality, where it occupies the fifth position. Considering the edge with the highest weight, the data indicate a concentration of themes from Profmat dissertations focused on *ensino médio* [secondary education].

The analysis of the words with the highest centrality combined with the relationships with the highest weight indicated that the theme with the most significant prominence in Profmat encompasses dissertations that presented *propostas* [proposals] for mathematics

teaching in *educação básica* [basic education] with an emphasis on secondary education. We noticed a greater focus on topics that deal with *aplicações* [applications] for secondary education than for *ensino fundamental* [elementary education], in addition to a predominance of dissertations focused on *ensino de geometria* [geometry teaching].

Figure 2

Visualisation of the ProfmatCG, ProfmatCGP, ProfmatCI, ProfmatCL, and ProfmatCP networks



polynomials, respectively]. Among the dissertations that deal with the teaching of whole numbers and fractions, we noticed a prominence associated with *ensino de operações fundamentais* [teaching fundamental operations]. Among those focused on the teaching of geometry, there was a highlight for those addressing *ensino de triângulos* [teaching triangles].

The results suggest that there is a second prominent theme in Profmat, which we call *estudo de conteúdos matemáticos* [study of mathematical content] with an emphasis on secondary education. In this sense, we have dissertations aimed at deepening the mathematical knowledge of the master's student that focus on the study of the following mathematical contents: *função quadrática, métodos de resolução de equações polinomiais, conjuntos numéricos (números complexos, reais e inteiros), sistemas de equações lineares, geometria plana com foco em triângulos, sequências, cônicas, probabilidade, geometria analítica, análise combinatória* and *matrizes* [Quadratic function, methods of solving polynomial equations, numerical sets (complex, real, and integer numbers), systems of linear equations, plane geometry with a focus on triangles, sequences, conics, probability, analytical geometry, combinatorial analysis, and matrices, respectively]. The third prominent theme identified was called proposals for approaches to teaching and learning mathematical content. this group consists of dissertations that deal with *resolução de problemas, modelagem matemática, construções geométricas, sequência didática, geometria dinâmica* and *jogos matemáticos* [Problem solving, mathematical modelling, geometric constructions, didactic sequence, dynamic geometry, and mathematical games, respectively]

We identified a fourth prominent theme that we named *propostas de atividades em sala de aula* [proposals for classroom activities]. In this group, we noticed a focus on activities aimed at students in the first grade of high school. The proposals include activities aimed at teaching and studying: geometry, with the use of GeoGebra; functions; and *matemática financeira* [financial mathematics]. The fifth prominent theme was called *prática pedagógica do professor* [teacher's pedagogical practice], dealing with: *metodologias, estratégias, métodos, and técnicas*

de ensino [methodologies, strategies, methods, and teaching techniques]. We named the sixth prominent theme identified as *análise da formação do professor de matemática da educação básica* [The analysis of mathematics teacher education for teaching basic education]. The results suggest that, in Profmat dissertations, there is an emphasis on analysis focused on mathematics teaching; we did not notice a prominence in discussions focused on *aprendizagem do aluno na sala de aula* [student learning in the classroom].

The word *escola* [school] is among the 22 biggest centralities, among the five analysed, and its importance is related to the prominence of the seventh identified theme: *análise de questões da olimpíada brasileira de matemática das escolas públicas (OBMEP)* [Analysis of questions from the Brazilian Mathematics Olympiad of Public Schools (OBMEP)]. We can also see dissertations associated with an eighth prominent theme called *experiências de ensino com alunos de escolas públicas* [teaching experiences with students from public schools]. On the other hand, the word *avaliação* [assessment] appears among the 83 highest centralities, among the five considered in this research. This allowed us to identify a ninth prominent theme called *sistemas de avaliação da educação básica* [Basic education assessment systems] and a tenth, called *avaliação da aprendizagem em matemática* [Assessment of mathematics learning]. The results suggest that the fifth, eighth, ninth, and tenth prominent themes are those that present a more direct approximation to the *prática do professor na sala de aula* [teachers' classroom practice]. The other groups focus on presenting: *propostas teóricas de ensino e de aprendizagem* and *contribuições para a formação do professor de matemática* [Theoretical teaching and learning proposals and contributions to mathematics teacher education].

We identified a group of areas of knowledge in mathematics highlighted in the titles of Profmat dissertations that are not explicitly part of the basic education mathematics curriculum: *cálculo diferencial, lógica matemática, teoria dos números, teoria dos grafos, equações diferenciais, teoria dos jogos, sequências* and *séries, curvas planas, álgebra linear, criptografia* [Differential calculus, mathematical logic, number theory, graph theory, differential equations, game theory,

The list of prominent themes presented in this research should not be considered definitive. We can make the criterion more flexible, considering words that appear in at least four lists of the highest centrality. For example, we noticed on the Profmat network a group of themes associated with dissertations that carried out documentary analysis of the Brazilian Mathematics Olympiad for public schools (OBMEP), the national secondary school “exam” (ENEM), and the national common “curriculum” base (BNCC). The words *curricular* and *exame* [curriculum and exam, respectively] are among the words with the highest centrality in four lists: degree, weighted degree, Laplacian, and proximity. These words occupy positions 197 and 198, respectively, in the list of greatest betweenness centralities. Although the words were not included in the criteria established in this research, the current context involving public policies for the teaching of mathematics in Brazil may favour the analysis of the OBMEP questions, analysis of questions from ENEM and the teaching of mathematics from the perspective of the BNCC to arouse interest in research on these themes.

FINAL CONSIDERATIONS

In this research, we identified 19 prominent themes based on the analysis of the titles of Profmat dissertations. We constructed the weighted and connected Profmat semantic network of cliques and, from the sequence of clique sizes in its initial configuration, we generated equivalent random networks of cliques to establish the number of vertices with the highest centralities to be analysed. The advantage of this method is that it provides a criterion that considers the size of the network and is independent of other factors, such as determining a critical point. In this article, the process of identifying themes considers the prominence of words from the perspective of centralities and the weight of their relationships.

The results suggest that the set of Profmat dissertations exhibits high adherence to the program’s guidelines from the perspective of the prominence of the themes proposed for teaching mathematics in basic education and the study of mathematical content, with a leading role for secondary education. Together with the other prominent themes identified, we can consider that this work presents a characterisation of

Profmat in its first decade of dissertation defences. The results showed that Profmat's main focus is actually mathematics teaching. On the other hand, we identified four prominent themes demonstrating a direct approach to the teachers' classroom practice out of a total of 19. From the perspective of teachers' pedagogical practice, we noticed a lower adherence of the set of dissertations to the Profmat objectives compared to the others.

Other future work involves identifying prominent themes by geographic region and by pole, and comparing them across four-year periods. We hope that this work can contribute to further investigations into Profmat, since the prominent themes identified contain descriptors that can be used for data collection. In the field of network science, we believe that this work can contribute to research that has clique networks as its object of study.

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AUTHORSHIP CONTRIBUTION STATEMENT

MG collected the data, performed an initial analysis, and wrote the first version of the article. ISF and JSPG actively participated in the discussion of the results, reviewing and approving the final version of the work.

DATA AVAILABILITY STATEMENT

The data supporting the results of this study will be made available by the corresponding author, MG, upon reasonable request.

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