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ARTICLE

THE PRESENCE AND CHARACTERISTICS OF ASTRONOMY IN THE INITIAL FORMATION OF PEDAGOGUES: AN ANALYSIS OF PEDAGOGICAL PROJECTS OF COURSES IN BRAZIL

Thayná Cristina Dias e Dias[1]
https://orcid.org/0000-0002-7501-0671

Camila Maria Sitko[2,3]
https://orcid.org/0000-0003-4620-1388

Rodolfo Langhi[4]
https://orcid.org/0000-0002-3291-5382

ABSTRACT:

Astronomy is still little studied in undergraduate courses, especially in the Pedagogy course, although teaching this content is recommended from the early years of Elementary School. In order to understand how this relationship between Astronomy and the initial formation of pedagogues takes place, this research aims to investigate the presence and characteristics of Astronomy in the Pedagogical Projects of Pedagogy Courses (PPC) present in the federal universities of the capitals of the 26 Brazilian states and the Federal District. The results point to the existence of Astronomy elements in only six disciplines, which are analyzed according to specific criteria of Bardin's categorical content analysis. It is considered that this insufficiency in the training of pedagogues can lead to a deficiency in the scientific training of Elementary School students. Therefore, there is a need to revise the Pedagogy curriculum, in order to contemplate an Education in Astronomy indicated for teaching in Basic Education.

Keywords:
Education in Astronomy;
Course Pedagogical Project (PPC);
Initial formation in Pedagogy.

A PRESENÇA E AS CARACTERÍSTICAS DA ASTRONOMIA NA FORMAÇÃO INICIAL DO PEDAGOGO: UMA ANÁLISE DOS PROJETOS PEDAGÓGICOS DE CURSOS DO BRASIL

RESUMO:

A Astronomia ainda é pouco estudada nos cursos de graduação, especialmente no curso de Pedagogia, embora o ensino desse conteúdo seja recomendado desde os anos iniciais do Ensino Fundamental. A fim de compreendermos como se dá essa relação entre a Astronomia e a formação inicial do pedagogo, esta pesquisa visa investigar a presença e as características da Astronomia nos Projetos Pedagógicos de Cursos (PPC) de Pedagogia presentes nas universidades federais das capitais dos 26 estados brasileiros e do Distrito Federal. Os resultados apontam a existência de elementos de Astronomia em apenas seis disciplinas, as quais são analisadas de acordo com critérios específicos da análise de conteúdo categorial de Bardin. Considera-se que essa insuficiência na formação dos pedagogos pode acarretar uma deficiência na formação científica dos alunos do Ensino Fundamental, havendo, portanto, a necessidade de revisão do currículo de Pedagogia, de forma a contemplar uma Educação em Astronomia indicada para o ensino na Educação Básica.

Palavras-chave:
Educação em Astronomia;
Projeto Pedagógico de Curso (PPC);
Formação inicial em Pedagogia.

1 Paulista State University "Júlio de Mesquita Filho", Graduate Program in Education for Science, Bauru, SP, Brazil.
2 Federal Technological University of Paraná, Campo Mourão, Paraná, PR, Brazil.
3 Federal University of South and Southeast Pará, Graduate Program in Education in Science and Mathematics, Marabá, PA, Brazil.
4 Paulista State University "Júlio de Mesquita Filho", Faculty of Sciences, Department of Physics, Bauru, SP, Brazil.

LA PRESENCIA Y LAS CARACTERÍSTICAS DE LA ASTRONOMÍA EN LA FORMACIÓN INICIAL DEL PEDAGOGO: UN ANÁLISIS DE LOS PROYECTOS PEDAGÓGICOS DE CURSOS EN BRASIL

RESUMEN:

La Astronomía aún es poco estudiada en los cursos de graduación, especialmente en el curso de Pedagogía, aunque se recomienda impartir este contenido desde los primeros años de la Enseñanza Primaria. Para comprender la relación entre la Astronomía y la formación inicial del pedagogo, esta investigación tiene como objetivo explorar la presencia y las características de la Astronomía en los Proyectos Pedagógicos de los Cursos de Pedagogía (PPC) presentes en las universidades federales de las capitales de los 26 estados brasileños y del Distrito Federal. Los resultados apuntan hacia la existencia de elementos de Astronomía en solo seis asignaturas, las cuales son analizadas según criterios específicos del análisis de contenido categórico de Bardin. Se considera que esta insuficiencia en la formación de los pedagogos puede conllevar una deficiencia en la formación científica de los alumnos de la Enseñanza Básica. Por lo tanto, surge la necesidad de revisar el currículo de Pedagogía, a fin de contemplar una Educación en Astronomía adecuada para la enseñanza en la Educación Básica.

Palabras clave:
Educación en Astronomía;
Proyecto Pedagógico de Curso (PPC);
Formación inicial en Pedagogía.

INTRODUCTION

The teaching of Astronomy and the initial training of pedagogues are two distinct areas, but if analyzed categorically, it is possible to extract points of convergence between them. Such a confluence comes into existence when, for example, the National Common Curricular Base – BNCC (Brasil, 2018) – establishes the teaching of Astronomy in the early years of Elementary School, in Basic Education, the stage of teaching in which the role of the pedagogue is predicted. However, their training, in general, does not include the teaching of this content. Thus, how could the teacher teach something they had no contact with in their training?

In the curricular selection built for the Pedagogy disciplines, almost nothing appears on themes that address Science teaching, especially the teaching of Astronomy, which can contribute to sustaining alternative conceptions about the Universe, and our position in the cosmos, among others (Langhi & Nardi, 2012). Thus, there are situations where alternative conceptions are passed on to students in the early years, or what are more common, situations in which the pedagogue teacher suppresses the contents because they do not understand them. As Langhi (2011) points out in his bibliographical review of alternative conceptions in Astronomy, one of the most recurrent themes was related to the shape of the Earth and its gravitational field, which generates in the teacher a "[...] feeling of incapacity and insecurity when working with the theme, unsatisfactory answers for the students, lack of contextualization suggestions [...]" (Langhi & Nardi, 2012, p. 104). As a result, "Astronomy does not seem to have its guaranteed space in the current school organization, which has training precepts that do not necessarily match official documents" (Carvalho & Ramos, 2020, p. 16).

In this sense, there is clearly a significant problem concerning the curriculum in the training of teachers in the early years of teaching Astronomy. We based ourselves on documentary research to describe and analyze the current situation in the area to understand this issue better. We based ourselves on the analysis of the Pedagogical Projects of Pedagogy Disciplines (PPC) of Pedagogy of 27 Brazilian universities, seeking to answer the following question: How is the teaching of Astronomy included in the PPC of the federal higher institutions located in the Brazilian capitals?

This article is part of an excerpt from a master's thesis in progress. A brief discussion will be made initially regarding the initial training of pedagogues and the importance of teaching Astronomy in the early years of Elementary School to answer our question. After that, we will present our data collection and analysis process based on Bardin's categorical content analysis. Finally, reflections will be made on the importance of the Pedagogy curriculum for teaching Science in the early years of Elementary School.

ASTRONOMY IN THE CURRICULUM OF INITIAL TEACHING TRAINING

When investigating the syllabi of Pedagogy disciplines in Brazil in public and private institutions in 2001, 2004, and 2006, Gatti (2009) listed a series of categories of the courses analyzed, among them that of "knowledge related to specific professional training," which contains the courses involving teaching Science. The author points out that

> [...] The courses in this group bring syllabi that register concern with the justifications on why to teach, which, in a way, would help to prevent these subjects from becoming mere prescriptions. However, only in a very incipient way do they record what and how to teach (Gatti, 2009, p. 23).

According to Sacristán (2000, 1998), the construction of the curriculum is often based on classical knowledge, for which a higher number of class hours is destined, since "[...] they form part of the culture considered as the valuable legacy in which to initiate, in some way, all citizens" (Sacristán, 2000, p. 67). From this perspective, Pedagogy is understood as having its classic knowledge fixed in the mandatory courses, thus adding more class hours. When we analyze them, we realize that classical knowledge focuses on a philosophical, pedagogical, and historical nature, with little or no teaching of specific areas, such as Geography, Biology, Physics, and Chemistry.

Given this, the construction of the school curriculum must be conducted by an education project that prioritizes such Science for Astronomy to be studied in the formal school space of teaching. In this sense, Sacristán (2013) argues that, based on this elaboration, "[...] we improve human beings, increase their well-being and economic development, mitigate social deficiencies, contribute to the redemption of human beings, their liberation" (Sacristán, 2013, p. 24).

With this intention, school contents need to be filtered, synthesized, and selected, not only according to a (dominant) culture but related to the most relevant issues for each social culture (Sacristán, 2000). Building social and cultural thought about our Planet Earth, we can think about the emergence of knowledge about the knowledge of man about the Universe that surrounds us, knowing the smallness in the face of the size of our world (Langhi & Nardi, 2012). Thus, teachers and trainers of these professionals must broaden their conceptions and understand teaching as research, "[...] taken as a simultaneously scientific, educational, and methodological principle" (Amaral, 2005, p. 39).

Batista (2016) also discusses how to address teachers' unpreparedness in teaching content in Astronomy. For the author, as much as training can be a continuous process of building new knowledge, even so, the essential pillar for teacher training takes place through initial training, and this stage should therefore be privileged. Batista (2016) argues that disciplines that train teachers should look more closely at the teaching of Astronomy.

Concerning the research on Science and Physics teaching from the point of view of Astronomy content, Langhi and Silva (2018) point out that the results of these investigations indicate serious problems in the initial training of teachers. The lack of this subject teaching leads teachers to face obstacles motivated by unpreparedness, such as difficulty finding help, books, and time for Astronomy-related study topics (Langhi & Silva, 2018).

Leite et al. (2013) also agree with this issue when they state that teacher training programs need to consider the results disclosed in the area of Education in Astronomy and Science teaching when elaborating their proposals.

Thus, based on the discussions and reflections presented and several others not mentioned here, the training of teachers who teach Science in the early years of Elementary School is understood as still insuf-

ficient in terms of the curriculum of the respective area and may reflect unfavorably in the teaching and notion of Science that children receive.

In this sense, analyzing teacher training requires investigating the curriculum documents designed to train this teacher, identifying the courses (mandatory and optional) and methodological models that the document presents as being essential for the initial training trajectory of this professional, which is performed in this study.

RESEARCH METHODOLOGY

The approach of this research was assumed as qualitative, of the documentary type, since the data collection occurred through public documents, considered by Marconi and Lakatos (2003) as a primary source of investigation. The documents in question were the Pedagogical Projects of Pedagogy Disciplines (PPC) present in the federal universities in the capitals of the 26 Brazilian states and the Federal District. Such documents were collected online,[1] on the institution's website,[2] or via email, in cases where the documents were not on the website.

The criterion for choosing the selected federal universities was determined considering that these institutions form a sizeable annual number of teachers in degree courses in this area and cover several cities around them, such as metropolitan regions and the interior of their respective states. Thus, these institutions are understood as forming a significant number of professionals who will work in the early years of Elementary Education, therefore offering a relevant panorama concerning the training of pedagogical teachers in Brazil.

We used Bardin's Content Analysis (CA) (Bardin, 2016) in categorical specificity as a data analysis methodology. This methodology consists of

> [...] a set of communication analysis techniques aimed at obtaining, through systematic procedures and objective description of the content of messages, indicators (quantitative or not) that allow the inference of knowledge related to the conditions of production/reception (inferred variables) of these messages (Bardin, 2016, p. 38).

The CA was used because we understand that "[...] categorization is an operation of classifying the constituent elements of a set, by differentiation and then by regrouping according to gender (analogy), with previously defined criteria" (Bardin, 2016, p. 117). We justified our choice of this analytical method by understanding that this categorization process can provide data that can characterize the panorama of Astronomy teaching in the Pedagogy disciplines analyzed.

The main target of data collection in the PPC was the syllabi of the Science courses present in these curricular proposals.[3] As Gatti (2009) points out, the term syllabus has different meanings, with some PPC understanding it as a list of course contents and others as course objectives, for example. However, most of the syllabi analyzed in this work bring a list of contents to be taught and the course's objectives.

With the PPC in hand, the syllabi of each Science teaching course and the contents presented in them were pre-analyzed, selecting those containing elements of Astronomy. As a way of classifying the historical, methodological, and/or practical and conceptual dimensions that appeared in the Science syllabi that addressed Astronomy content, already in the material exploration phase, we used three analytical approaches developed by Batista (2016). Our choice is justified by recognizing that such approaches "[...] should be included in the syllabi of courses involving science in the initial training for teachers in the early years, as it would be an adequate structure for the training of a professional in this area" (Batista, 2016, p. 63). Chart 1 below presents the dimension of each approach.

Chart 1. Focus of the courses

FOCUS	DIMENSION	CATEGORY
Focus on Science teaching conceptions and trends.	Courses that present historical and experimental aspects and different conceptions related to Science in their syllabus.	A
Focus on theoretical-methodological perspectives and their pedagogical implications.	Courses that present methodological aspects of "how to do."	B
Focus on the theoretical and practical basis for the classroom.	Courses that present Science contents that should be taught.	C

Source: Batista, 2016.

After exploring and categorizing the data, we completed the second stage of the CA for the approaches brought in Chart 1 and other categories mentioned below, in item 4. In its third stage, the CA contemplated the treatment of results and inferences about the question researched. The following section presents such results.

IDENTIFICATION AND CHARACTERIZATION OF COURSES THAT PRESENT ASTRONOMY CONTENT IN THE PPC INVESTIGATED AND THEIR CONTEXTS

From the Pedagogy PPC of the 27 federal universities participating in the research, a total of 66 courses identified with a focus on Science teaching were analyzed. Among these, only six had elements related to Astronomy, i.e., only about 9% of the courses included a curriculum aimed at training teachers to teach Astronomy in the early years of Elementary School. Such syllabi were then analyzed according to the following criteria: their focuses, according to Batista (2016); class hours, form, and content; comparison with contents of the BNCC; professionals who worked in the production of the PPC; graduate profile and discipline objectives; and associated non-formal spaces. Such analyses will be described below.

a) Focuses: When analyzed by focus, according to Batista's (2016) categorization, of the six courses identified, only three presented approaches relevant to categories A, B, and C, as Chart 2 shows below.

Chart 2. Courses that presented elements of Astronomy

UNIVERSITY	YEAR OF CREATION OF PPC	COURSE NAME	CATEGORY	Course CH	Discipline CH
UFPA	2010	Methodological Approaches to Science Teaching	A, B, and C	68	3211
UFT	2007	Fundamentals and Methodology of Teaching Natural Sciences	A, B, and C	60	3225
UFBA	2012	Natural Sciences in Elementary Education	C	68	3313
UFRN	2017	Astronomy and Education (optional)	A, B, and C	60	3220
UFG	2015	Fundamentals, Contents, and Methodology of Natural Sciences II	B and C	80	3304
UFRGS	2018	Exploring the Universe: From Quarks to Quasars (optional)	C	30	3255

Source: Own authorship.

Of the six courses analyzed, two are specific to Astronomy teaching. The others are called Fundamentals and Methodology (three), and, finally, one focuses on Science at the Elementary School level. We can see that all six are in category C. However, when analyzing the basic bibliography of the courses (Chart 3), the specific contents (corresponding to category C) still appear in smaller quantities. Given this, we can infer that one of the characteristics of most specific courses is that, whether in terms of themes or bibliographies, they refer more to the methodological plan and historical aspects than what should be taught at school. However, the six are in category C. Gatti (2009) addresses this type of data and clarifies that the minority of specific courses is designed for the perspective of "what" to teach.

Thus, "this data makes it clear how the specific contents of the courses to be taught in the classroom are not the object of initial teacher training" (Gatti, 2009, p. 24). The author infers that "in professional training courses, theoretical references predominate, whether of a sociological, psychological, or other nature, with an association in a few cases to educational practices" (Gatti, 2009, p. 24). It is also noticed that two courses are from the Northeast region, two from the North region, one from the Midwest region, and one from the South region. On the other hand, in the PPC analyzed, the Southeast region did not present any Astronomy content.

b) Class hours: The class hours of these courses are limited when compared with the total class hours of the discipline since the course with the highest number of class hours (80h) still corresponds to only 2.42% of the total class hours. A possible explanation for the insufficient number of class hours of courses involving areas of teaching Science and Astronomy in Pedagogy disciplines would be the large offer of courses focused on a more psychological and sociological view of the area and, consequently, the offer of more class hours destined to courses of this nature. These effects can be elucidated by what Sacristán (1998) points out when he states that Pedagogy has become invisible and psychological. For the author, studies in this area have focused on theoretical issues in psychology that have not yet met, to a certain extent, the real needs of their students.

The fact is that training in Pedagogy is extensive, resulting in a multipurpose professional, who is the teacher who works in Basic Education, more specifically in the initial years, who needs to appropriate knowledge from different areas and try to develop them in an interdisciplinary way (Lima, 2007). In this sense, there are different work fronts for the professional pedagogue, ranging from school management, for which the psychological and sociological training mentioned is relatively adequate, up to working in the classroom, in the early years of Elementary School, a focus of the present work, for which we affirm that the curriculum still needs to be rethought, in terms of scientific content.

c) Form and content: Another essential point that should be mentioned corresponds to the format of the courses in the PPC, since of the six courses mentioned, two are optional, i.e., likely not to be offered to all students, depending on the regulation of each discipline specifically. Next, these Astronomy contents are analyzed in more detail based on the syllabi and bibliographies presented in the investigated documents (Chart 3).

Chart 3. Syllabi of courses that had elements of Astronomy

UNIVERSITY	SYLLABI	BIBLIOGRAPHY
UFPA	**Theoretical-Methodological Approaches to Science Teaching:** Relationship between scientific knowledge and the teaching and learning process in the field of science education for schoolchildren; Science as reading and transforming the natural world; Theoretical-methodological trends in science education; Use of instructional resources in science education; Approach to themes related to Science and technology with importance in the conditions of human life; Chemistry in everyday life of contemporary society; Earth and Universe: Stars and phenomena of the Earth-Sun-Moon system used as orientation and everyday reference.	**BASIC BIBLIOGRAPHY** Auler, D., & Auth, M. A. (2001). Ciência e tecnologia: Implicações sociais e o papel da Educação. *Ciência & Educação*, v. 7, n. 1, pp. 1-13. Carvalho, A. M. P. (1995). *Ciências no Ensino Fundamental:* o conhecimento físico. São Paulo: Scipione. Chassot, A. (2000). *Alfabetização científica:*questões e desafios para a educação. Ijuí: Ed. Unijuí. **COMPLEMENTARY BIBLIOGRAPHY** Universidade de São Paulo. (1993). Prática de ciência na escola: vamos discutir? *III Encontro Nacional de Professores de Ciências.* São Paulo, novembro. Brasil. Secretaria de Educação Fundamental. (1997). *Parâmetros curriculares nacionais:* ciências naturais. Brasília: MEC/SEF. Delizoicov, D., Angotti, J. A. P., & Pernambuco, M. M. (2002). *Ensino de Ciências:* fundamentos e métodos. São Paulo: Cortez. Santos, W., & Mol, G. (2005). *Química e Sociedade.* São Paulo: Nova Geração. Teixeira, P. M. M. (2003). Educação científica e movimento C. T. S. no quadro das tendências pedagógicas no brasil. *Revista Brasileira de Pesquisa em Educação em Ciências*, v. 3, n. 1, Janeiro/Abril. Wortmann, M. L. C., & Veiga-Neto, A. (2001). *Estudos Culturais e Educação.* Belo Horizonte: Autêntica.

UNIVERSITY	SYLLABI	BIBLIOGRAPHY
UFT	**Fundamentals and Methodology of Teaching Natural Science:** Legal and theoretical-methodological assumptions of the teaching of Natural Sciences; Main trends in Natural Sciences in the 20th and 21st centuries; The mutual relations between Sciences and technologies; Brief history of Natural Sciences and their teaching in Brazil; Problem-based learning in the search for a scientific understanding of nature-society relationships; The ethical issue, the creation of values, attitudes, and postures in these relationships; Methodological organization strategies (theoretical and practical) in the construction of knowledge and development of skills in the teaching of Natural Sciences; Analysis and textual interpretation, observation, experimentation, comparison, modeling, and field procedures for the teaching-learning of Astronomy; Physics, Chemistry, Biology, Geosciences, Health, and Environment. The analysis of the everyday practice of teaching in schools as an interface with research. Case study.	**BASIC BIBLIOGRAPHY** Delizoicov, D., & Angotti, J. A. P. (1998). *Metodologia do ensino de Ciências.* São Paulo: Cortez. Fracalanza, H., & De Amaral, I. (1995). *O ensino de ciências no primeiro grau.* São Paulo: Atual. Morais, R. (1992). *Ciências para as séries iniciais e alfabetização.* Porto Alegre, RS: Sagra Luzzatto.
UFBA	**Natural Sciences in Elementary Education:** Knowledge; Observation and experimentation as fundamental methods in the study of nature; The Earth, the Solar System, and the Universe; Living beings and their relationship with each other and with the environment; The human body: structure, functions, and health; Matter and energy: sources and transformations; Man's action on nature; Technological resources and the natural environment.	There is no basic bibliography in the PPC that we analyzed.

UNIVERSITY	SYLLABI	BIBLIOGRAPHY
UFRN	**Astronomy and Education (optional):** Conceptual and historical introduction to Astronomy and its dialogues with Education; Astronomical phenomena and the organization of space, time, and life by human societies; Celestial sphere and coordinate systems; Astronomical laws: Kepler, Newton, and Einstein; Movements of celestial bodies; Study of the solar system, stars, constellations, planets, and the known Universe; Astronomy in everyday observation: eclipses, moon phases, tides, and seasons; Astronomy and its relationship with living organisms; Astrogeography and Geoastrophysics; approaches from Astronomy to Geography; Astronomical observation practices with and without instruments; The teaching of Astronomy in Elementary and Secondary Education: contents, methodologies, and practices.	**BASIC BIBLIOGRAPHY** Adams, F., & Laughlin, G. (2001). *Uma biografia do universo*: do Big Bang à desintegração final. Rio de Janeiro: Jorge Zahar Editor. Aristóteles. (2004). *Meteorology*. Tradução de E. W. Webster. Adelaide: University of Adelaide. Ashcroft, F. (2001). *A vida no limite.* Rio de Janeiro: Jorge Zahar Editor. Bisch, S. M. (1998). *Astronomia no ensino fundamental: natureza e conteúdo do conhecimento de estudantes e professores.* 301 f. Tese (Doutorado em Ensino de Ciências) – IF/USP, São Paulo. Galilei, G. (2001). *Diálogo sobre os dois* máximos sistemas do mundo ptolomaico e *copernicano.* São Paulo: Discurso Editorial/Fapesp. Mendes, R. P., & Dalcol, J. C. (2009). Lei n. 10.267: Georreferenciamento e sua aplicação prática. 2009. *Revista Científica FAJAR*, v. 1, n. 8, pp. 6-43, jan./jun. Moreira, D. (2012). *Proposta de metodologia e procedimentos para obtenção de informações planimétricas georreferenciadas de imóveis rurais e urbanos para fins de desapropriação e registro.* Departamento de transportes e obras de Terra – FATEC-SP. Disponível em: http://bt.fatecsp.br/system/articles/180/original/13decio.pdf Acesso dia 25/05/2012. Mourão, R. R. F. (1987). *Dicionário enciclopédico de astronomia e astronáutica.* 1. ed. Rio de Janeiro: Editora Nova Fronteira. Sagan, C. (1983). *Cosmos*. Rio de Janeiro: Editora Francisco Alves. USP, Universidade de São Paulo (1986). Instituto Astronômico e Geofísico (USP.IAG). *Anuário Astronômico.* São Paulo: USO. **COMPLEMENTARY BIBLIOGRAPHY** Brasil. Secretaria de Educação Fundamental. (1997). *Parâmetros curriculares nacionais:* ciências naturais. Brasília: MEC/SEF. Brasil. Secretaria de Educação Fundamental. (1997). *Parâmetros curriculares nacionais:* geografia. Brasília: MEC/SEF. Sagan, C. (1996). *Pálido ponto azul:* o futuro do homem no espaço. São Paulo: Companhia das Letras.

UNIVERSITY	SYLLABI	BIBLIOGRAPHY
UFG	**Fundamentals, Contents, and Methodology of Natural Sciences II:** Research and work projects; Basic concepts and methodological procedures related to the contents of the Natural Sciences: Botany, Zoology, Ecology, Environmental Education, and Astronomy; Discussion of transversal themes such as Ethnic-Racial Education and Environmental Education.	**BASIC BIBLIOGRAPHY** Barbosa, M. C. S., & Horn, M. G. S. (2008). *Projetos pedagógicos na Educação Infantil.* Porto Alegre, RS: Artmed. Carvalho, I. C. M. (2008). *Educação ambiental:* a formação do sujeito ecológico. 3 ed. São Paulo: Cortez. Espinoza, A. (2010). Experimento na escola: um instrumento de ensino. In: *Ciências na escola:* novas perspectivas para a formação dos alunos. São Paulo: Ática. Martins, J. S. (2005). *Trabalho com projetos de pesquisa:* do ensino fundamental ao ensino médio. 4 ed. Campinas, SP: Papirus. Ricklefs, R. E. (2012). A economia da natureza. Rio de Janeiro: Guanabara Koogan. Periódico: *Revista Ciência Hoje.* Ed: SBPC. **COMPLEMENTARY BIBLIOGRAPHY** Arce, A. *et. al.* (2011). *Ensinando Ciências na Educação Infantil.* Campinas, SP: Alínea. Barbosa, M. C. S., & Horn, M. G. S. (2008). *Projetos pedagógicos na Educação Infantil.* Porto Alegre, RS: Artmed. Coutinho, L. M. (2002). O bioma do cerrado. In: Klein, A. L. *Eugen Warming e o cerrado brasileiro:* um século depois. São Paulo: Editora Unesp. Geraldo, A. C. H. (2009). *Didática de Ciências Naturais na perspectiva histórico crítica.* Campinas, SP: Autores Associados. (Coleção Formação de Professores). Vidal, W. N. (2000). *Botânica:* organografia; quadros sinóticos ilustrados de fanerógamos. 4. ed. Ver. Ampl. Viçosa: UFV.

UNIVERSITY	SYLLABI	BIBLIOGRAPHY
UFRGS	**Exploring the Universe: From Quarks to Quasars (optional):** Distance and time scales in the Universe; The Night sky; Solar and extrasolar planets; Star evolution; White Dwarf Stars, Neutron, Stars and Black Holes; Galaxies; Quasars; Cosmology; Dark Matter; Dark Energy.	**BASIC BIBLIOGRAPHY** Comins, N. F., & Kaufmann III, W. J. (2010). *Descobrindo o Universo.* Porto Alegre: Bookman Companhia Editora Ltda. ISBN 9788577807406. Disponível em: https://www.livrariadafisica.com.br/detalhe_produto.aspx?id=101607 Horvath, J. E. (2008). *O ABCD da Astronomia e Astrofísica.* São Paulo: Editora Livraria da Física. ISBN 9788578610050. Disponível em: https://www.livrariadafisica.com.br/detalhe_produto.aspx?id=31753 Oliveira Filho, K. S., & Saraiva, M. F. O. (2014). *Astronomia e Astrofísica* – 3a. ed. 2014 – em cores. São Paulo: Editora Livraria da Física. ISBN 978-85-7861-187-3. Disponível em: https://www.livrariadafisica.com.br/detalhe_produto.aspx?id=142840 Oliveira Filho, K. S., & Saraiva, M. F. O. *Hipertextos – Astronomia e Astrofísica*. Disponível em: http://astro.if.ufrgs.br/#gsc.tab=0 Santiago, B. et al. (Curadoria) (2009). *Catálogo da Exposição Em Casa, no Universo.* Museu da UFRGS. Saraiva, M. F. O. et al. (2008). *Astrofísica.* UFSC. ISBN 978-85-99379-57-8. **COMPLEMENTARY BIBLIOGRAPHY** Friaça, A. C. S. et al. (2001). *Astronomia*: uma visão geral do universo. São Paulo: Edusp. ISBN 978-85-314-0462-7. Disponível em: http://www.edusp.com.br/detlivro.asp?ID=607622 Karttunen, H. (2007). *Fundamental Astronomy.* Berlin: Springer. ISBN 9783540341444. Disponível em: http://dx.doi.org/10.1007/978-3-540-34144-4org. Lépine, J. R. D. (2008). *A Via Láctea:* nossa ilha no universo. São Paulo: EDUSP. ISBN 9788531410567. Disponível em: http://www.edusp.com.br/detlivro.asp?id=410567 Maciel, W. J. (2018). *Introdução à estrutura e evolução estelar.* São Paulo: Edusp. Viegas, S. M. M., & Oliveira, F. (2004). *Descobrindo o universo.* São Paulo: Edusp. ISBN 9788531407949. Disponível em: http://www.edusp.com.br/detlivro.asp?ID=40794931

Source: Own authorship.

Chart 3 enables us to see that most of the syllabi present Astronomy teaching elements intended for methodological procedures for teaching the Earth-Sun, Earth-Sun-Moon, and Universe System in general, despite not mentioning any basic bibliography for studies of these themes. On the other hand, the courses at UFRN and UFRGS present all the basic and complementary bibliographies for teaching Astronomy, and their syllabi are intended explicitly for elements of this Science.

The syllabus of the course "Astronomy and Education" (UFRN), in addition to several specific contents of Astronomy, also addresses the theme "Teaching Astronomy in Elementary and High School: Contents, Methodologies, and Practices." In the course offered by UFRGS, the proposal states that the teacher

will have a broad theoretical basis for Astronomy's elements. However, methodological aspects about how to teach these contents are not addressed.

Chart 3 highlights the syllabi of UFPA, UFT, UFBA, and UFG courses. The list of contents they make available makes us question whether the teacher trainer can work all the contents mentioned with average class hours of 60h. For example, the syllabus of the course "Fundamentals, Contents, and Methodology of Natural Sciences II" (UFG) mentions, among other themes, the methodological procedures related to the contents of the Natural Sciences: Botany, Zoology, Ecology, Environmental Education, and Astronomy. In addition, it discusses transversal themes, such as ethnic-racial education and environmental education. This course has class hours of 80 hours, which we consider very relevant. However, its syllabus intends to address the basic concepts of five different areas within the Natural Sciences and their methodological procedures and propose dealing with transversal themes cited. Faced with this reality, we ask ourselves: Can this course teach what it proposes with these class hours?

d) Comparison with contents indicated in the BNCC: The BNCC has been severely criticized for preserving in its ontology a consensus for philanthropy concerning the production of knowledge "[...] used by private foundations to obtain a consensus among multiple social and institutional actors to support a particular public policy [...]" (Tarlau & Moeller, 2020, p. 02). Veiga and Silva (2018), Flôr and Trópia (2018), and Franco and Munford (2018) also emphasize that the country's new official curriculum proposal represents a step backward concerning citizenship education, constituting itself as a document with an indoctrinator character. Likewise, Sacristán (2000) presents discussions that are still very current when analyzing the objectives of new curricular reforms, which are created "[...] in most cases, to adjust the school system to social needs better and, to a much lesser extent, to change it, although they can stimulate contradictions that provoke movements toward a new equilibrium" (Sacristán, 2000, p. 18). Despite everything, the new curriculum base in the country, the BNCC (MEC, 2028), is already in force for Elementary and Secondary Education, being the document that currently guides Basic Education. Thus, Elementary School I teachers (pedagogues) need to know Science teaching and the like to meet the document's request.

Thus, in this section, the following were compared: the teaching contents of Astronomy indicated in the National Common Curricular Base – BNCC (MEC, 2018); the thematic unit Earth and Universe for the initial years; and the contents in the syllabi of the six PPC analyzed, in an attempt to investigate the points of convergence and divergence that these documents – the first one designed for student training and the other for teacher training – adopt. Chart 4 presents the comparison mentioned above.

Chart 4. BNCC Astronomy contents versus Astronomy contents contained in the PPC analyzed

Year	BNCC CONTENTS	ASTRONOMY CONTENT IN PEDAGOGY SYLLABI
1st year	Time scales	Earth and Universe: Stars and phenomena of the Earth-Sun-Moon system used as orientation and everyday reference (UFPA). Analysis and textual interpretation, observation, experimentation, comparison, modeling, and field procedures for the teaching-learning of Astronomy (UFT). The Earth, the Solar System, and the Universe; Living beings and their relationship with each other and the Environment (UFBA). Conceptual and historical introduction to Astronomy and its dialogues with Education. Astronomical phenomena and human societies' organization of space, time, and life. Celestial sphere and coordinate systems. Astronomical laws: Kepler, Newton, and Einstein. Movements of celestial bodies. Study the solar system, stars, constellations, planets, and the known Universe. Astronomy in everyday observation: eclipses, moon phases, tides, and seasons. Astronomy and its relationship with living organisms. Astrogeography and Geoastrophysics: Approaches from Astronomy to Geography. Astronomical observation practices with and without instruments. The teaching of Astronomy in Elementary and High School: Contents, methodologies, and practices (UFRN). Basic concepts and methodological procedures related to the contents of Astronomy (UFG). Distance and time scales in the Universe. The Night Sky. Solar and extrasolar planets. Star evolution. White Dwarf Stars, Neutron Stars, and Black Holes. Galaxies. Quasars. Cosmology. Dark Matter. Dark Energy (UFRGS).
2nd year	Apparent motion of the Sun across the sky The Sun as a source of light and heat	
3rd year	Earth features Sky observation Land uses	
4th year	Cardinal points Calendars, cyclic phenomena, and culture	
5th year	Constellations and celestial maps Earth's rotational motion Periodicity of Moon phases Optical instruments	

Source: Own authorship.

It is possible to note that some elements converge in the selected syllabi and the BNCC. However, others are implicit and may be deleted, depending on how the syllabus is interpreted and the course taught. Some topics on the undergraduate syllabi are very general. It is not known, for example, whether the phenomena of the Earth-Sun-Moon System mentioned in the PPC at UFPA or the topic on Earth, Solar System, and Universe at UFBA address time scales, the Sun as a source of light and heat, among other items indicated by the BNCC. The UFG syllabus indicates the teaching of basic concepts of Astronomy. However, what is meant by "basic concepts" is not clear. In the UFT syllabus, when addressing observation and experimentation for teaching and learning in Astronomy, it is unclear what kind of experiments (or content related to them) will be carried out.

Although UFRN prepares a broad syllabus covering most of the elements indicated in the BNCC, optical instruments are not addressed. Concerning the UFRGS syllabus, while it discusses crucial topics in Astronomy, essential elements are not made explicit, such as the teaching of Earth rotation and periodicity of the Moon phases, which we imagine to be covered in the item "solar planets." Some more advanced content is indicated, which is essential for a better understanding of Astronomy by the student. However, it does not meet their immediate needs in the classroom.

Based on this analysis, we infer that such syllabi can contemplate the contents the pedagogue will need to teach. However, they could not be considered as they do not appear explicitly in the document. This same problem can occur when the teacher in charge of that course studies such a syllabus.

As already discussed, one of the gaps in the teachers' curriculum is the little importance given to astronomy teaching elements: only 9% of PPC from Brazilian federal universities express an incentive to include topics in the area in their syllabi, assuming a written curriculum. For Goodson (1997), it is necessary to remember that "[...] the written curriculum is the visible and public testimony of selected rationales and the legitimating rhetoric for schooling" (Goodson, 1997, p. 20). The relevance of assuming a curriculum that includes elements of Astronomy in the syllabi ends up constituting an added value to everything that involves this teaching.

Thus, studies that focus on teaching Astronomy are essential and required. They are indispensable for us to think more broadly about the (un)certainties of the Universe, our location (Milky Way, Solar System, Earth), and other theme-related subjects. Leite et al. (2021) investigated the justifications for teaching Astronomy, concluding that the main reasons for teaching this Science are related to sentimental, socio-historical-cultural issues and a greater understanding of the world and its interdisciplinarities. However, for actions in this direction, the first step is to include teaching Astronomy in all areas of Education curricula, especially in the teaching degree courses in Pedagogy, in which teachers who work in the initial years of Basic Education are trained.

We align ourselves with the arguments of Leite et al. (2021) and Langhi and Nardi (2015) in defending the learning that students (in general, and not specifically those in the early years) can achieve if introduced to Astronomy, such as preservation of the environment, sustainability, understanding of the world, and ability to make connections with other areas of knowledge that investigate the human being and our environment. In our view, learning would have positive effects if worked from the first years the children are exposed to Science, as Carvalho (2020) also defends.

e) Professionals: Another point to reflect concerns who built and/or is building the Astronomy teaching syllabi, consequently, the teaching of Science for the Pedagogy discipline. If they are Physics, Biology, or Chemistry teachers, would they prepare syllabi focusing on content related to the teaching levels in which the pedagogues will work (Early Childhood Education, early years of Elementary School, and Youth and Adult Education)?[4] Questions of this nature are present in the reflections of Sacristán (2000, p. 67) when he recognizes that "the courses and areas of knowledge that form the school curricula are, in many cases, arbitrary selections, without internal coherence, that do not transmit or cultivate the basic and genuine essence of each area."

We formulated other questions as Astronomy contents emerged in the courses, such as, for example, how and why were Astronomy contents included in the syllabi of the six courses? Are there teachers qualified to teach such Science? Could it be that, through the other Science contents presented in the six courses' syllabus, teachers can teach Astronomy content, using them interdisciplinary? Such questions echo in this research process since, in addition to a curriculum established in the document, this needs an action, i.e., to be implemented in the teacher training process.

In an attempt to understand what led the Pedagogy disciplines at the six universities[5] to adopt Astronomy content in their syllabi, we emailed the discipline coordinators at the time of the creation of the PPC. Of the six messages, we received only one reply from a coordinator, stating that she could not answer why the course was included in the PPC of Pedagogy. Thus, the message we emailed was forwarded to the Geography professor responsible for inserting the course in the discipline. However, after this episode, there was no more response. We constructed, therefore, the hypothesis that the insertion of the course in the Pedagogy discipline may have occurred due to the indication of professors who were in the Astronomy area or the influence of professors who had an affinity with the subject.

For the construction of the characterization of Astronomy teaching courses, we also evaluated external and internal elements of the PPC syllabi because "[...] analyzing concrete curricula means studying them in the context in which they are configured and through which they are expressed in educational practices and results" (Sacristán, 2000, p. 16). With this perspective, as an element external to the PPC, the faculty of the disciplines whose syllabi were identified with Astronomy content was investigated to observe whether

the professors develop research or are trained in Astronomy. However, we did not obtain expressive results: of the six institutions, only eight professors mentioned some activity related to Astronomy in their Lattes curriculum, such as participation in Boards (Undergraduate and Masters) of themes on Astronomy, or participation in extension activities involving Science teaching, without delimiting, however, a specific theme, or taught Science teaching courses in the Pedagogy discipline.

f) Graduate profile and discipline objectives: The profile of Pedagogy graduates and discipline objectives were investigated. The profile of graduates in the six institutions was noted to aim at training them to work at different levels of Education based on a critical perspective. There is also an emphasis on a profile focused on educational coordination and management, configuring a multiple training profile.

We infer that most of the speeches present in the profile of the graduate do not clarify the educational intention of this professional, as when they mention, for example, that "It is expected that the pedagogue has a broad understanding of the universe of culture and the production of knowledge" (UFG).

This happens concerning the objectives of the discipline, which expand to the "production and dissemination of scientific and technological knowledge in the educational field in school and non-school contexts" (UFT). In specific passages, the documents even state that they aim at the dissemination of scientific knowledge, which appears, however, very vaguely in the PPC, given that it does not indicate a clear definition of what is understood by scientific knowledge, nor does it clarify how they can relate to Science teaching.

g) Non-formal spaces: In addition to the investigation of the PPC and the teacher's initial curriculum, it can also be said that the analysis of everything that involves the curriculum is inevitable because elements external to formal education are also used for its creation, as is the case of non-formal education spaces (Langhi & Nardi, 2009), which can promote astronomy dissemination for teachers, favoring their understanding of the subject. Non-formal education is characterized by taking place outside the school space and, mainly, outside the school curriculum. While educational activities occur in non-formal spaces, the intentionality differs from Formal Education (Marandino, 2015), as there are no prerequisites, evaluations, or class hours to be fulfilled. Thus, based on the website of the Association of Brazilian Planetariums and the institutional websites of each of the six selected universities, a brief survey was carried out of the non-formal spaces that disseminate Astronomy and are located in the capitals where the six syllabi were collected.

All six universities present projects related to Astronomy's teaching and dissemination; only UFT does not have a planetarium. While UFPA also does not have this resource, the State University of Pará – whose headquarters are located in Belém, the same city where the UFPA Pedagogy discipline is offered – houses two planetariums, one fixed and the other mobile. Thus, it is understood that undergraduates can visit this type of place, even if they are not from the same institution. Therefore, it is possible to infer that, besides the course that addresses elements of Astronomy, other non-formal spaces of Astronomy Education are offered, such as planetariums, Astronomy clubs, and any other extension project in the area.

MAKING DISCUSSIONS ABOUT THE TEACHING OF ASTRONOMY

Given everything that was analyzed, from the reflections about the Science courses to the six syllabi related to the teaching of Astronomy, no justifications for the presence of such elements in the curriculum were evidenced. The professors' responses who participated in the decisions to implement the Astronomy teaching proposal could explain, or even indicate, a creation motivated by the particular interests of the professors, which would already be relevant data, according to the precepts of Sacristán (2000). However, even without such answers, we initially affirm, based on the theoretical framework used, that what is proposed (or imposed!) – be it laws that regulate Education, be it pedagogical projects designed for the curriculum of degree courses – corresponds to cultural selection of the curriculum, not demonstrating to escape this circumstance.

However, our first contact with the data allowed us to see that the teaching of Astronomy was thought of differently since Astronomy was not included in the six syllabi due to the cultural selection of the curriculum or because of the importance of this teaching in the initial training of teachers and Basic Education. Given this finding, we hypothesize that the creation of courses with Astronomy contents was planned by a professor who: either researched in the area (this seems more evident in the optional courses specifically aimed at teaching Astronomy) or a professor who taught the course of Sciences and wanted to include Astronomy teaching in the curriculum, even though he had not graduated in that area.

Even so, the choices of permanence of Astronomy teaching in the syllabi are still subjected to the influence of the curricular apparatus, i.e., linked to a code[6] (Sacristán, 2000). For example, this Science was contemplated in some of the syllabi analyzed, and in others (specifically in six courses), it became more evident. This suggests that "what is in effect at a given moment is still an uncertain product, which could have been otherwise, and which may be different both today and in the future" (Sacristán, 2000, p. 23). This situation leads us to the hypothesis, even in a subjective way, that the insertion of Astronomy contents in the syllabi may have been built by the interest of professors. Based on this hypothesis, it is possible to think that this scenario may change in the future, concerning the presence (more expressively, or less) of the teaching of this Science in Pedagogy PPC, through the elaboration of a new version of the document by other professors, that manifest other interests and other visions about it. [7]

We question whether the code chosen by the professors to insert Astronomy teaching in the PPC analyzed contemplates content views with the following:

> [...] students' learning possibilities, their interests, their way of learning; or that they are organized around globalizing units to make learning more meaningful; that they are arranged in a sequence that is considered most appropriate: spiral, linear, etc.; that the methods and courses are selected considering all these psychological and pedagogical factors, in addition to opting for principles such as the connection of formal learning with the student's previous experiences, with the cultural realities of the immediate environment, etc. (Sacristán, 2000, p. 84).

When these same questions about choosing Astronomy teaching content are placed concerning the guidelines that govern Basic Education (i.e., content that early-year teachers need to "know"), the insertion arguments are more evident: the conceptions used to teach elements of the thematic unit Earth and Universe (MEC, 2018), for example, when considering the importance, especially in the early years of Elementary School, of "[...] sharpening even more the curiosity of children for the phenomena natural resources and develop spatial thinking based on everyday experiences of observing the sky and related phenomena" (MEC, 2018, p. 328).

As a result, in the early years of Elementary School, the expectations regarding the teacher who teaches Science are that their students develop "[...] knowledge about the movement of the sky and the way we perceive and interpret them" (Carvalho & Ramos, 2000, p. 96).

FINAL NOTES

Based on what has been exposed, it is possible to infer that the training of pedagogues at the analyzed universities presents a considerable lack of issues associated with the teaching of Astronomy, which is a worrying fact since it is these professionals who will offer the first contact of students in the early years with Science and Astronomy.

Furthermore, even in disciplines where some astronomy elements were present, problems were encountered. It is important to emphasize that, of the Astronomy contents contemplated in the six analyzed syllabi, only a small part has points of convergence with the contents foreseen in the BNCC (MEC, 2018), which shows a lack of synchrony between what is studied in the degree course and what is sought to be taught in Basic Education.

The teacher's lack of contact with Astronomy in their initial training curriculum can lead to problems in their future teaching practice, among them the creation and/or potentialization of alternative conceptions about astronomical knowledge, which will be passed on to their students. Thus, it is clear that this is a complex educational issue, as it involves both professional training and the student's perception of Science in the early years. It is understood that there is a long way to go for including Astronomy Education in the curriculum of early-year teachers and, consequently, in the early-year classroom. Thus, it is necessary that the efforts made in the Pedagogy disciplines, which aim at a polyvalent training of the teacher, with the use of innovative teaching methodologies and theoretical foundations of learning, are aligned with the teaching of scientific content to promote an education critical science for children (not only in Astronomy), from the early years.

This research showed factual evidence that the mandatory curriculum matrices of Pedagogy disciplines at federal universities in the country's capitals, for the most part, do not offer Astronomy content for the initial training of teachers in the early years of Elementary School. This result has already been affirmed in most research, articles, and academic studies that focus on the insufficiency of astronomy elements in the training of teachers in the early years (Langhi & Nardi, 2005; Batista, 2016; Lopes, 2018). Our study, however, differs by presenting a national focus on the area.

The six courses that presented elements of Astronomy in their syllabi reveal some problems that may hinder their implementation in practice. For example, four contain a large amount of content for minimal class hours to teach them. Even so, they present the possibilities and characteristics of teaching Astronomy to the teacher of the initial years, which was not evidenced in the other 60 courses analyzed.

By taking on the opportunities of a course that includes Astronomy, curricular privileges are built for the formation of the pedagogue, with the contributions that this Science offers, especially when developed in an interdisciplinary way, making students aware of themes related to citizenship, environmental education, sustainability, geography, etc.

Thus, we suggest addressing this problem through the introduction of Astronomy content in Pedagogy disciplines based on the collaboration between the university and non-formal spaces that disseminate this Science since these have much to offer to teachers in all areas of teaching, including the early years, providing secure information and disseminating astronomical knowledge.

Finally, it is essential to emphasize the importance of teacher training being conducted not only for school management and for understanding teaching and learning methods but also for introducing children to the world of Science, as well indicated by Moraes, Lima, and Carvalho (2021), as it is on this first scientific experience – and, in this case, astronomical – that children's appreciation and future interest in Science depends. Thus, a lack of training in Astronomy in the pedagogue's graduation can lead to a deficit of scientific/astronomical training and a lack of interest in its students.

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Data Availability Statements

The dataset that supports the study will be made available in the Scielo EPEC dataverse.

NOTES

1 The documents were collected until the end of 2019.

2 The e-mec platform was used for consultation, which contains the accreditation of all duly regularized Higher Education courses in the country. Available at https://emec.mec.gov.br/. Accessed on: April 30, 2021.

3 The Science courses in this study involve: Teaching Science, Natural Sciences, Environmental Education, and Astronomy.

4 For this level of Education, the pedagogue works at the beginning of Stage 1, corresponding to Elementary School.

5 Federal University of Pará, Federal University of Tocantins, Federal University of Bahia, Federal University of Rio Grande do Norte, Federal University of Goiás, and Federal University of Rio Grande do Sul.

6 For Sacristán (2000), the code is characterized as elements, ideas, sequences, methodologies, etc., adopted in a curriculum for students and teachers.

7 It is essential to clarify that only the courses of the PPC of the federal universities were analyzed. We know that there are several state universities located in capitals and that they show an excellent incentive for Astronomy. However, they were not part of the chosen sample.

Thayná Cristina Dias e Dias
Master in Science and Mathematics Education. Doctoral student at the Graduate Program in Education for Science at the São Paulo State University "Júlio de Mesquita Filho" – UNESP (Bauru Campus), Brazil, São Paulo, Bauru, 17011-101.
E-mail: thayna.dias@unesp.br

Camilla Maria Sitko
PhD in Science Teaching and Mathematics Education. Adjunct Professor A at the Federal Technological University of Paraná – UTFP (Campo Mourão Campus), Brazil, Paraná, Campo Mourão, 87301-060.
E-mail: camilasitko@utfpr.edu.br

Rodolfo Langhi
Doctor in Education for Science. Assistant professor at the Physics Department of the Faculty of Sciences of the São Paulo State University "Júlio de Mesquita Filho" – UNESP (Bauru Campus), Brazil, São Paulo, Bauru, 17033-360.
E-mail: rodolfo.langhi@unesp.br

Institutional Address:
Thayná Cristina Dias e Dias
Programa de Pós-graduação em Educação para Ciência
Universidade Estadual Paulista
Bauru – SP | Brasil
CEP 17011-101

Publisher:
Geide Rosa Coelho

Contato:
Centro de Ensino de Ciências e Matemática de Minas Gerais – CECIMIG
Faculdade de Educação – Universidade Federal de Minas Gerais
revistaepec@gmail.com

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