

The conceptions of teacher education of the PIBID Mathematics initiation scholarship students at UFF: a cohesive analysis with the use of CHIC

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2238-0345 

10.37001/ripem.v13i4.3466 

Received • 11/06/2023

Approved • 10/08/2023

Published • 07/10/2023

Editor • Gilberto Januario 

Abstract: The research showed the process of training teachers of the Institutional Program for Teaching Initiation Scholarships (PIBID) with the objective of investigating the possible contributions of the implementation process. We tried to answer the following question: What characteristics related to the initial teacher training process can be identified in the implementation of the PIBID of Mathematics by the Fluminense Federal University in the period 2009-2013? A questionnaire was applied to 38 undergraduates, with the aim of analyzing the stages and conceptions of teacher training, identifying characteristics, opinions, expectations. As a methodology, we used the cohesive analysis applied to the discourse, using the CHIC software. In conclusion, it is possible to state that PIBID contributed to teacher training guided by dialogue, by immersion in the heart of the school, for the construction of professional identity through the exchange of experiences, the experience of concrete cases, the dialectical relationship between theory and practice and reflection on practice.

Keywords: Mathematics Education. Educational Policy. Training of Teachers. PIBID. Analysis of Cohesive.

Las concepciones de la formación del profesorado de los becarios de pregrado de PIBID Matemáticas de UFF: un análisis cohesivo con el uso de CHIC

Resumen: La investigación mostró el proceso de formación de docentes del Programa Institucional de Becas de Iniciación a la Docencia (PIBID) con el objetivo de investigar las posibles contribuciones del proceso de implementación. Intentamos responder a la siguiente pregunta: ¿Qué características relacionadas con el proceso de formación inicial de profesores se pueden identificar en la implementación del PIBID de Matemáticas por parte de la Universidade Federal Fluminense en el período 2009-2013? Se aplicó un cuestionario a 38 estudiantes de pregrado, con el objetivo de analizar las etapas y concepciones de la formación docente, identificando características, opiniones, expectativas. Como metodología se utilizó el análisis cohesivo aplicado al discurso, utilizando el software CHIC. En conclusión, es posible afirmar que el PIBID contribuyó a la formación docente guiada por el diálogo, por la inmersión en el seno de la escuela, para la construcción de la identidad profesional a través del intercambio de experiencias, la vivencia de casos concretos, la relación dialéctica entre teoría y práctica y reflexión sobre la práctica.

Palabras clave: Educación Matemática. Política Educativa. Formación del Profesorado. PIBID. Análisis Cohesivo.

As concepções de formação docente dos bolsistas do PIBID de Matemática da UFF: uma análise coesitiva com o uso do software CHIC

Resumo: Esta pesquisa evidenciou o processo de formação de professores do Programa Institucional de Bolsas de Iniciação à Docência (PIBID) com o objetivo de investigar as possíveis contribuições do processo de implementação. Procurou-se responder à seguinte questão: Quais características relativas ao processo de formação inicial de professores podem ser identificadas na implementação do PIBID de Matemática pela Universidade Federal Fluminense, no período de 2009-2013? Aplicou-se um questionário a 38 licenciandos com o intuito de analisar as etapas e as concepções de formação docente, bem como identificar características, opiniões e expectativas. Como metodologia, utilizou-se a análise coesitiva aplicada ao discurso, a partir do software CHIC. Concluiu-se que o PIBID contribuiu para uma formação de professores pautada pelo diálogo e pela imersão no seio da escola, visando a construção da identidade profissional por meio da troca de experiências, das vivências de casos concretos, da relação dialética entre teoria e prática e da reflexão sobre a prática.

Palavras-chave: Educação Matemática. Política Educacional. Formação de Professores. PIBID. Análise Coesitiva.

1 Initial considerations

This work¹ deals with the Institutional Program for Teaching Initiation Scholarships (PIBID), which has been part of the Ministry of Education's (MEC) Public Policy for Initial Teacher Training since 2007, and is conceived as the largest program for encouraging and valuing teachers, integrating public and private higher education with basic education. The program aims to improve the process of initial teacher training by immersing teaching initiation scholars (PID) in the heart of the school, experiencing the daily educational routine through strategic and methodological teaching actions.

This paper discusses the possible contributions of the implementation process of the PIBID Mathematics subprojects at the Fluminense Federal University (UFF), and analyzes the scholarship holders' conceptions of teacher training. The Hierarchical, Implicative and Cohesive Classification (CHIC) software was used to create groupings of the agents' answers to the questionnaire and to detect the cohesions between the selected variables, with the aim of achieving a broader and more complete evaluation.

The conceptions were investigated using the methodology of cohesive statistical analysis, according to Gras, Régnier, Lahanier-Reuter, Marinica and Guillet (2017). In addition, we sought to answer the following question: What characteristics relating to the process of initial teacher training can be identified in the implementation of the Mathematics PIBID by the Fluminense Federal University, in the period 2009-2013?

The structuring pedagogical principles of teacher training from the Basic Education Teacher Training Directorate (DEB) are established and induced by the Coordination for the Improvement of Higher Education Personnel (CAPES), these are:

Connection between theory and practice; integration between training institutions, schools and postgraduate programs; balance between knowledge, skills, attitudes and ethics; articulation between teaching, research and extension. These basic principles respect the autonomy of training institutions and education networks, as well as local and regional characteristics, but when they are intentionally incorporated into the pedagogical projects of each partner institution, they produce a dynamic capable of renewing and innovating teacher training in the country (Gatti, André, Gimenes &

Ferragut, 2014, p. 5).

The pedagogical principles on which PIBID is built are in line with the studies of Nóvoa (2009), which produce a very significant argument about the need for teacher training conceived within the profession. Considering the elements highlighted by this author, the PIBID has the following pedagogical principles:

1. teacher training based on work in schools and the experience of concrete cases;
2. teacher training carried out by combining the theoretical and methodological knowledge of teachers from higher education institutions with the practical and experiential knowledge of public school teachers;
3. teacher training that is attentive to the multiple facets of everyday school life and to investigation and research that lead to the resolution of situations and innovation in education;
4. teacher training carried out through dialogue and collective work, emphasizing the social responsibility of the profession (Neves, 2012, p. 365).

According to Neves (2012), PIBID combines a policy of improving initial teacher training with valuing teaching careers. In this sense, the program provides CAPES grants to BIDs — undergraduate students — with the aim of placing them in basic schools to plan and develop teaching activities. The scholarship holders are supervised by area coordinators (professors from higher education institutions — HEIs) and supervisors (teachers from the public schools where the practice takes place) in order to ensure a standard of quality. In this collaborative work between undergraduates, supervisors and coordinators, there is a process of shared enrichment, whose impacts are positive both in the training courses and in the schools. Souza and Miranda (2014) defined PIBID as follows:

PIBID is a program to encourage and value teaching and improve the process of training teachers for Basic Education, which aims to integrate Higher Education (teacher training) with Basic Education by raising the quality of academic actions aimed at the initial training of teachers at public universities, as well as the inclusion of undergraduates in the daily life of public schools, providing them with opportunities to develop innovative and interdisciplinary methodological strategies (p. 2).

Souza, Oliveira Jr., Kistemann Jr. and Coutinho (2019) pointed out that the successful implementation of PIBID Mathematics at UFF, the Federal University of Juiz de Fora (UFJF) and the Federal University of the Triângulo Mineiro (UFTM) was based on the importance and need for interactions and commitments between internship subjects and teaching practices in undergraduate courses. In this way, it favors full training, for the construction of a teacher as an autonomous professional, well-supported in both theory and practice, who knows how to reflect, make decisions and create, ensuring active, creative, effective and transformative pedagogical action. From this perspective, Souza *et al.* (2019) point out:

We consider it to be an innovative program to improve teacher training and, consequently, the quality of teaching in public basic education schools, expanding and valuing practice in the period of initial teacher training more effectively, by offering incentives through scholarships to students, basic education teachers and the university (p. 120).

Therefore, the PIBID — in addition to being a program to value teacher training — is

also an action that must take into account all the complexity of professional practice: the fragility of the career; the low salaries of teachers; the infrastructure of basic education schools; the valuation of the profession; and the incessant struggle for the professionalization of teaching (Silveira, 2015, pp. 12-13).

UFF's participation in the period from 2009 to 2013 was through two institutional projects: PIBID UFF and PIBID UFF 2. According to Chinelli (2015), PIBID UFF was implemented in 2010 and consisted of seven subprojects from undergraduate courses, six from the Niterói campus (Physics, Chemistry, Mathematics, Language — Portuguese Language, Biological Sciences and Pedagogy) and one from the Santo Antônio de Pádua campus (Mathematics). PIBID UFF 2 emerged due to a new CAPES call for proposals, with the intention of including new degree courses that were not included in the 2009 call for proposals. As a result, it was made up of thirteen sub-projects for degree courses, eleven of which were on the Niterói campus (Biology, Social Sciences, Physical Education, Philosophy, Physics, Geography, History, Language — Portuguese Language, Mathematics, Pedagogy, Chemistry) and two on the Santo Antônio de Pádua campus (Pedagogy and Mathematics).

The UFF PIBID had two Mathematics PIBID subprojects, which began in March 2010 and were developed at the Institute of Mathematics and Statistics (IME), located in Niterói/RJ. The second Mathematics sub-project was implemented at the Instituto do Noroeste Fluminense de Educação Superior (INFES), in Santo Antônio de Pádua/RJ. PIBID UFF 2 had two Mathematics subprojects: one at IME and the other at INFES, which were implemented between July 2012 and December 2013. These institutional projects had a conception of initial teacher training aimed at building a professional identity immersed in the heart of the school, constituted by the UFF and basic school partnership, giving due prominence to the teachers, who became, throughout the implementation process, co-trainers.

2 Methodological procedures

It is possible to process and analyze multidimensional data thanks to the various statistical programs available on the market. Of particular note, is the Hierarchical, Implicative and Cohesive Classification (CHIC) software, used for data interpretation and based on implicative statistical analysis (ISA).

For Gras, Régnier and Guillet (2009), ASI is part of a theoretical field focused on the concept of statistical implication, i.e. quasi-implication, which differs from the implication of mathematical logic. According to Régnier and Andrade (2020, p. 40), "the development of this field as a mathematical object has enabled the construction of theoretical tools that provide a method of data analysis, applied in research in various areas of knowledge".

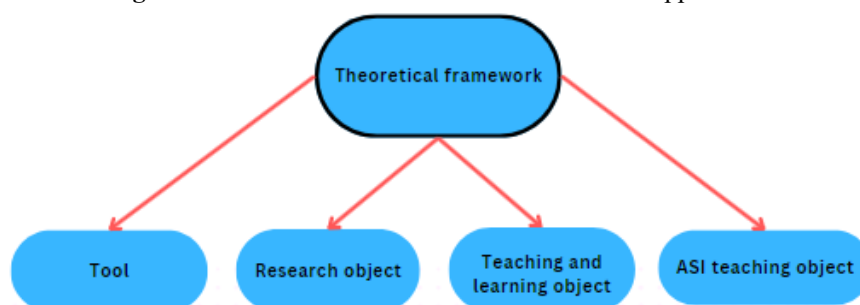
Generally speaking, as an example, if a group of UFF students are part of the Mathematics PIBID program, then they probably all like mathematics. In quasi-implication, the existence of a UFF PIBID student who doesn't like math doesn't invalidate the implication, which, in mathematical logic, it would. The essence of this concept of quasi-implication — as a mathematical object in the areas of probability and statistics — has enabled the construction of theoretical tools that provide a method of analysis.

Régnier and Andrade (2020) point out that when using ASI as a tool, some stages must be taken into account when constructing the data, which are included in the planning of a survey, which can have both a qualitative and quantitative focus.

Regardless of the type of research, it is possible to use the ASI theoretical framework (Figure 1), but it is necessary to consider how the data will be constructed. It is therefore up to

the researcher to assess how this tool can help them in their analysis. Régnier and Andrade (2020) point out that there are several factors that influence the construction and validation of relevant, valid and reliable data. They point out, for example, that in classroom research, generalizations cannot be made without precautionary data analysis results for all classrooms. Finally, they conclude that these results can be very useful for analyzing a given phenomenon.

Figure 1: Theoretical framework of ASI: different approaches



Source: Régnier and Andrade (2020, p. 41)

In this study, cohesive statistical analysis was used, with the support of the CHIC software, which allows interpretation by constructing the crossings of variables, showing the dynamics of the behaviors of the subjects surveyed in terms of cohesion. As Almouloud (2015, p. 43) points out, "these analyses make it possible to visualize, organize, build models and explain phenomena associated with the data". It is important to stress that the data obtained was analyzed in the light of the context in which it was collected and the references constructed.

Because it offers the researcher calculations and graphical representations, the CHIC software was used to build groupings of the answers — obtained through the questionnaire applied — and detect the cohesion between the selected variables, aiming for a broad and complete analysis. In this sense, it was possible to analyze the conceptions of teacher training, the contributions, the possible impacts and the actions of the students involved in the implementation process of the PIBID Mathematics subprojects at UFF. With this in mind, we used CHIC software version 7.0, an efficient program for the type of analysis carried out in this research.

Gras (2015) points out that

the CHIC software has the following functions: to extract association rules from a data set based on regularities between the data (variables), crossing subjects (or objects) and variables; to provide an association quality index; and to represent a structuring of the variables obtained through these rules (p. 11).

According to Valente (2015), the CHIC software offers the following features:

[...] the extraction, from a data set, of the rules of association between variables, crossing subjects and variables or crossing other variables present in the study; the provision of an association quality index; and the representation of the structuring of the variables obtained through these rules, and the visualization of the representation of the analyzed data can be done through the similarity trees, the cohesive tree or the implication graph (p. 65).

CHIC offers three types of analysis: (i) similarity; (ii) cohesive; and (iii) implicative. Similarity analysis allows the visualization of similarities between classes of variables mapped

onto a hierarchical tree (dendrogram), making it possible to organize and interpret data according to their grouping and intersection (Andrade & Valente, 2014). Cohesive analysis establishes meta-rules (rules of rules) of the type "if... probably, then", also expressed in a hierarchical tree, in which the further away from the root, the less strong the relationship identified. Finally, implicative analysis determines the relationships between variables, expressing them in graphs.

Cohesive analysis makes it possible to interpret intra and inter-class relationships between responses. The cohesion index between two variables is extended to the calculation of class cohesion. The latter gives an account of the quality of the oriented implication within a class of variables and translates the notion of meta-rules or rules about rules. An ascending hierarchy or cohesive tree graphically translates the successive nesting of the classes constituted according to the cohesion criterion, which decreases according to the levels (in the opposite direction to the formation of the classes of variables) of the hierarchy. A confidence interval on cohesion makes it possible to avoid the formation of classes that have no implicative meaning, which is not the case in classic hierarchies, as Almouloud and Coutinho (2015) point out.

According to Gras (2015),

the set of these same variables is also structured according to an oriented hierarchical tree that represents meta-rules (rules of rules) of the type "if such and such a rule is observed then, in general, such and such another rule is also observed". Each meta-rule is assigned a quality index considering its values over $[0;1]$ called the cohesion index (p. 22).

In order to analyze the information collected through the questionnaire, the methodology of cohesive analysis was used, with the aim of making statistically supported decisions in a stable way, with pertinent answers, using the CHIC software as support. According to Almouloud (2005), this type of analysis makes it possible to visualize, organize, build models and explain phenomena associated with the data. Gras and Almouloud (2002) suggest that, when interpreting, the research question and objectives should be taken into account.

In the PIBID UFF and PIBID UFF 2 institutional projects, around 80 students took part in the PIBID Mathematics sub-projects between 2009 and 2013, 38 of whom worked on a voluntary basis and answered the questionnaire.

The data collection instrument was made up of 37 closed questions and 9 open questions, and was provided using an online form, from March 5, 2015 to April 5, 2015. Of the undergraduate teaching fellows, 15 were from IME (Niterói campus) and 23 from INFES (Santo Antônio de Pádua campus). In terms of gender, 17 were male and 21 female. In addition, 18 worked in the job market outside teaching; 3 worked in public primary education; 10 in private primary education; two in public and private education; 1 in higher education and 4 in primary and higher education.

3 Results e discussion

In ASI, in particular, the main variables are used to construct the classes. Secondary (supplementary) variables are generally used for description and identification. In order for CHIC to carry out the calculations needed to build the groupings and representation of the data, it is necessary to prepare a spreadsheet with a *Comma Separated Values* (CSV) extension, so that the data can be opened by the CHIC software. In the spreadsheet, secondary variables are

identified with a space and a lowercase "s", otherwise CHIC classifies them as primary.

In the study, the response variables in the questionnaire applied to the teaching fellows were coded, assigning a value of 0 (symbolizing absence) or 1 (representing presence). A binary variable was chosen, making each item in the questionnaire a statistical variable to be considered by the CHIC software. According to Régnier and Andrade (2020), the advantage of using 0 or 1 is that it makes this binary variable both qualitative (presence or absence of a characteristic) and discrete quantitative (it can be counted), as well as making it possible to add up the values to quantify the specifics.

The CHIC software offers the researcher two types of modeling: when the research has a sample from a large population, it is preferable to use the Poisson distribution, otherwise the binomial distribution is more appropriate. There is no minimum amount of data in the literature for the use of CHIC, but — in our view — we have defended and adopted a minimum of 15 subjects in our research to justify the use of this methodology, otherwise discourse analysis would be more appropriate.

Out of a total of 80 scholarship holders, 38 took part in the study, so the inferences are limited to this group. In this case, given that the study universe is finite, the decision was made to use probabilistic modeling of the binomial distribution, which made the analyses feasible, i.e. its use allows this variable to be both qualitative (absence or presence) and discrete quantitative, since it can be counted, making it possible to quantify the respective characteristics.

In this research, the data mining process was used for the analysis, discarding the answers that were not discriminating, i.e. “cleaning the data” from the spreadsheet obtained, adopting the criterion of treating variables by grouping those with totals less than or equal to 1, so that all the columns represented discriminating variables.

The questionnaire items were constructed based on the results of the readings carried out during the doctoral process; the participation of the main author as coordinator of the program area; and, above all, the theoretical framework. As for the methodological contributions, the principles of implicative statistical analysis (ISA), similarity analysis and cohesive analysis were used, as published in Souza (2016).

It should be emphasized that the aim of this study was not to make inferences about all PIBID scholarship holders, but rather to identify the characteristics, impacts and contributions of the implementation process, as well as to interpret conceptions about teacher training based on the relationships generated by CHIC and observed for our sample of 38 respondents.

The Table 1 summarizes the response variables with their respective codes from the questionnaire applied to the 38 scholarship holders taking part in the research.

Table 1: Variable code of the answers after "data cleaning" for analysis with CHIC

Question/Variable Code
5. Did you study in elementary school? Fully in public school and Mostly in public school (V5PU s) Fully in private school and Mostly in private school (V5PR s)
6. Did you study at secondary school? Fully in public school and Mostly in public school (V6PU s) Fully in private school and Mostly in private school (V6PR s)
7. Are you an undergraduate student at the UNIVERSITY? YES (V7S s) NO (V7N s)
10. Do you like mathematics?

Agree (V10C)	Totally Agree (V10CT)
11. Do you work in a field other than teaching? YES (V11S s) NO (V11N s)	
12. What are or were your expectations of your degree course in Mathematics? Only a higher education degree to be able to have a career in another area (V12DA s); Only a higher education degree to be able to take part in public examinations (V12DP s); To build up a body of knowledge about mathematics and its didactics in order to be a good teacher (V12CMD s); Building/solidifying mathematical knowledge already seen in basic school (V12CME s); Other expectations (V12OE s).	
13. Do you currently hold or have you ever held a PIBID grant? Yes, I currently have (V13S s) I don't currently have one, but I used to be a PIBID scholarship holder (V13N s)	
14. PIBID Mathematics has contributed to your teacher training. Agree (V14C) Totally Agree (V14CT)	
18. PIBID has encouraged the training of teachers at university level for basic education. Agree (V18C) Totally Agree (V18CT)	
19. PIBID has contributed to valuing the teaching profession. Disagree (V19D) Agree (V19C) Totally Agree (V19CT)	
20. PIBID has raised the quality of initial teacher training in degree courses, promoting integration between Higher Education and Basic Education. Agree (V20C) Totally Agree (V20CT)	
21. The PIBID program has brought undergraduates into the daily life of public schools, providing them with opportunities to create and take part in methodological, technological and teaching practice experiments of an innovative and interdisciplinary nature that seek to overcome problems identified in the teaching and learning process. Agree (V21C) Totally Agree (V21CT)	
22. PIBID has encouraged public primary schools, mobilizing their teachers as co-trainers of future teachers and making them protagonists in the processes of initial training for the teaching profession. Agree (V22C) Totally Agree (V22CT)	
23. PIBID has contributed to the link between theory and practice necessary for teacher training, raising the quality of academic activities in degree courses. Agree (V23C) Totally Agree (V23CT)	
24. PIBID has contributed to teacher training based on working in schools and experiencing concrete cases. Agree (V24C) Totally Agree (V24CT)	
25. PIBID has contributed to teacher training that combines the theoretical and methodological knowledge of teachers from higher education institutions with the practical and experiential knowledge of public school teachers. Agree (V25C) Totally Agree (V25CT)	
26. PIBID has contributed to teacher training that is attentive to the multiple facets of everyday school life and to investigation and research that lead to the resolution of situations and innovation in education. Agree (V26C) Totally Agree (V26CT)	
27. PIBID has contributed to teacher training based on dialog and collective work, highlighting the social responsibility of the profession. Agree (V27C) Totally Agree (V27CT)	
30. Which activity(ies) did you carry out most at the school as part of the Mathematics PIBID? Tutoring (V30AR) Designing and implementing learning situations (V30ESA) Class observation (V30OA) All the activities described above (V30TA)	

31. Was it possible for you to compare the theory of your mathematics degree course with school practice? Often (V31F) Occasionally (V31O) Rarely (V31R)
32. Your performance in the Mathematics PIBID was in: Elementary school (V32EF s) Secondary school (V32EM s) Primary and secondary school (V32EFM s)
33. How was your relationship with the PIBID supervising teacher? Good (V33B s) Very Good (V33MB s) Excellent (V33E s)
37. The PIBID in Mathematics promoted an appreciation of your course. Disagree (V37D) Agree (V37C) Totally Agree (V37CT)
38. The implementation of the Mathematics PIBID program in the elementary school provided a positive experience in relation to the other colleagues on your degree course. Agree (V38C) Totally Agree (V38CT)
39. After participating in PIBID Mathematics, you feel better prepared to face the difficulties of the classroom. Disagree (V39D) Agree (V39C) Totally Agree (V39CT)
40. After taking part in the Mathematics PIBID, her desire to continue in a teaching career increased. Disagree (V40D) Agree (V40C) Totally Agree (V40CT)
41. The principal and math teachers supported the implementation of the Math PIBID at the school. Disagree (V41D) Agree (V41C) Totally Agree (V41CT)
42. The work of the area coordinator provided methodological perspectives for teaching mathematics. Agree (V42C) Totally Agree (V42CT)
43. Have you published any papers about your PIBID Mathematics experience? YES (V43S) NO (V43N)
45. Which campus was the PIBID you took part in? Niterói (V45N s) Santo Antônio de Pádua (V45P s)

Source: Souza (2016, pp. 203-204).

It should be noted that the open questions and response variables that are not shown in tables 1 and 2 were analyzed at other times during the doctoral research, using different methodologies.

Table 2: Open questions in the questionnaire applied to teaching fellows

34. Name at least two positive points (if any) that marked your participation in PIBID.
35. Name at least two negative points (if any) that marked your participation in PIBID.
36. What was the activity or event that most marked you during your time with PIBID?

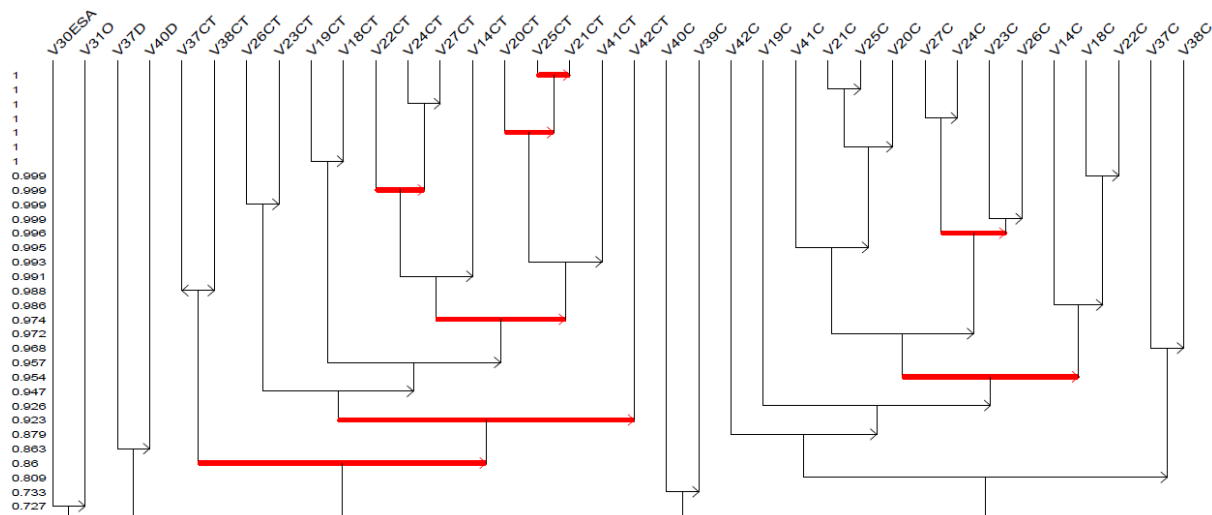
Source: Research data

The cohesive tree in Figure 2 is represented by the dendrogram; the red arrows established by the CHIC default, when they are closer to the root, have a higher cohesion index between the variables indicated. Variables were cleaned by removing those whose relationships had a cohesion index of less than 0.70 or which had no implication with another variable.

Figure 2 shows the result obtained after preliminary analysis and data cleaning, forming a cohesive tree with eight significant nodes, which are analyzed below.

The first class (Class 1) is made up of six significant nodes and the hierarchical associations of the response variables in which the agents totally agreed with the questions in the questionnaire (V37CT, V38CT, V26CT, V23CT, V19CT, V18CT, V22CT, V24CT, V27CT, V14CT, V20CT, V25CT, V21CT, V41CT, V42CT).

Figure 2: CHIC cohesive tree after "cleaning the variables"



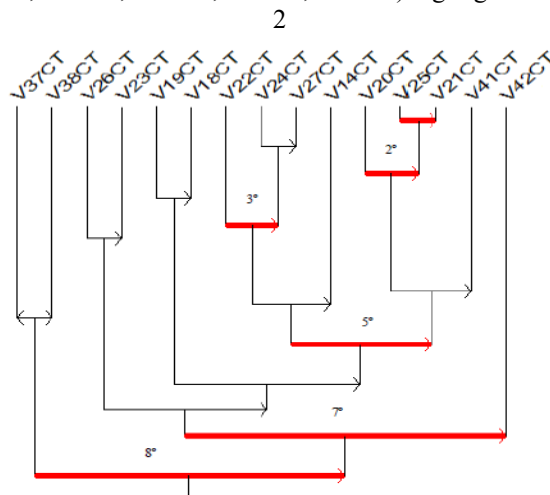
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Source: Souza (2016)

The second large class (Class 2) is made up of two significant nodes from the answers to the variables in which the agents agreed with the questions (V42C, V19C, V41C, V21C, V25C, V20C, V27C, V24C, V23C, V26C, V14C, V18C, V22C, V37C, V38C) and were hierarchically associated by CHIC.

The analysis begins with the hierarchies associated with the variables that make up Class 1, which has the largest number of red arrows (significant nodes), a total of six, without following the order of the significant nodes.

Figure 3: Class 1 consisting of the variables (V37CT, V38CT, V26CT, V23CT, V19CT, V18CT, V22CT, V24CT, V27CT, V14CT, V20CT, V25CT, V21CY, V41CT, V42CT) highlighted from the cohesive tree in Figure 2



Source: Souza (2016)

Class 1 is characterized by the total agreement of the teaching fellows (BID) on questions 14, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 37, 38, 41 and 42. The results obtained with the support of CHIC highlight the appearance of five of the six significant nodes, which have cohesion indices greater than 0.97, and another with a cohesion index greater than 0.85. These indices indicate that the associations between the variables show strong cohesion of the rules and meta-rules that have been established.

These questions indicate all the contributions of the implementation of PIBID in the initial training of mathematics teachers: (i) the incentive to train teachers for Basic Education;

(ii) PIBID's contribution to valuing the teaching profession; (iii) raising the quality of initial training by integrating Higher Education and Basic Education; (iv) the inclusion of undergraduates in the daily life of the public school system; (v) the participation of public school teachers as co-trainers; (vi) the articulation between theory and practice promoted by PIBID; (vii) reference to working in schools and experiencing concrete cases in teacher training; (viii) combining the theoretical and methodological knowledge of academia with the practical knowledge experienced by teachers in public schools; (iv) contributing to training that is attentive to the multiple facets of everyday school life; (x) teacher training based on dialog and collective work; (xi) valuing undergraduate courses; (xii) positive experience in relation to other undergraduate colleagues; (xiii) support from the management and teachers of the participating schools; (xiv) the work of the area coordinator, providing methodological perspectives for teaching mathematics (Souza, 2016).

The hierarchical associations of Class 1 and the contributions of the implementation process in the initial training of IDBs provide significant evidence to affirm that the characteristics and conceptions pointed out are fundamental to the construction of the habitus, praxis and, above all, the professional identity of these future teachers and those who are in the process of in-service training. Thus, in the educational sphere, there is the creation of an "in-between place" which, according to Nóvoa (2017), is

a place of liaison and articulation between universities, schools and public policies. It is a "common house" for training and the profession, inhabited by academics and representatives of schools and the profession, with the capacity to decide on the direction of initial training, professional induction and continuing training (p. 1116).

This immersion of the BID in the heart of the basic school develops the construction of experiential knowledge through the implementation of the activities outlined, experiencing the exercise of teachers' functions and the daily practice of their profession, incorporating it into individual and collective experience in the form of habitus and skills, know-how to be, and know-how to do, as highlighted by Tardif (2012). These training situations that the PIBID Mathematics subprojects provided for the scholarship holders allowed them to develop habitus. In other words, certain dispositions acquired in and through real-life practice, which will enable them to deal with these everyday situations in the profession.

Still according to Tardif (2012),

habitus can be transformed into a teaching style, into "tricks" of the trade and even into "professional personality" traits: they are then manifested through personal and professional know-how to be and know-how to do validated by daily work (p. 49).

Before starting the actual analysis, it is necessary to make a few remarks about two concepts that will be discussed below: typicality and optimal group.

The treatment of typicality occurs in the analysis of multidimensional data when a part of the subjects shows typical behavior in relation to the total elements of the set. According to Almouloud (2015), typicality helps the researcher interpret similarity and cohesive trees. From this perspective, CHIC can reveal to the researcher that some PIBID fellows — participants in the research — have typical behaviors in relation to all the others. Thus, the analysis of

typicality determines an optimal group in relation to the total number of subjects in a set of variables. According to Almouloud (2015),

subjects whose value obtained for typicality is high can be considered prototypical of the population. We can find out which is the optimal group of subjects who are the most typical of a path or a class and identify the most typical supplementary variable of this path or this class (p. 54).

The CHIC software — in its data processing — statistically calculates, in relation to the existing supplementary variables, all the risks of making a false statement that a given supplementary variable is typical of that set of subjects. According to Souza (2016), the supplementary variable with the lowest risk (lowest probability) of making this false statement is called the typical variable.

The optimum group is defined as the group made up of the most typical subjects in a path or class. In this way, the most typical supplementary variable of that path or class can be identified (Almouloud, 2015). In this study, the identification of the agents that make up the optimum group is used in order to extract some textual records to help in the analysis and also to exemplify the implicative relationships found by CHIC.

Next, we analyze the significant nodes identified in Figure 3, referring to Class 1, respecting their order of decreasing quality of cohesion obtained from the CHIC results.

Classified at level 1, there is the first significant node formed by the association of the variables (V25CT V21CT). The first rule established by CHIC indicates the following implication ($V25CT \rightarrow V21CT$). In other words, "if the agents who totally agreed that PIBID contributed to teacher training by combining the theoretical and methodological knowledge of teachers from higher education institutions with the practical and experiential knowledge of public school teachers, then they probably totally agreed that the PIBID inserted the undergraduates into the daily life of schools in the public education system, providing them with opportunities to create and participate in methodological, technological and teaching practice experiences of an innovative and interdisciplinary nature that seek to overcome problems identified in the teaching-learning process", with a cohesion index tending towards 1.

We identified 12 agents who answered question 25 and 17 who answered question 21. The optimum group established by CHIC is made up of the 12 agents (38, 32, 34, 19, 17, 10, 1, 20, 29, 26, 23, 21), whose typical variable for this subclass is (V33E), those agents who had an excellent relationship with the supervising teacher, with a 0.06 risk of this statement being false.

The responses of agents 1 and 10, belonging to the optimum group, regarding question 34 of the questionnaire applied, illustrate the implication found by CHIC and help in the analysis carried out.

Exchanging experiences and learning a lot from fellow scholarship holders and teachers [Textual record of agent 1] (Souza, 2016, p. 181).

The opportunity to work directly in the classroom, an opportunity that we don't find in a significant way in the compulsory internship. Through this work, we were able to assess the reality of the students we were working with and, based on this, develop meaningful, non-traditional teaching strategies [Agent 10's textual record] (Souza, 2016, p. 221).

Aiming to illustrate a similar analysis, in the research carried out by Gatti *et al.* (2014), they highlighted the relationship built between the university and the basic school through

PIBID as very positive, in the articulation between theory and practice and for attracting and winning good students to teaching.

The second significant node in Class 1 is at level 5 and is made up of the association of the variables (V25CT V21CT), which represents the first significant node, with the variable (V20CT), with the following implicative relationship ($V20CT \rightarrow (V25CT \rightarrow V21CT)$), with a cohesion index tending towards 1.

This rule established by CHIC — through the association of these variables that make up the second node — reveals some characteristics of the implementation process of the PIBID Mathematics subprojects, which are: (i) integration between Higher Education and Basic Education; (ii) training mediated between the theoretical knowledge of academy and the practical knowledge of Basic Education teachers; (iii) insertion of undergraduates in the daily life of schools.

In this node, it can be seen that 13 agents totally agreed with question 20; 12 agents with question 25; and 17 with question 21. The typical variable for this subclass is (V33E), i.e. it represents the agents who had an excellent relationship with the supervising teacher, with a risk of 0.06 that this statement is false. This interpretation can be identified in the aspects found in the textual records of some agents:

The opportunity to work directly in the classroom, an opportunity that we don't find in a significant way in the course's compulsory internship. Teaching Practice and Academic Experiences, participating in congresses and writing papers [Agent 4's textual record, in question 34] (Souza, 2016, p. 253).

(i) Provided greater experience in the classroom, since they actively participated in classes, both during regular and extra-regular hours; (ii) Encouraged the development of academic work, with the aim of publishing it in congresses [Agent 5's textual record, in question 34] (Souza, 2016, p. 253).

The statements transcribed in the analysis confirm the results presented in the cohesive analysis, revealing some characteristics obtained from the relationship between theory and practice through the implementation of PIBID.

The implicative relationship that constitutes the third node at level 9 ($V22T \rightarrow (V24CT \rightarrow V27CT)$) has a cohesion index of 0.999. Some of the characteristics of the teacher training process through PIBID are identified: (i) primary school teachers co-training undergraduates; (ii) training mediated by work in everyday school life; (iii) training consisting of dialog and collective work.

In this sense, these characteristics, to a certain extent, offer indications that the BIDs recognized the teachers in their profession, in particular, in the case of the Mathematics PIBID, the supervising teachers as subjects of knowledge, as Tardif (2012) points out. In this sense, the fellows had their training in the heart of the basic school, where pedagogical practices took place, establishing relationships through practical experiences, perceiving and living the daily school life.

In the results obtained with CHIC support, eight agents totally agreed with question 22; in question 24, 13 agents were found; and in question 27, 15 agents. The optimum group is made up of the same 12 agents (10, 21, 14, 18, 34, 32, 19, 17, 4, 29, 26, 20), whose typical variable for this subclass is (V12OE), representing the agents who indicated that they had other expectations regarding the degree course, with a risk of 0.00994 that the statement is false.

The hierarchical and relational analysis of this node can initially be made by anchoring it in the narrative presented by agent 27, based on the textual records of question 34.

1° — PIBID inserted me into the daily life of a public school, providing opportunities to create and participate in methodological, technological and teaching practice experiences of an innovative and interdisciplinary nature. 2° — Participating in PIBID allowed me to compare the theory exposed during the Mathematics degree course with the practice of the school in which I participated as a scholarship holder [Textual record of agent 27, in question 34] (Souza, 2016, p. 214).

Classified at level 18 is the fifth node, which was considered by CHIC to be the most significant. This node emerges through the association of variables, with the following implicative relationship $((V22CT \rightarrow (V24CT \rightarrow V27CT)) \rightarrow V14CT) \rightarrow ((V20CT \rightarrow (V25CT \rightarrow V21CT)) \rightarrow V41CT)$, which indicates a cohesion index of 0.974. The node is composed of the first three significant nodes analyzed from Class 1, with the association of new variables to the third significant node, the variable (V14CT), relating to the second significant node with the variable (V41CT).

A characteristic of this node was the total agreement with the statements made in these eight questions. It is noteworthy that, in addition to the characteristics identified in the analysis of the first three significant nodes, the undergraduates have the perception that PIBID Mathematics has contributed to their teacher training, and that the management and teachers of the schools have supported the development and execution of the actions.

The typical variable for this subclass is variable (V33E): agents who had an excellent relationship with the PIBID supervising teacher, with a risk of 0.0254 that this statement is false. The agents that make up the optimal group for this implicative rule are: (1, 21, 10, 17, 34, 19, 20, 26, 29, 32). The highlighted passages state the results obtained with the support of CHIC and the analysis carried out.

1- Learning how to express oneself more clearly with the student, either verbally or in writing in the activities, with the aim of really making it clear to the student what is being asked. 2- Improvement in writing, and the opportunities to take part in congresses, either just as an observer, or presenting reports of experiences in which some problems not seen by us involved in the project are observed by other professionals in the field of education, improving the products generated more and more. 3- The experience of preparing material and activity sheets, whether concrete or digital [Textual record of agent 17, in question 34] (Souza, 2016, p. 257).

The relationships between the variables in which the undergraduates totally agreed with the statements presented, the characteristics identified, and the passage quoted allow us to say that there are indications that the PIBID contributed to the training process of the scholarship holders, with an emphasis on dialog, the exchange of experiences and immersion in everyday school life. This experiential knowledge was built through mediation between theory and practice, providing them with teaching skills and reflection on the teaching profession.

Despite these important considerations, initial training needs to examine the purposes and consequences of its teaching practice. In this way, it is necessary to "teach future teachers teaching skills and help them achieve purposes that are justifiable in educational and moral terms in a society that proposes to be democratic" (Zeichner, 2011, p. 63).

The seventh node is made up of the significant nodes (1, 2, 3, 5) already analyzed, whose implicative relationship is: $((V26T \rightarrow V23CT) \rightarrow ((V19CT \rightarrow V18CT) \rightarrow ((V22CT \rightarrow (V24CT \rightarrow V27CT)) \rightarrow V14CT) \rightarrow ((V20CT \rightarrow (V25CT \rightarrow V21CT)) \rightarrow V41CT)))) \rightarrow V42CT)$, with a cohesion index of 0.923. The typical variable of this seventh node is made up of agents who had other expectations of the Mathematics degree course, with a risk of 0.0585 that this statement is false.

These rules indicate that, in addition to the characteristics identified in the significant nodes (1, 2, 3, 5), the agents realized that the initial training through immersion in the school — provided by the implementation of the actions of the Mathematics PIBID — was in line with the relationship between theory and practice, raising the quality of academic actions, valuing the teaching profession, with the fundamental participation of the area coordinator in the methodological perspectives for teaching mathematics.

These interpretations obtained in the analysis of the seventh node are corroborated in the reports in questions 34 and 36, given by the agents who took part in the PIBID implementation process.

Drawing up lesson plans and taking part in events, which helped me overcome my shyness [Agent 15's textual record, in question 34].

Professional growth and maturity. [Agent 33's textual record, in question 34].

Taking part in PIBID helped me to gain experience in the classroom that I didn't have. [Agent 7's textual record, in question 34].

1) Through PIBID I was able to experience the reality of the classroom in public schools; 2) It really prepared me to take on the role of a teacher [Textual record of agent 12, in question 34] (Souza, 2016, p. 260).

In the relationships between the variables of the groupings established by CHIC for this subclass and the textual records, we can point to indications that the implementation of the PIBID actions provided the undergraduates with fundamental experiences for the construction of their professional identities.

The eighth significant node is positioned at level 27 and is made up of the hierarchical association of variables, with the following implicative relationship: $((V37CT \rightarrow V38CT) \rightarrow (((V26CT \rightarrow V23CT) \rightarrow ((V19CT \rightarrow V18CT) \rightarrow (((V22CT \rightarrow (V24CT \rightarrow V27CT)) \rightarrow V14CT) \rightarrow ((V20CT \rightarrow (V25CT \rightarrow V21CT)) \rightarrow V41CT)))))) \rightarrow V42CT$), with a cohesion index of 0.826. This node is made up of the significant nodes (1, 2, 3, 5, 7) analyzed above. The hierarchical associations built by the 15 variables are obtained by the cohesion rules and by analyzing the data with the support of CHIC, whose characteristic of this node is related to the answers given by undergraduates who totally agreed with all the questions (37, 38, 26, 23, 19, 18, 22, 24, 27, 14, 20, 25, 21, 41, 42) in the questionnaire applied.

The analysis also shows that, in the agents' view, the Mathematics PIBID promoted an appreciation of the course and provided a positive experience in relation to other colleagues on the course. The typical variable for this node is (V12OE), relating to agents who had other expectations regarding the degree course, with a risk of 0.0437 that this statement is false.

The aspects contained in the records extracted from the answers to questions 34 and 36 by some of the undergraduates are examples of the relationships identified in Figure 3.

It helped in my training as a teacher [Agent 16's textual record, question 34].

Articulation and integration of teaching theory and practice to overcome problems in the teaching-learning process, guided by good professionals [Agent 20's textual record, question 34].

Experience in the classroom and the reality of what it really means to be a teacher [Agent 25's textual record, question 34] (Souza, 2016, p. 263).

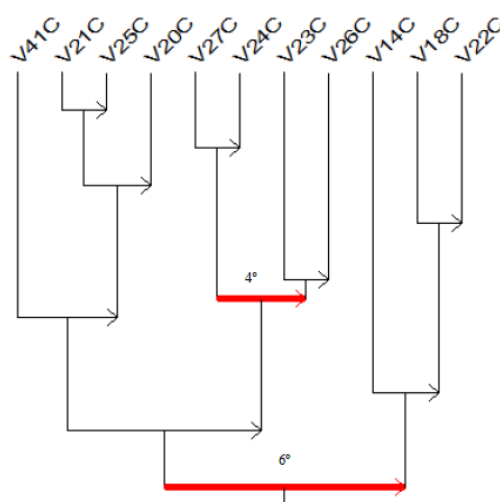
In summary, it can be said that the actions woven, designed and implemented by the

BIDs of the UFF Mathematics PIBID promoted the articulation between Teaching, Research and Extension. It can also be identified that the different methodological perspectives in the construction of the teaching activities promoted the relationship between theory and practice.

To these aspects, it is necessary to add the importance of the link between primary school teachers and undergraduates. Direct contact with teachers in action and with their process of constructing and reconstructing practical responses (professional knowledge) in the face of the complexity of everyday school life favors undergraduates in the constitution of their own representations of what it means to be a future teacher, as they broaden their conceptual understandings and their way of teaching and learning, as Almeida and Pimenta (2014) point out.

Class 2 is analyzed, made up of the responses from agents who agreed with the questions that make up the variables in this class.

Figure 4: Class 2 made up of the variables (V42C, V19C, V41C, V21C, V25C, V20C, V27C, V24C, V23C, V26C, V14C, V18C, V22C, V37C, V38C) highlighted in the cohesive tree in Figure 2.



Source: Souza (2016)

Na Figure 4 shows the fourth significant node of the cohesive tree at level 12, which is made up of the implicative rule $((V27C \rightarrow V24C) \rightarrow (V23C \rightarrow V26C))$, with a cohesion index of 0.996.

We identified a significant number of agents who answered these questions: 23 agents agreed with question 27; question 24 identified 25 agents; question 23 identified 24 agents and question 26 identified 27 agents. The optimum group in the fourth node is made up of 21 agents (7, 30, 2, 28, 38, 35, 36, 37, 31, 27, 8, 9, 15, 13, 12, 6, 25, 24, 23, 22, 5), and the typical variable is (V12OE), i.e. agents who had other expectations of their degree course, with a risk of this statement being false of 0.00994.

The data presented here, referring to the fourth node, makes it possible to state that the implementation of PIBID has favored dialogue and collective work, contributing to training that is referenced within the school, linking theory and practice. There is evidence that this training was fundamental to the quality of the actions implemented by the subprojects and thus contributed to the process of training teachers who are aware of the complexity of the school. This interpretation is evidenced by the aspects of the records extracted from questions 34 and 36 of the questionnaire applied to the scholarship holders, corroborating the analysis carried out.

Access to the day-to-day life of a math teacher and students' difficulties [Textual record of agent 30, in question 34].

Contact with the school environment and the student body as a future teacher. The development of projects on content in which the students had the greatest difficulty [Textual record of agent 36, in question 34] (Souza, 2016, p. 265).

In the joint analysis of the CHIC results and the textual records highlighted, it can be inferred that the immersion of the BIDs in everyday school life through training with an emphasis on practice enabled the undergraduates to identify some problems, such as the organization of work, discipline and difficulties in the classroom in basic schools. This interpretation is based on the records relating to question 35 in Table 2.

Noticing the disrespect of several students towards their respective teachers [Agent 2's textual record].

Indiscipline among elementary school students. The undervaluing of public school teachers [Textual record of agent 13].

Disinterest on the part of most of the students and difficulty in organizing the school to implement the projects [Agent 25's textual record] (Souza, 2016, p. 265).

These aspects necessarily require efforts to promote initial teacher training with a strong practical component, which allows future educators to experience complex classroom experiences (Esteve, 1999).

For Nóvoa (2017), it is essential to build models that value the preparation, entry and professional development of teachers. In other words, initial training must be thought of in relation to professional induction and continuing training. In this sense, there is a need to rethink training within universities, with strong external links, with a view to teacher practice.

Among the alternatives is the PIBID, which is of great importance to us. However, although Brazil has advanced and very interesting legislation, the reality in the field of teacher training is fragile. It is in this context that training is proposed "with moments of strong theoretical slant in the disciplines and sciences of education, followed by moments of work in schools, during which new problems are raised to be studied through reflection and research" (Nóvoa, 2017, p. 1116).

It's important to note that the dynamics of the implementation process of the Mathematics PIBID through the immersion of the BIDs in the heart of the school allowed the undergraduates to experience the complexity of the school, to experience the good and bad moments of the classroom context.

With a cohesion index of 0.954, the sixth node of the cohesive tree in Figure 4 emerges, classified at level 22 and formed by the hierarchical association of variables with the following implicative relationship: $((V41C \rightarrow (V21C \rightarrow V25C) \rightarrow V20C) \rightarrow ((V27C \rightarrow V24C) \rightarrow (V23C \rightarrow V26C))) \rightarrow (V14C \rightarrow (V18C \rightarrow V22C))$. This node is located in the second class and is established by the responses of the agents who agreed with the statements in the questions and the fourth significant node.

The optimum group in the sixth node is made up of 18 agents (35, 7, 13, 12, 9, 5, 22, 8, 6, 37, 36, 27, 24, 25, 28, 31, 30, 2), whose typical variable in this set is (V33B): the agents who had a good relationship with the supervising teacher, with a risk of 0.0617 that this statement is false.

These implicative rules determined by CHIC allow us to analyze and deduce that the

BIDs' immersion in the implementation of PIBID at the school was supported by the management and teachers. As such, a dialog and collective work was fostered, so that they were able to articulate the theory learned in the degree courses with the pedagogical practice of the primary school teachers. This interpretation is exemplified by the records extracted from open questions 34 and 36 of the questionnaire, corroborating the analysis carried out.

I was able to follow the reality of the classroom more closely [Textual record of agent 31, in question 34].

Seeing how receptive the students in the schools are to the scholarship holders. Noticing the students' improvements with day-to-day contact [Textual record of agent 2, in question 34] (Souza, 2016, p. 268).

In the analysis, there are signs that the students are immersed in teaching practice, enabling them to face the complexity of the elementary school classroom.

In addition to the analysis carried out on the sixth significant node, the general analysis of Class 2 shows that the undergraduates had a strong presence from the area coordinators with regard to the methodological perspectives discussed, reflected on and implemented in learning and teaching situations in Mathematics, thus contributing to the appreciation of teaching, as well as the Mathematics degree course, and establishing a positive experience for other colleagues on the course.

The records extracted from question 36 exemplify the interpretation given to the general analysis carried out of Class 2 of the cohesive tree in Figure 4.

Each activity contributed to my work in the classroom, so there's no way of describing any of them. As well as the events, where we exchanged experiences with fellows from other places who carried out their work differently, but unlike the activities, one event was so remarkable for me, because in it, I was able to see how other work was carried out at national level, this event was the PIBID Congress in Goiânia, at UFG [Textual record of agent 6].

Visit of elementary school students to the University [Textual record of agent 19].

Drawing up lesson plans and workshops for elementary school students [Textual record of agent 20] (Souza, 2016, p. 270).

According to Chinelli (2015), the strategic training actions implemented by the PIBID subprojects in partnership with Basic Education are aimed at intervening in the school system. According to the author, they also have the intention of training teachers who are able to organize their teaching work with attention to the needs of society, in a position to deal with the complexity of the classroom, recognizing themselves as ethical and reflective professionals. Silveira (2015, p. 13) points out that PIBID has "played an important role in the construction of knowledge, in the re-signification of training and in the acute participation of training institutions and their members within basic education schools".

4 Final considerations

The cohesive tree in Figure 2 shows the association of 36 variables, establishing various classes, but in this study we chose to analyze only two: Class 1 and Class 2, due to the criteria adopted. It can thus be seen that the response variables are not mixed, i.e. Class 1 contains implicative rules in which the agents totally agree, and Class 2 contains the responses of agents who only agree.

The analysis shows that the implementation of the PIBID Mathematics subprojects met the objectives and pedagogical principles proposed by the program, especially those structuring

DEB teacher training. In addition, the results observed confirm that there was the construction of experiential, procedural and instrumental knowledge by the teaching initiation agents, from the perspective of Tardif (2012).

The partnership between the university and the basic school has promoted an articulation that has contributed to the construction of a collaborative space for teacher training. In addition, the school is the privileged *locus* for resizing the knowledge built up by teachers, which manifests itself in pedagogical action and conceptions of teaching and learning processes (Lelis, 2013).

In summary, according to the cohesive analysis, the undergraduates perceived the effects and positive impacts of participating in the PIBID and building their professional identity and praxis. Therefore, the activities planned, developed and applied by the BID in the process of implementing the mathematics subprojects considered the praxis that takes place in the partner schools where the actions took place as a starting and ending point for initial teacher training, for the construction of professional identity and teaching professionalism, as described by Almeida and Pimenta (2014).

It is also important to point out that the dynamic established between the UFF and the school, through the PIBID Mathematics subprojects, was fundamental for the constitution of the dialectical relationship between theory and practice lived and experienced by the agents (teaching initiation scholarship holders, supervisors, coordinators and school teachers), important for initial and in-service training, leading to a positive position about PIBID.

It is in this context that the interaction between the elementary school teacher and the IDBs in the classroom helps undergraduates in initial training to build their representations of what it means to be a future teacher, as it fosters their conceptual understanding of how to teach and learn.

The use of these references, in general, allows us to affirm that the UFF's PIBID in Mathematics has promoted a link between the university and the school, fulfilling the role of training and informing students and continuing training for primary school teachers. This perspective allows for the construction of methodologies for the teaching and learning process, in which teaching is centered on the teacher and learning on the student, in a constant dialogical relationship of adaptation. This, in turn, is constituted through teaching projects and, consequently, a new pedagogical praxis for the future teacher, since their actions are organized in such a way that all agents become protagonists of their own training. However, it is important to note that there may be cases where this has not happened.

The aforementioned aspects are fundamental to understanding the actions of the agents in the process of implementing the UFF Mathematics PIBID subprojects, due to the relationships between the agents and the objective conditions in which the actions and learning situations were implemented, consolidating the training and teaching work spaces as favorable for initial and in-service training, thus constituting a relevant public policy for valuing the teaching profession.

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