

Justifications for the Teaching of Astronomy in Basic Education: The Opinion of Licensed Teachers in Physics

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Abstract: Several researches in Brazil present diverse justifications for the teaching of Astronomy to be developed in Basic Education, however, such allegations do not derive from investigations on the subject, but from the researcher's own experience, either as a teacher or as a promoter of Astronomy. Therefore, this paper aims to broaden this discussion by presenting the results obtained with a questionnaire made to physicists in formal education and online learning modalities of the Federal University of Alagoas (UFAL), where it was asked: What justification do you point to the importance for teaching Astronomy subjects in Basic Education? The method used was the survey, and a total of 77 answers were obtained for the question, being 44 of students of the online learning (OL) and 33 of the formal education. The set of responses was transformed into a corpus in which a textual analysis was performed through IRAMUTEC software. Of the 77 responses presented, 65 were analyzed, and the results show that one of the categories identified provides coherent arguments directly related to one of the categories presented in the referenced researches, that is, Astronomy awakens feelings and concerns and is a motivating element in the teaching process-learning of science.

Key words: basic education, teaching of astronomy, textual analysis

1. Introduction

There are broad discussions about the justification for teaching Astronomy in Basic Education in Brazil, this debate begins with the axiological dimension that human beings attribute to astronomical phenomena since ancient times, that is, generally "we are driven by pleasures, curiosities and needs of probing the unknown" (Gama & Henrique, 2010, p. 9). In this sense this science is prodigal in awakening in people an innate interest that comes from the particular search of the human being to understand his own existence.

Therefore, starting from this principle, it is feasible to expect that the teaching of Astronomy in Basic Education may somehow contribute to people's attempt to obtain answers, beyond common sense, about astronomical phenomena, and even about their own existence. In this sense, several studies in Brazil, besides, present diverse justifications so that the teaching of this science in Basic Education is assured, since, "Astronomy is especially appropriate to motivate the students and to deepen knowledge in several areas, therefore, the teaching of Astronomy is highly interdisciplinary" (Langhi & Nardi, 2013, p. 108).

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In a research carried out by Soler and Leite (2012), which aimed to "identify how the researches in Astronomy teaching deal with the importance and justifications that they provide for this subject in the classroom", 29 papers were analyzed, which presented "any mention of importance and justification that could be attributed to the teaching of Astronomy" (Soler & Leite, 2012, p. 372).

Therefore, the authors gathered all the foundations inserted in the 29 articles, drawn from "the main periodicals of the area of Science, Physics and Astronomy Education in the country" between 2000 and 2011, which presented the importance or some justification for teaching of Astronomy. Therefore, "the main arguments presented by the researchers to promote the teaching of Astronomy" were organized into four broad categories, namely: (1) awakening of feelings and concerns; (2) socio-historical-cultural relevance; (3) expansion of worldview and awareness; (4) interdisciplinarity.

On the other hand, Soler and Leite (2012) also argue that the justifications presented by the researchers (in the 29 articles) to teach Astronomy in Basic Education do not derive from investigations on the subject, but from the researcher's own experience, as a teacher, or as an astronomer.

Another research involving this theme was published by Langhi and Nardi (2014), whose objective was to make "a qualitative analysis of a sample of articles published in Brazilian scientific journals of the teaching area", in order to examine the "discourses of researchers in relation to Education in Astronomy", and, therefore, to identify what these researchers claim as justifications for the teaching of this science.

Thus, these authors present seven categories with possible justifications for the teaching of Astronomy in Basic Education, namely: (1) Astronomy Education contributes to History and Philosophy of Science (HPS) and Science, Technology and Society (STS) in education; (2) Astronomy education favors the elaboration of experimental activities and the observational practice of the sky; (3) astronomy is a motivating element; (4) astronomy is highly interdisciplinary; (5) presence of conceptual errors and failures in textbooks, alternative conceptions in students and teachers, and low popularization in Astronomy; (6) the teaching of Astronomy is promoted by National Curricular Parameters (NCP)¹, and there is a need to reverse the current deficient teacher training framework; (7) There is the potential for interaction with the professional community of astronomers and non-formal educational spaces.

Naturally the discussions about the importance and the justifications of teaching Astronomy in Basic Education come from the view that researchers have in relation to this science, that is, from a personal experience acquired during their professional activities, however, which would be the point of view of physics graduates in the online learning (OL) and formal education modalities, that is, of future professors in this respect? After all, these professionals are those who will work with this science in High School. In this sense, this paper aims to broaden this discussion by presenting the results obtained with the questioning of the subjects mentioned, on such justifications.

2. Materials and Methods

The proposed questionnaire was applied to physics graduates of the OL and formal education modalities of

¹ The National Curricular Parameters (NCP) are reference documents for Elementary and High School Education throughout Brazil. The purpose of NCP is to guarantee to all Brazilian children and young people a set of knowledge recognized as necessary for the exercise of citizenship. They are guiding documents that present the limits and the conditions for the operation of the schools, as well as, it deals with the minimum content to be taught in the disciplines. In addition, its indications can be adapted to the local peculiarities in the vast territory of that country.

the Federal University of Alagoas (UFAL), participation was voluntary and they answered the following question: What justification do you point to the importance of teaching Astronomy subjects in Basic Education? Thus, 77 respondents participated, being 44 of the modality OL and 33 of the modality formal education, which presented 77 valid answers.

In this work, instead of performing the classical content analysis, we opted to develop a textual analysis with the objective of identifying the thematic diversity present in the students' explanations. For that, the set of responses was transformed into a corpus for analysis through IRAMUTEQ software (Camargo & Justo, 2015), that is, a textual or lexical analysis. According to Camargo and Justo (2015), this program examines textual data from written or transcribed expositions, as is the case of the solutions presented by the respondents to the open question considered here. Such responses are classified by the software as text segments (TS).

One of the types of textual analysis performed by IRAMUTEQ is the Descending Hierarchical Classification (DHC), which will be used in this research, "this analysis aims to obtain classes of TS that, at the same time, present similar vocabulary to each other, and vocabulary different from the segments of other classes". Thus, "from these analyzes the software organizes the analysis of the data in a dendogram that illustrates the relations between the classes" (Camargo & Justo, 2015, p. 10).

Therefore, the dendogram provides the results "which allows us to describe each of the classes, mainly by their characteristic vocabulary (lexicon) and their asterisks (variables)". In addition, "based on the chosen classes, the software calculates and provides the most characteristic TS of each class allowing the contextualization of the vocabulary typical of each class" (Camargo & Justo, 2015, pp. 10–11). That is, each of the classes will consist of a grouping of words, which belong to segments of text (or answers) that have a homogeneous vocabulary, as well as represent different proportions of the discourse presented by the respondents to the proposed question.

In this sense, "what the lexical analysis proposes to do is precisely to provide statistical data regarding the acts of language through which the subjects manifest themselves and interact with the world" (Aquino, 2015, p. 31). Thus, from these parameters the revealed classes were interpreted considering their meanings, resulting from this process thematic categories referring to each class.

Therefore, this investigation was conducted in order to analyze each class generated by the software IRAMUTEQ, trying to explain its meaning in the form of a thematic category, and with the purpose of identifying through them the possible justifications that the researched present for the teaching of Astronomy in Basic Education, as well as, if these feasible justifications (or categories) pointed out by the licensed teachers are in line with those exposed by the researchers.

3. Results and Discussions

In the course of processing the corpus for this group of respondents, the IRAMUTEQ software recognized the 77 responses attributed to the question, as the texts to be investigated, and thus, due to the previous configuration, they were divided into 77 TS, among which were found 483 different forms (words) out of a total of 1525 occurrences.

After the processes of lemmatization (change in the way the software will use the dictionary) and parameterization (cleaning the text, eliminating instrumental words) from the total of 77 TS, the program classified 65 of these, corresponding to 84.42% of the segments of these were then dismembered into seven different classes according to the DHC performed, and presented through a dendogram (Figure 1).

The dendogram is a diagram in the form of a tree that organizes certain variables, in this case, the classes arising from the textual analysis, its reading must be performed from the bottom up (Figure 1), so in a first moment (1st partition), the corpus, was divided in two primary subcorpus, the first one is constituted by four classes and the second by three classes. In a second moment (2nd partition) the first subcorpus was split, giving rise to two secondary subcorpus (third and fourth) each with two classes, while the second subcorpus gave origin to the fifth subcorpus and class one. Finally, there is the third (third partition), in which case the third subcorpus gave rise to classes seven and six, and the fourth subcorpus presents classes three and two, while the fifth subcorpus consists of classes five and four.



Figure 1 DHC Dendogram

For the descriptive analysis of the vocabulary of each class, it is necessary to calculate the average frequency of the set of words of the totality of the corpus, as well as to consider those words with X^2 of association with the class greater or equal to 3.84, or is: $X^2 \ge 3.84$, because in this case, p < 0.05.

The average frequency was obtained by dividing the total number of occurrences by the number of different words, in this case we have: 1525 divided by 483, whose result is approximately equal to 3.15, the frequency of each word is presented by the software IRAMUTEQ, and is reproduced in the third column of Table 1.

It is also worth noting that, as Gambôa (2014, p. 103) points out, X^2 represents "the degree of connection of a word with the class to which it belongs", thus, this parameter can be "used criterion of valuation of the existing association". Therefore, through this technique, one can measure that "the larger the X^2 , the more significant the relation between word and class, that is, it is more common to find it in the considered class and more unlikely its presence in the other classes of partition". In addition, the greatness p identifies the level of significance of the association of the word with the class, that is, the smaller the value of p, the larger the combination.

In this case, in the first column are the seven classes distributed according to the dendogram, in the second column are inserted the words classified for each class, these words that are derived from the answers of the students are organized according to their frequency of recall and X^2 , related in the 3rd and 4th columns respectively, in the 5th column appears the values of the level of significance, and finally, in the 6th column are inserted some characteristics referring to the TS constituents of each class, as well as the possible thematic categories, elaborated from the TS analysis.

Therefore, class one is composed of 13.85% of TS (Table 1) and from the analysis of this set of answers a possible thematic category emerges, which highlights the importance of knowing the Sun and the planet in which

we live, according to the related text segments, this would be one of the justifications for the teaching of Astronomy in Basic Education indicated by the respondents. This justification can be verified in the following statements: (1) "for students to know the importance of the Sun and especially for life on Earth" (* student_58); (2) "It is important, because if we live it is because our planet receives light from the Sun" (* student_06).

Class	Word	Frequency	X^2	р	Features/Possible themed categories
1	Sun	5	33.7	0.0001	It has 9 text segments, or 13.85% of the total. To know the Sun and the planet we live in
	Know	7	21.81	0.0001	
	Planet	11	5.63	0.01767	
4	Earth	6	30.90	0.0001	It has 8 text segments, or 12.31% of the total. Understand the phenomena that surround the Earth.
	Eclipse	4	15.52	0.0001	
	Understand	9	10.00	0.00156	
	Phenomena	10	8.40	0.00334	
	Star	4	5.61	0.00375	
	Form	5	3.85	0.01785	
5	Planet	11	13.33	0.0001	It has 11 text segments, or 16.92% of the total. Learn about the phenomena that occur on Earth and its relationship with other stars.
	Learn	6	11.63	0.0001	
	Form	5	7.15	0.01767	
	Astro	6	5.14	0.02332	
	Phenomena	10	4.48	0.03436	
2	Important	7	21.81	0.0001	It has 9 text segments, or 13.85% of the total. Important to know the world or the cosmos.
	Knowledge	25	16.71	0.0001	
	World	4	13.36	0.00025	
	Encourage	4	4.67	0.03068	
3	Origin	4	26.52	0.0001	It has 9 text segments, or 13.85% of the total. It brings themes related to the origin of the Universe.
	Universe	15	25.49	0.0001	
	Content	3	7.36	0.00668	
6	Physics	9	21.10	0.0001	It has 10 text segments, or 15.38% of the total. Relationship with Physics.
	Theme	10	18.07	0.0001	
	Interest	4	3.92	0.04762	
	Concept	4	3.92	0.04762	
7	Day by day	4	26.52	0.0001	It has 10 text segments, or 13.84% of the total. It arouses the curiosity of the student.
	Awakening	7	21.81	0.0001	
	Curiosity	4	13.36	0.04762	

Table 1 The Seven Classes of DHC

Source: Software IRAMUTEC.

Classes four and five (Table 1) (29.23% of TS) complement each other and generally follow the same line of class one, that is, the text segments presented are related to the study of Astronomy contents, so in these two classes the importance of Astronomy is highlighted by the fact that through this one can understand and learn more about the planet Earth and the various phenomena that surround it, as well as the relationship of the Earth with other stars. Such evidence can be observed in the following responses: (1) "The relation that planets and stars have with some phenomena occurring on planet Earth such as seasons of the year and solar and lunar eclipses" (*student_40); (2) "With the knowledge of Astronomy the student will be able to understand phenomena such as

seasons of the year the movement of the stars and planets as well as these movements influence the markings of time" (*student_46).

Therefore, considering the three previous classes referring to the second primary subcorpus, where the respondents attribute as justifications for the teaching of this science in Basic Education a more pragmatic sense, that is, the search for knowledge of the phenomena that involve the stars closest to the Earth, In this perspective, it may be admitted that there is an indirect relationship with the category (3) presented by Soler and Leite (2012), in the sense that such knowledge can broaden the world view, and also with the category (2) highlighted by Langhi and Nardi (2014), from the perspective that the search to understand such phenomena can "favor the elaboration of experimental activities and the observational practice of sky".

Classes two and three (Table 1) also complement each other and represent 27.70% of the text segments, in this case, they arise from the analysis of TS thematic categories where the graduates emphasize that the teaching of Astronomy is important, since it can be used in the search for the knowledge of the phenomena that govern space, or the world, and addresses the themes concerning the origin of the Universe, reinforcing the indirect relation proposed in the previous paragraph. This can be verified in the following answers: (1) Astronomy increases understanding of the world in which we live and enhances students' knowledge (*student_13); (2) Studying Astronomy subjects is important so that we become aware of how space works (*student_36).

The set of answers presented in class six (15.38% of TS) was synthesized in a category where the highlight licensed teachers as justification the fact that astronomical subjects are closely linked to the concepts studied by Physics, so this justification contemplates in part that presented by the aforementioned authors, which highlights that Astronomy is highly interdisciplinary. Such information can be clarified in the following responses: (1) "Addresses topics that will help students in future subjects of physics" (*student_20); (2) "It instigates the curiosity of the students by strengthening their knowledge of phenomena of the stars and physicists" (*student_52).

Finally, class seven (Table 1) is composed of ten segments of text, that is, ten answers, which corresponds to 13. 84% of the total segments analyzed. In this class the underlying category emphasizes that the licensed teachers point out as justification to teach Astronomy in Basic Education the fact that this science can awaken the scientific curiosity of the students. This justification is in line with the first category presented by Soler and Leite (2012), and the third category highlighted by Langhi and Nardi (2014), and Caniato (1974, p. 40) points out that "the study of the sky has always shown a great motivating effect, but also gives the student the opportunity to feel a great aesthetic pleasure linked to science: the pleasure of understanding a little of the Universe where we live". In this sense, the evidences presented by the licensed teachers can be noted in the following answers: (1) "to arouse the curiosity in the student and to make with it looks for the knowledge of which it is necessary and clear the basic knowledge in astronomy can encourage it to act in the area" (*student_41); (2) "awaken early in the students the desire for science" (*student_05).

4. Final Considerations

This work shows that most of the possible categories elaborated from the students, answers, delineated through the textual analysis, present relations of similarity with some of the categories of justifications presented by the researchers, however, this occurs indirectly. In other words, the licensed teachers in their majority is limited to justify the importance of the teaching of Astronomy in Basic Education, emphasizing that this science is

important so that the students can know the Sun and the planet in which we live, to understand and to learn about the phenomena that involve the Earth, and its relationship with other stars. And more broadly highlight that it is important to know the world or the cosmos, as well as, address the themes related to the origin of the Universe. That is, the respondents present a pragmatic view on the justifications for the teaching of this science.

However, it is also possible to highlight a category in which the licensed teachers emphasize the importance of the teaching of Astronomy due to its relation with Physics, which in part this one in consonance with one of the categories presented by the researchers in the works mentioned above, which highlights the interdisciplinary character of this science. Finally, of the seven possible categories of justifications obtained with the answers of the licensed teachers in Physics, one of them presents coherent arguments and directly related to one of those categories presented in the referenced researches, that is, Astronomy awakens feelings and restlessness, besides being a motivating element in the teaching-learning process of the sciences.

In this sense, the data show that in the process of training these professionals, in addition to access to the specific contents of Astronomy, it is also necessary to promote discussions in order to make future physics teachers aware of the importance of this science in students' cognitive and social development of Basic Education.

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