International Council of Association for Science Education

REVIEW ARTICLE

The Relationship between Formal Education and Non-Formal Education: A Descriptive and Analytical Review of the Publications about Astronomy Education in Journals and Events Related to Science Teaching in the Brazilian Context

Isadora Moutinho Carvalho A. Menezes[1], Daniel Fernando Bovolenta Ovigli[2]*, Pedro Donizete Colombo Junior[2]

[1]Postgraduate Program in Science Education, Federal University of Itajubá (UNIFEI), Itajubá, Minas Gerais, Brazil, [2]Department of Science Education, Mathematics and Technologies, Federal University of the Triângulo Mineiro, Uberaba, Minas Gerais, Brazil

***Corresponding Author:** daniel.ovigli@uftm.edu.br

ABSTRACT

The present research aims to analyze the publications related to astronomy education that discusses the interface between formal education (FE) and non-FE (NFE) at scientific events and a journal in the Brazilian context. These events were the National Symposium on Astronomy Education, the National Meeting on Research in Science Education (ENPEC), and the National Symposium on Physics Teaching. We also analyzed the journal "Latin American Journal of Astronomy Education" (RELEA). The objective was to understand how the approach between FE and NFE in the teaching of astronomy is constructed. The delimitation of the analyses covering the period 2001–2014 coincided with the constitution of Area 46 by the Coordination of Improvement of Higher Education Personnel (CAPES), which regulates postgraduate programs in Brazil. In a theoretical-methodological aspect, the ideas of content analysis proposed by Bardin (2011) were adopted. Among the results, we observed that few studies dealt with the relationship between FE and NFE; however, almost half of them occurred in institutions commonly classified as FE (i.e., schools), and the actions were mediated by teachers. Among the main activities, we highlight the observations the sky, guided tours, and play activities, with more than 60% of the activities going through three moments proposed by Allard et al. (1994): Before, during, and after the accomplishment of the activity in a non-formal space. The results found in this research can foster reflections about teacher training courses since more and more NFE spaces are present in teaching-learning processes, but little has been done to associate FE and NFE in teaching practice. We discuss what difficulties are faced by teachers to approach FE and NFE.

KEY WORDS: education; astronomy; formal education; non-formal education relationship; content analysis

INTRODUCTION

In Brazil, the Complementary Educational Guidelines to the National Curricular Parameters (NCPs) state, among their objectives, the promotion of general competencies that articulate different learning contexts, disciplinary, or not, in which astronomy teaching is included (BRASIL, 2002). As such, "Universe, Earth, and Life" is one of the structural themes proposed for teaching physics in Brazilian high schools. The approach of this theme aims to develop content related to the proposed models for the origin, evolution and constitution of the universe, as well as themes related to Sun-Earth-Moon relationships, such as seasons of the year, movement of the planets in the solar system, phases of the moon, eclipses, and tides, among other astronomical phenomena (BRASIL, 2002).

In Brazil, as in the international context, different studies have been developed about this theme. Soler (2012) in the study "Astronomy in the Curriculum of the State of São Paulo and in the NCP: A review about the theme Sky Observation" discusses the main justifications used in different scientific papers in astronomy teaching. Among the results, the author highlights the six most cited decisive points. One, the theme is responsible for arousing feelings and concerns; two, sociocultural-historical relevance; three, broadening of worldview and awareness; four, interdisciplinarity; five, there exists deficiency in teacher training and misconceptions presented in textbooks; and six, students' and teachers' initial conceptions. To the author, there is a "common sense of the act of teaching and disseminating astronomy" (Soler, 2012. p. 33), the points were made from teaching practices and cannot be disregarded.

For Falk and Dierking (2000), learning involves a dialogue between the individual and the personal, sociocultural, and physical contexts in which he/she is inserted. Thus, part of the students' difficulties in assembling what is studied is the low contextualization that occurs in school. Langhi and Nardi (2012) pointed out, as one of the needs, developing activities related to astronomy education with the justification that this area of science is present in our daily lives (as in the succession of days, seasons, etc.), regardless of sociopolitical

conditions, and it influenced - and still influences - several areas of knowledge (physics, biology, literature, etc.). However, as stated by Aroca et al. (2012), when subjects related to astronomy were discussed, they rarely go beyond what was contained in textbooks; that is, it is not common to use interactive and practical activities (experiments and/or observations) to approach this topic.

Regarding the advantages of teaching content related to astronomy, some research also points to the importance of including in the topics taught in science class activities in non-formal education (NFE) spaces, for example, visits to science centers, like astronomical and planetary observatories. NFE spaces allow for different articulations between content, the contemplation of different rhythms of learning, and the privileging of collective learning, unlike the perspectives normally adopted by schools. We must also consider that in recent decades there has been a significant increase in research that discusses scientific education in Brazil and the teaching of astronomy, taking significant proportions in the production of knowledge and providing subsidies for the improvement of education in the country, whether in scope of teacher training or school practices. In addition, they open a way for the necessity of periodical studies of bibliographical revision about this production.

In the Brazilian context, there are few studies that address the relationship between FE and NFE environments, especially in astronomy teaching. Even though the study of this partnership is the focus of several discussions about improvements in basic education (Colombo Junior et al., 2015), there are a few situations in which the FE and NFE partnership occurs in a satisfactory way (Allard and Boucher, 1998).

We agree with Langhi and Nardi (2009) for whom the subjects related to astronomy have great potential for development, either by the possibility of a partnership between school and astronomical communities (professional and/or amateur) or due to easy access to the study "laboratory" - the sky-enabling observations. It is also supported by the creation of astronomy clubs, proposals for activities that use scientific dissemination products (books, films, videos, etc.), and observations of the sky as incentives for the study of astronomy.

This study aimed to understand how the research and integration between FE and NFE related to astronomy education in Brazil have taken place. The objective was to undertake a study that analyzed what has been published in the area of astronomy teaching in three main scientific events concerning astronomy education and the main relevant Brazilian periodical, in the light of content analysis (as proposed) by Bardin (2011). Based on Bardin's (2011) proposal for content analysis, we categorized and described studies according to the thematic focus of the research, developing a critical analysis about how the partnership between FE and NFE in astronomy teaching was constructed, and considered the theoretical assumptions of Allard et al. (1994) in the face of the identified research.

An analysis of publications on the teaching of astronomy was carried out on three national events: The National Symposium of Astronomy (SNEA), National Meeting of Research in Science Education (ENPEC), and National Symposium of Physics Teaching (SNEF). We also analyzed the journal Latin American Journal of Astronomy Education (RELEA). The intention was to try to understand how the relationship between FE and NFE in astronomy teaching was constructed and how this had been reported in the publications of the events (through published event proceedings) and the aforementioned journal, RELEA. Considering the Brazilian context, scientific events related to astronomy teaching, such as the SNEA, are relatively recent therefore, ENPEC and SNEF helped complement the scope of analysis of the journal (RELEA) dedicated exclusively to works focusing on astronomy teaching.

The choice of these academic events and the journal was based on three factors. First, SNEF and ENPEC traditionally include publications in the area of astronomy teaching. Second, SNEA has been consolidated as an important congress that discusses astronomy teaching. Third, RELEA, launched a decade ago, has been discussing and fostering discussions about astronomy teaching as a specialized journal on the subject.

From a study that we characterize as being a "knowledge state," the methodological aspect adopted by the present research was quantitative and qualitative (Bogdan and Biklen, 1994), which allows us to point out paths that have been taken and aspects that are addressed in the work under analysis. In general, the research can be understood in two distinct, but correlated phases: (i) Survey and classification of the papers found in the different media surveyed and (ii) content analysis of selected papers in the FE-NFE partnership.

THEORETICAL FRAME

Dichotomy between FE and NFE

There is no full agreement on what defines NFE, and it is common to assume as determining points the environment in which the activities or approaches carried out in the development of a given activity occur. There are authors who use the place of occurrence to delimit the type of education, determining that FE necessarily occurs within the educational institution and NFE outside these institutions (Gohn, 2006; Vieira et al., 2005). Others argue that the physical delimitation itself is not able to determine the theoretical basis and methodological characteristics and thus characterizes the type of teaching (Gadotti, 2005; Jacobucci, 2008).

In this study, to characterize FE and NFE, in agreement with the ideas of Gadotti (2005) and Jacobucci (2006; 2008), we do not consider that the environment (school, museum, observatories, Internet, etc.) is the decisive factor in the classification of the type of education. Additionally, the intentionality and the methodology adopted by the mediator (agent responsible for conducting the NFE activity is able to be a monitor and/or teacher) are essential for a categorization. In FE, intentionality is usually marked by formality, regularity, and sequentiality

since NFE is characterized by discontinuity, eventuality, and informality.

For example, Vilaça et al. (2013) presented a planetarium as an environment for the development of possible FE activities (continuous teacher training), NFE (guided visits for school attendance), and scientific dissemination (service to the public). Considering the above example, the school space was also delimited as a possible welcoming place for NFE activities.

We agree that the school can welcome NFE activities, commonly mediated by the teacher, and in line with the school's FE activities, for example: Theater, games, and knowledge fairs are activities that can occur within the school and characterize the partnership between FE and NFE, and in astronomy teaching, sky observation activities are common as an intermediary of this dichotomy.

Even without a consensus definition of NFE, for our classifications, we consider the ideas expressed by Gadotti (2005), who argued that such education can happen in schools:

NFE is more diffuse, less hierarchical, and less bureaucratic. NFE programs need not necessarily follow a sequential and hierarchical "progression" system. They may be of variable duration and may or may not grant learning certificates. (p. 2).

In this paper, we adopt as non-formal activities those less hierarchical, in which there is a "horizontal" relationship between mediator and students, and usually happens collectively (Braund & Reiss, 2006). Activities may vary in length, and the place where they occur is not decisive for classifying it as formal or non-formal, so non-formal activities may occur at school. Intentionality and planning are characteristic features of these non-formal activities. The evaluation process of performance is not traditional, with the distribution of grades to determine the level of learning.

The Content Analysis according to Bardin

Content analysis, according to Bardin (2011), is a "set of communication analysis techniques that uses systematic procedures and objectives to describe the content of messages" (p. 44). These analytical techniques aim to understand the documents through the processes of description, inference, and interpretation of the characteristics of the text. The description process is given by the succinct enumeration of main characteristics of the analyzed sample; inference is comprised of the procedures of logical deduction about the knowledge expressed by the message; and the interpretation, the last phase of the analysis process, is the meaning given to the characteristics of the object of study.

The amount and diversity of documents that can be submitted to content analysis, which can belong to several domains of communication (Bardin, 2011), are comparable to the number of people involved in the communication as well as the nature of the message support. The code - a sign system used to represent and transmit information (Portuguese language or LIBRAS, Morse code, etc.) - and support can be linguistic (written or oral), iconic (images, signs, etc.), and/or other semiotic codes (music, behaviors, etc.). The number of people involved in the communication can be one (monologue), two (interviews, letters, etc.), restricted group (group conversations, interviews, etc.), or mass communication (books, films, etc.).

The content analysis, according to Bardin (2011), is widely diffused in the educational environment, being adopted for the analysis of different types of materials, such as: Interviews (Castro, 2007; Conte, 2013; Kapitango-A-Samba, 2011), questionnaires (Miranda, 2013), or evaluation applied in courses (Aguilar, 2011), and also with a software as an aid to do the analysis (Iberico, 2014).

Regardless of the type of material submitted to the analysis, the content analysis must include the "three time poles" of pre-analysis, material exploration and treatment of results, and inferences and interpretation (Bardin, 2011). Although for the accomplishment of content analysis, the categorization process is not obligatory, it is (nonetheless) commonly developed:

[...] An operation to classify constitutive elements of a set, by differentiation and then, by regrouping according to the genus (analogy), with the previously defined criteria. The categories are rubrics or classes, which bring together a group of elements (record units, in the case of content analysis) under a generic title, grouping made due to the common characters of these elements (Bardin, 2011, p. 147).

Bardin (2011) points out that to define categories it is necessary to go through the processes of inventorying (when isolating the elements studied) and classification (assigning organization to messages). The categories are efficient and relevant when the same element of the study is not compatible in more than one of them and when they are adapted to the material of analysis and do not allow subjectivities. The process of categorization leads to the investigation and inferences of variables (causes) whose effects are taken from the analyzed object and thus permits interpretations mediated by the methodology.

In the present study, the pre-analysis process was based on the choice of the study material. That is, the works were initially selected within the given period, from 2001 to 2014. The delimitation of the analyses covered this temporal cut to resonate with the creation of Area 46 by the Coordination for the Improvement of Higher Education Personnel (CAPES), which regulates postgraduate programs in Brazil. Subsequently, papers were chosen whose subject is related to astronomy, and specially those papers which deal with the dichotomy between FE and NFE In the course of the analysis, an article could not be allocated to more than one category (FE, NFE, and approach between FE and NFE).

Even if the definition of NFE is not unanimous, here we delimit as activities which characterize such a model of education based on Gadotti (2005) and other authors, and cited above - this first category of analysis employed the "box process" that is, the categories were previously defined. In the classifications that happened later - when only the articles that

deal with the FE-NFE approach in astronomy teaching were analyzed - we made use of "procedure by collection," and the categories were determined after the study of the material.

For the analysis of the FE-NFE approach, we also support the ideas brought by Allard (1999) as a theoretical-methodological reference. According to the author, the Formal-Non-Formal dichotomy requires three moments: Before, during, and after the accomplishment of the characterized NFE activity. Even though all activities take place within the school, NFE activities have a less rigid and less hierarchical character, and therefore, it is possible to distinguish the steps of approach between FE and NFE.

The first moment is the preparation, usually carried out in the classroom, for the practice of non-formal activity. To make a connection between the objects of study, the students are given reasons for the visit (or realization of the observation, game, etc.), at which moment there is development of questions to be researched. During the NFE activity, observation, and discussion of the study objects, data collection and discussion with peers and teachers are done, and such actions may occur in science centers, observatories, museums, etc., and at school. The last process, with the return to the classroom, deals with the resumption of topics worked in both environments and aims at appropriating the object of the study by the students.

RESULTS AND DISCUSSION

Due to the specificities of this study, it was decided to make a temporal cut from the creation, in 2001, of the Area 46 (teaching) by CAPES, linked to the Brazilian Ministry of Education and regulates postgraduate programs. The Area 46 (teaching) is constituted, along general lines, by the science teaching (Physics, Chemistry, Astronomy, etc.) and Mathematics.

In view of the analyses of ENPEC 2001–2014 and SNEF 2001-2014, there were periods when few or no papers were published. This was in part the justification for RELEA beginning its publications in 2004 and SNEA starting in 2011. In addition, the major events SNEF and ENPEC are biannual. The total number of publications can be seen in Table 1.

The total number of articles published in these events and journal shown a total of 8664 articles (Table 1) with ENPEC the largest number of articles (61.7%) related to the theme. It should be noted that publications quadrupled since the 3rd ENPEC in 2001 through the 9th ENPEC in 2013, evidencing the growth in the number of research that has been developed in the national context. This is an important result when we understand that this event brings together many teachers working in Brazilian Basic Education that seeks through participation in events to discuss their practices as well as engage in ongoing professional development.

After this initial analysis, a survey of the papers related to the theme of astronomy was carried out. For the preparation of Table 2 and determination of which papers would fit as publications related to the topic of astronomy, the titles of all the publications were read and summarized. Table 2 covers all the papers of the RELEA journal and the SNEA symposium since both are dedicated to disseminating works on astronomy teaching.

ENPEC presented the largest number of publications. However, the work related to astronomy does not exceed 2% of the total number of published articles, and in 2013, the year with the highest percentage, astronomy-related articles reached only 2.36% of the total publications.

Table 1: Total publications of the four events chosen in the period delimited for analysis (2001–2014)

Year	Journal				
	RELEA	SNEA	ENPEC	SNEF	Total
2001	-	-	233	226	459
2002	-	-	-	-	00
2003	-	-	451	391	842
2004	05	-	-	-	05
2005	05	-	738	462	1205
2006	03	-	-	-	03
2007	05	-	958	298	1261
2008	07	-	-	-	07
2009	08	-	799	410	1217
2010	07	-	-	-	07
2011	08	98	1235	417	1758
2012	08	88	-	-	96
2013	09	-	1060	600	1669
2014	12	123	-	-	135
Total	77	309	5474	2804	8.664

The hyphen (-) indication refers to the fact that in that period there was no promotion of the event and/or periodical

Table 2: Total publications, within the period delimited for analysis (2001–2014), of the events RELEA, SNEA, ENPEC, and SNEF that address astronomy subjects

Year	Journal				
	RELEA	SNEA	ENPEC	SNEF	Total
2001	-	-	05	19	24
2002	-	-	-	-	00
2003	-	-	08	21	29
2004	05	-	-	-	05
2005	05	-	13	21	39
2006	03	-	-	-	03
2007	05	-	10	22	37
2008	07	-	-	-	07
2009	08	-	12	15	35
2010	07	-	-	-	07
2011	08	98	16	45	167
2012	08	88	-	-	96
2013	09	00	25	47	81
2014	12	123	-	-	135
Total	77	309	89	190	665

In addition, approximately only 7% of the total papers presented in SNEF related to astronomy. However, in 2011, this percentage exceeded 10% of published articles. It can be inferred from the results obtained that most of the papers presented at these events did not generate scientific articles in specialized national journals, such as RELEA. As noted, RELEA is the only magazine in Brazil that works specifically with the teaching astronomy theme.

In connection with Table 2, a survey of the number of papers found and the geographic location of their production indicated that more than half (58%) of the papers analyzed were developed in the Southeast region of Brazil and that the region with the second most publications was the South, with 22%. These are the regions with the highest HDI (United Nations Human Development Index, which analyzes the quality of life of a given population).

The analysis also showed that 5% of the publications came from other countries (Spain, Argentina, etc.), outnumbering the publications of the North region (1%) and approaching the Northeast (7%) and Central West regions (7%) [Figure 1].

An indication of the reduced number of papers addressing astronomy subjects may be due to the small number of undergraduate physics courses where at least one astronomy subject is considered compulsory. Justiniano et al. (2012) observed that only 12% of the 47 Brazilian federal universities analyzed by them had undergraduate degrees in physics and the four that had science courses with a degree in physics have at least one astronomy discipline as a regular feature. None of them were located in the Midwest and North regions.

From the papers that were related to the astronomy theme, we classified the types of education in FE, NFE, and those that presented the FE/NFE approach [Table 3].

Comparing the total value presented in Table 3 with the amount in Table 2, the absence of 167 papers (related to the SNEF and SNEA events) should be noted because the classification of the type of education (relationship FE-NFE) was publications whose full papers were not available to the researchers. These abstracts were excluded because it was impossible, only with the information contained in them, to carry out the analyses mentioned, regarding the development of FE-NFE approach activities. Note that the SNEA does not provide much of the work because, in general, the event makes it optional to submit a complete paper for authors who will not participate with oral presentations. As an example, we pointed out that in the 3rd SNEA (2014) of the 123 accepted, 80 papers presented only an abstract and therefore were removed from the scope of analysis. In some editions of the SNEF (2001 and 2003), the sites did not offer the works or only offered the abstracts.

The published papers dealing with astronomy were initially classified into three categories: FE, NFE, and FE-NFE. Some examples of those that have been characterized as FE dealt with: Theoretical deepening in certain contents of astronomy; traditional and basically expository didactic proposals; survey

Table 3: Classification of RELEA, SNEA, ENPEC, and SNEF journals in approach on FE, NFE, and relationship of FE-NFE[1]

Journal	Type of education			
	FE	NFE	Relationship FE-NFE	Total (%)
RELEA	46	11	20	77 (100)
SNEF	96	23	29	148 (78)
SNEA	104	61	23	188 (61)
ENPEC	49	20	20	89 (100)
Total	294	115	92	502

NF: Formal education, NFE: Non-formal education

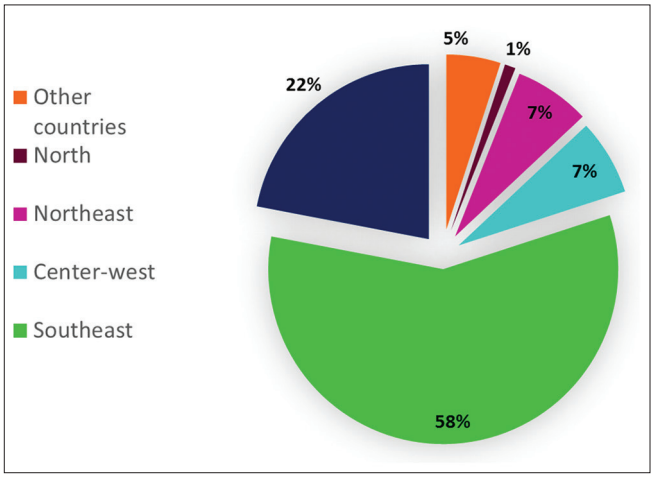

Figure 1: Regions of origin of the publications whose subject deals with astronomy

of the initial students' conceptions or teachers; content analysis of textbooks; states of art; distance learning courses; etc. We emphasize that the place is not a determining factor for the classification of the type of education, and the proposals of distance education analyzed were characterized by the rigid planning of activities, followed by habitual performance evaluations, with questionnaires and discussions in forums. For example, Mota (2012) article "Astronomy and Astrophysics in High School: A proposal for a distance course to aid in the verification of operative invariants" said "[…] the option for distance learning is justified by the need to investigate the performance of adolescents, accustomed to the digital world" (p. 134).

The papers categorized as NFE dealt with surveys done in NFE spaces, about guides on how to conduct a NFE activity (such as games or astrophotography), presenting techniques, and procedures for the operation of the activity, without better detailing the practices that were proposed concomitantly with the FE activities. In addition, this classification included activities in which - even if developed with students of elementary, middle, and high school - the only step was done in museums, planetariums, science centers, etc. At the end of this first classification, the FE-NFE approach category was composed of activities that approximated classes with

astronomy content to observations of the sky, guided tours, games, theater, science fairs, etc.

Nevertheless, the analysis of Table 3 shows that the number of publications that were dedicated to sharing experiences and research in FE is much higher when compared to the number of papers that seek to share knowledge about FE-NFE. In the events and the journal analyzed, the percentage of papers classified as FE-NFE in the astronomy theme exceeds 26%. In SNEA - a symposium dedicated to discussions in the field of astronomy teaching - this percentage of papers on the FE-NFE approach does not exceed 13%.

For the analysis and classifications, 92 papers were considered that dealt with FE-NFE and were considered characteristics of the activities explained by these papers, among them:

i. What types of activity characterized these types of education;
ii. What is the target audience for the activities;
iii. Where they occur to FE-NFE Approach activities;
iv. Who was the mediator of non-formal activities;
v. Structuring moments for the dichotomy between FE and NFE according to Allard et al., (1994).

Figure 2 highlights what FE-NFE approach activities were developed or proposed and these were presented in the papers analyzed. For this analysis [Figures 2-5], the categories were created after the data collection and analysis, which Bardin (2011) named as text categorization. Such a categorization process was done in this way to avoid omitting information. Figure 2 is related to the types of activities developed during the formal education (FE)-non-FE approach.

The Guided Tours category, corresponding to 21% of the activities, consisted of guided visits in museums, planetariums, science centers, and/or observatories. A few activities (2%) used a mobile planetarium. These happened inside schools and at science fairs. In the Leisure Activity category (18%), the educational activities were games, theater, and video production. It is evident in Figure 2 that more than 50% of the activities were sky observations, which occurred in school environments. Of these, 47% were at night, 43% during the daytime, and 10% for both night and day observations.

Many proposals for daytime observations were directed to students of primary and secondary education, who represented the majority of the target audience (77%), as shown in Figure 3.

While basic education (i.e., elementary and high school) students were the majority (77%), it is interesting to note that there were a few proposals (2%) aimed at students of adult and youth education (EJA). Also of interest is that only 7% were aimed at higher education students. This low number of proposals may be related to what has already been stated about the limited number of undergraduate courses in physics that have astronomy in the disciplines studied.

One possibility related to the dichotomy between FE and NFE can be the star observations. However, these must be systematic and accompanied by theoretical studies. Nevertheless, according to Leite (2002), teachers often present conceptions very close to those that are presented by students, usually exposing representations from a geocentric view. Problems in teacher training and discouragement from the subject can help

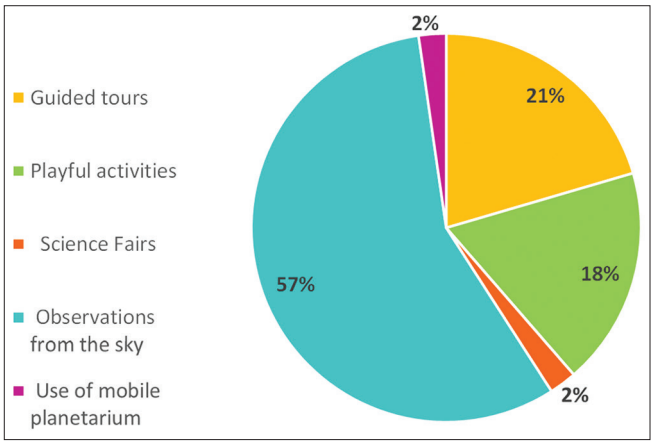

Figure 2: List of types of activities developed during the formal education (FE)-non-FE approach

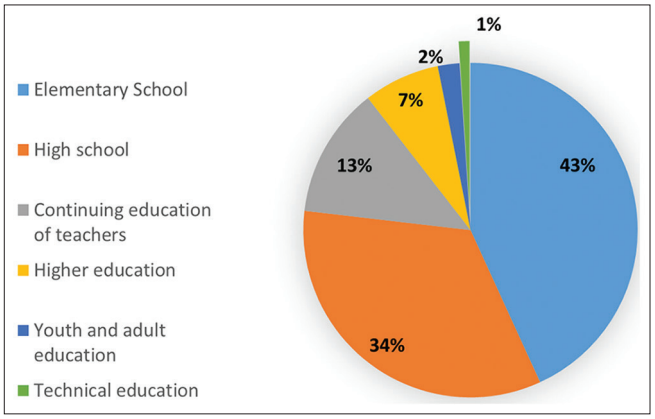

Figure 3: Target audience of formal education (FE)-non-FE approach activities

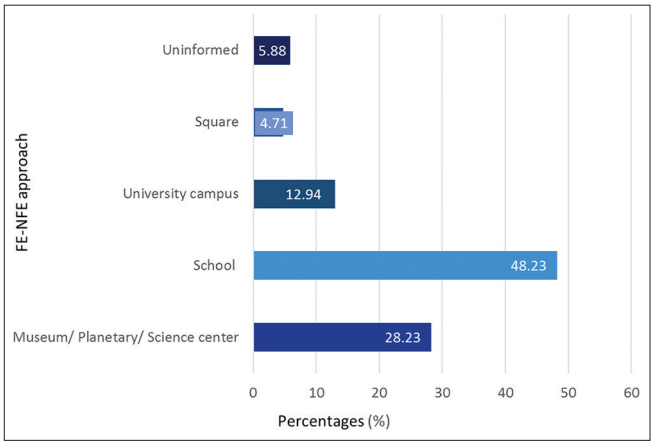

Figure 4: Spaces where formal education (FE)-non-FE approach activities occur

explain/account for the small number of teachers who choose to perform these activities in schools.

As shown in Figure 4, almost 50% of the proposals for NFE activities took place within educational institutions. Therefore, it would be reasonable to expect that the students' teacher would intervene as a mediator; this did in fact happen in 49% of the 92 works analyzed. Although it seems to be a high number, this set was only 10% of the total (502 works) that dealt with astronomy.

As seen in Figure 4, <30% of these activities occurred in museums, planetariums, science centers, or observatories. This result is worrisome since in Brazil the most frequent visitors to places such as planetariums and astronomical observatories are public schools. Visits to institutions such as museums, planetariums, and science centers are important to the science learning and the personal growth of the student through their interactions with their peers in these sociocultural interactions (Griffin, 2004; Marandino, 2001), only 28.23% of the proposed activities took place in these environments. For the analysis of the person in charge of the mediation in activities presented in the analyzed publications, the following categories were noted: Teacher, professor–researcher, monitor (museum, science center, etc., also called mediator), undergraduate/extension student, member of the astronomy club, and not specified. Figure 5 shows the percentage of papers according to each category.

As shown in Figure 5, almost half of the activities were mediated by the teacher, which is consistent with the amount of activities proposed in schools. In our categorization, professor–researcher in general was the one who performed these activities in partnership with the regular teacher or the one who provided continuing teacher training courses. These were responsible for 19% of the mediations between the FE and NFE. Monitors of museums, center of sciences, planetariums, etc. corresponded to 18% of the proposals analyzed. A little less than 10% corresponded to undergraduate students; in some cases, they are students of the Institutional Program for Scholarships for Initiation in Teaching (PIBID), who carried out the mediation of non-formal activities.

As previously reported, Allard et al. (1994) indicated three essential stages in the FE-NFE approach: Preparation that preceded a non-formal activity, realization of the non-formal practice, and finally, the resumption (in classroom) of the questions worked. Therefore, Figure 6 shows the percentage of work performed by the different FE-NFE approach moments: Before, during, and after activities; only during activities; and in only two moments, before and during or during and after NFE activity.

Figure 6 indicates that more than 60% of the analyzed papers developed the three stages when they proposed FE-NFE approaches in astronomy teaching. Approximately 74% of the sky observation activities went through the three FE moments (before, during, and after). The other activities include only two of the moments (before and during or during and after).

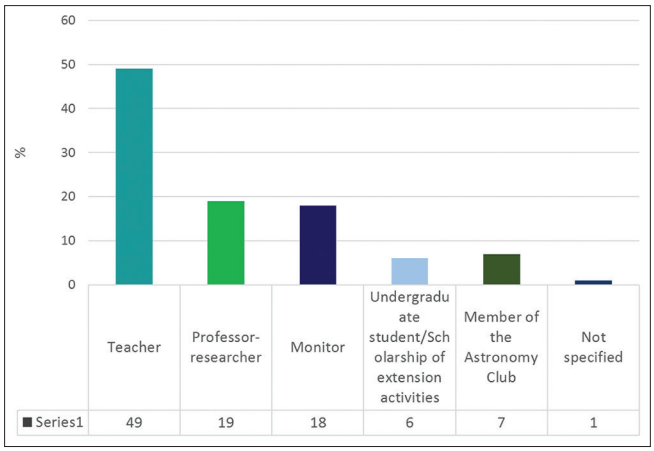

Figure 5: Formal education (FE)-non-FE approach activities mediator

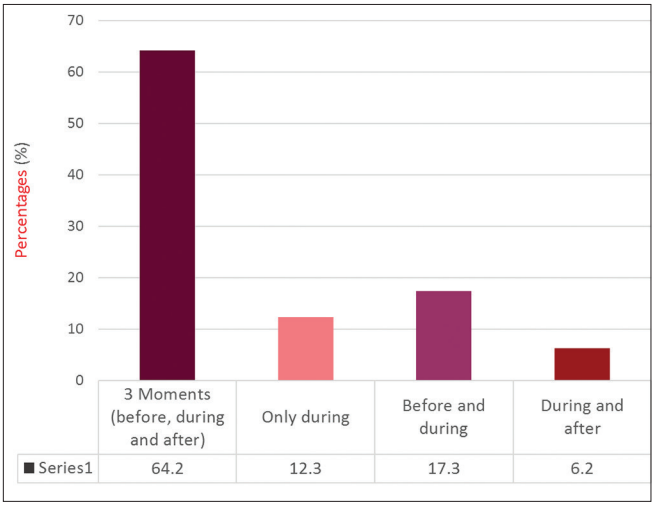

Figure 6: Temporal stages of the formal education (FE)-non-FE approach structuring process

Activities that indicated only two stages of the FE-NFE approach process usually initiated or finalized the didactic proposals with sky observation activities. Those proposals that showed development of activities only during the FE-NFE approach were related to play activities, usually games played with students of basic education.

With the analysis of the publications, we noted that there were few proposals that intended to make the FE-NFE approach through astronomy contents, compared to the initial amount. However, most of those who worked on the FE-NFE dichotomy performed the three temporal stages of the activity structuring process proposed by Allard et al. (1994).

Final Considerations

This research aimed to carry out a descriptive and analytical study, using content analysis (Bardin, 2011), of the publications on astronomy teaching in periodicals and events in the area of science teaching in Brazil concerning FE and NFE. For this purpose, we analyzed the publications of the SNEA, the National Meeting on Research in Science Education (ENPEC), and the National Symposium on Physics Education (SNEF), as

well as the Latin American Journal of Astronomy Education (RELEA) journal. We sought to understand which types of activity characterized the FE-NFE approach process, the target audience, and mediator of the proposals, the physical space where the activities took place in and how the possible dichotomy between FE and NFE occurs, according to Allard et al. (1994).

The survey and initial classification of the papers found in the different media surveyed revealed that few papers published in the periodical and in the analyzed events were related to astronomy teaching, about 7.7% of the publications. Of the publications that dealt with subjects related to astronomy, just under 20% presented proposals in the relationship between FE and NFE. We concluded that there were few studies that dealt with astronomy teaching and that, even in traditional events of physics education, such as SNEF, few publications addressed this relation.

Considering that astronomy teaching, by recommendations of the NCPs, is part of the curriculum of elementary and secondary education in Brazil, we were still startled when we looked at the national level. It is important to reflect on the results found. Although they demonstrate that, for the most part, the FE-NFE approach activities were directed to students of basic education and that the mediation of these activities was usually done by the teacher, this amount did not exceed 1% of the total of publications. However, on the other hand, of the 92 studies covering the FE-NFE approach, more than 60% included the three stages (before, during, and after) proposed by Allard et al. (1994) in astronomy teaching.

In addition, we conclude that content analysis has proved to be a very fruitful tool/method of analysis for the work we intended to do, allowing us to observe, for example, the FE-NFE approach proposals. This study highlighted that for the most part, these take place in schools, are directed to students of basic education, and are commonly addressed through observations from the sky, and the work in general does not present the difficulties in working with the FE-NFE relationship.

Finally, we understand that the results found in this research can foster reflections about science teaching and scientific work on at least two fronts. The first refers to the research field. Our results show that the research in the Brazilian context concerning the investigation about the relationship between FE and NFE is still small. Contrary to this point, in recent years, we have experienced in Brazil a continuous growth of NFE institutions, such as observatories and science centers. In this context, we understand that it is necessary to narrow the relations between EF and NFE and the research field.

The second point reflects the teaching practice. It is known that around the world the most frequent visitors of the NFE spaces are public schools. It is also a fact that teachers usually develop extra classroom activities with their students. However, our results demonstrate that the relationship between EF and NFE was not a consideration in some teacher actions. We argue that the teaching and learning process is not only linked to the classrooms, because we learn continuously and in different educational spaces.

With the above, this research, presenting only part of the relationship of the FE and NFE interactions, reflects a step toward the awareness of teachers and researchers about the importance of considering this approach to maximize scientific education for everyone. Furthermore, for improvement in science education, this research highlights the need for teacher training courses inserting such discussions in initial teacher training of the future teacher.

REFERENCES

Aguilar, M.B.R. (2011). *Representações Sociais de Alunos Secundaristas do Timor-Leste Quanto à Dimensão Escolar da Química.* São Paulo: Dissertação de Mestrado-Instituto de Física, Instituto de Química, Instituto de Biociências, Faculdade de Educação - Universidade de São Paulo.

Allard, M. (1999). Le partenariat ecole-musee: Quelques pistes de réflexion. *ASTER: Recherches en Didactique des Sciences Expérimentales*, 29, 27-40.

Allard, M., & Boucher, S. (1998). *Éduquer au musée: Un módele théorique de pédagogie muséale.* (Cahiers du Québec; CQ119. Collection Psychopédagogie), Québec: Hurtubise HMH.

Allard, M., Boucher, S., & Forest, L. (1994). The Museum and the School. *McGill Journal of Education*, 29(2), 1-17.

Aroca, S.C., Colombo Junior, P.D., & Silva, C.C. (2012). Tópicos de física solar no ensino médio: Análise de um curso com atividades práticas no Observatório Dietrich Schiel. *Revista Latino-Americana de Educação em Astronomia*, 14, 7-25.

Bardin, L. (2011). *Análise de Conteúdo*. Portugal: Edições. pp. 70.

Bogdan, R., & Biklen, S. (1994). *Investigação Qualitativa em Educação-Uma Introdução à Teoria e aos Métodos.* Porto Alegre: Porto Editora.

Braund, M., & Reiss, M. (2006). Towards a more authentic science curriculum: The contribution of out-of-school learning. *International Journal of Science Educatio*n, 28(12), 1373-1388.

Castro, A.M. (2007). *A Avaliação da Aprendizagem no Contexto da Inclusão de Alunos com Necessidades Educacionais Especiais na Escola Pública.* (Tese de Doutorado). São Paulo: FEUSP.

Colombo Junior, P.D., Ovigli, D.F.B., & Lourenco, A.B. (2015). *The school-museum partnership in Brazil: What does researches says?* 17th Annual International Conference on Education. ATINER's Conference Paper Series EDU2015-1695. Atenas, Grécia: Athens Institute for Education and Research. pp. 3-12.

Conte, K.M. (2013). *Espaço formativo da docência do ensino superior: Um estudo a partir do Programa de Aperfeiçoamento de Ensino (PAE) da Universidade de São Paulo.* (Tese de Doutorado). São Paulo: Faculdade de Educação, Universidade de São Paulo.

Falk, J., & Dierking, L. (2000). *Learning from Museums. Visitor Experiences and the Making of Meaning*. Lanham: Altamira Press.

Gadotti, M. (2005). *A Questão da Educação Formal/Não-formal*. Vol. 01. Sion: Institut Internacional des Droits de l Enfant. pp. 1-11.

Gohn, M.G. (2006). Educação não-formal, participação da sociedade civil e estruturas colegiadas nas escolas. *Rio de Janeiro: Revista Ensaio-Avaliação e Políticas Públicas em Educação*, 14(50), 11-25.

Griffin, J. (2004). Research on students and museums: Looking more closely at students in school groups. *Science Education,* 88, S59-S70.

Iberico, A.M.F. (2014). *Educação para a cidadania na escola: Representações de professores de ensino médio*. São Paulo: Dissertação (Mestrado)-Faculdade de Educação, Universidade de São Paulo.

Jacobucci, D.F.C. (2006). *A Formação Continuada de Professores em Centros e Museus de Ciências no Brasil.* Campinas: Tese de Doutorado, Faculdade de Educação, Universidade Estadual de Campinas.

Jacobucci, D.F.C. (2008). Contribuições dos espaços não-formais de educação para a formação da cultura científica. *Em Extensão*, 7, 55-66.

Justiniano, A., Germinaro, D.R., Reis, T.H., & Cândito, S.D. (2012).

Disciplinas de Astronomia nos Cursos de Formação de Professores das Universidades Federais. São Paulo: II Simpósio Nacional de Educação em Astronomia (SNEA). pp. 262-268.

Kapitango-A-Samba, K.K. (2011). *História e Filosofia da Ciência no Ensino de Ciências Naturais: o consenso e as perspectivas a partir de documentos oficiais, pesquisas e visões dos formadores*. São Paulo: Tese (Doutorado)-Faculdade de Educação, Universidade de São Paulo-USP.

Langhi, R., & Nardi, R. (2009). Ensino da astronomia no Brasil: educação formal, informal, não formal e divulgação científica. *Revista Brasileira de Ensino de Física*, 31(4), 4402-11.

Langhi, R., & Nardi, R. (2012). *Educação em Astronomia*: *Repensando a Formação de Professores*. Brasil: Escrituras.

Leite, C. (2002). *Os professores de ciências e suas formas de pensar a Astronomia.* São Paulo: Dissertação (Mestrado em Educação), Instituto de Física e Faculdade de Educação, USP.

Marandino, M. (2001). Interfaces na Relação Museu-Escola. *Caderno Catarinense de Ensino de Física*, 8(1), 85-100.

Ministério da Educação (BRASIL). (2002). *PCN+ Ensino Médio***:** *Orientações Educacionais Complementares aos Parâmetros Curriculares Nacionais Para o Ensino Médio.* Brasília: Ciências da Natureza, Matemática e suas Tecnologias.

Miranda, C.L. (2013), *As representações sociais de licenciandos em Química sobre "Ser Professor".* São Paulo: Dissertação (Mestrado) Apresentada aos Institutos de Física, Química, Biociências e à Faculdade de Educação da Universidade de São Paulo.

Mota, A.T. (2012). *Astronomia e Astrofísica no Ensino Médio: Uma proposta de um curso a distância para auxiliar na verificação de invariantes operatórios*. São *Paulo: II* Simpósio Nacional de Educação em Astronomia (SNEA). pp. 130-138.

Soler, D.R. (2012). *Astronomia no Currículo do Estado de São Paulo e nos PCN: Um olhar para o tema Observação do Céu.* São Paulo: Dissertação (Mestrado em Ensino de Ciências)-Instituto de Física, Instituto de Química, Instituto de Biociências e Faculdade de Educação, Universidade de São Paulo.

Vieira, V., Bianconi, M.L., & Dias, M. (2005). Espaços não-formais de ensino e o currículo de ciências. *Ciência e Cultura*, 57(4), 21-23.

Vilaça, J., Langhi, R., & Nardi, R. (2013). *Planetários enquanto espaços formais/não-formais de ensino, pesquisa e formação de professores*. Águas de Lindóia**:** IX Encontro Nacional de Pesquisa em Educação em Ciências (ENPEC). pp. 1-8.