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The Beauty and Pleasure of Understanding: Engaging with Contemporary Challenges Through Science Education (Proceedings of ESERA 2019)

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The Proceedings of ESERA 2019 is an electronic publication for revised and extended papers presented at the ESERA 2019 conference in Bologna, Italy during the 26-30 August, 2019. All papers in the eProceedings correspond to communications submitted and accepted for the ESERA 2019 conference. All proposals to the conference went through a double-blind review process by two or three reviewers prior to being accepted to the conference. A total of 1314 proposals (out of which 65 were symposia) were presented at the conference and in total 238 papers are included in the eProceedings.

The authors were asked to produce updated versions of their papers and take into account the discussion that took place after the presentation and the suggestions received from other participants at the conference. On the whole, the eProceedings presents a comprehensive overview of ongoing studies in Science Education Research in Europe and beyond. This book represents the current interests and areas of emphasis in the ESERA community at the end of 2019.

The eProceedings book contains eighteen parts that represent papers presented across 18 strands at the ESERA 2019 conference. The strand chairs for ESERA 2019 co-edited the corresponding part for each strand 1 to 18. All formats of presentation (single oral, interactive poster, ICT demonstration/workshop and symposium) used during the conference were eligible to be submitted to the eProceedings.

The co-editors carried out a review of the updated versions of the papers that were submitted after the conference at the end of 2019. ESERA, the editors and co-editors do not necessarily endorse or share the ideas and views presented in or implied by the papers included in this book.

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WITHIN THE PROCEEDINGS:

Part 1: Learning science: Conceptual understanding

Part 2: Learning science: Cognitive, affective, and social aspects

Part 3: Science teaching processes

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CONTENTS

THE DIFFERENT TYPOLOGIES DESCRIBING THE INTEREST IN SCIENCE

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It is essential understanding students' interests to help improving the teaching-learning process. Thus, investigations aimed at understanding how young people think and feel about Science and Technology have emerged. One of these initiatives lies on the project called Brazil Barometer, which is a 4-point Likert scale questionnaire comprising 96 questions that investigate the interest of young people in Science and Technology, among other things. The current study used data generated through the application of Brazil Barometer to 2,404 students in the age group 15 years in 2014; thus, these students were used as a representative sample of the Brazilian young population in this age group. Four (4) different typologies of Brazilian students were found based on the k-means clustering method: Reluctant, Enthusiast, Unselective Undecided, Selective Undecided. In addition, the interest of each typology was analyzed based on six different topics such as Health, Mystery, Scientific innovations, Agriculture, Science and Scientists, and Technology, which were determined based on the hierarchical clustering method. It was possible concluding that topics such as Mystery and Scientific innovations presented the greatest potential to boost students' intrinsic motivation, since they were the ones recording above average interest rates in all four typologies.

Keywords: Interest in Science; Intrinsic Motivation; Students' typology.

INTRODUCTION

Student demotivation is a common complaint among teachers, including Science teachers, who often attribute such demotivation to the mismatch between school speed and that of the digital world. This lack of interest in school contents is concerning because, as Pozo and Crespo (2009, p. 40) stated, "students are not interested in Science, they do not want to strive to study; therefore, since learning Science is an intellectual, complex and demanding task, they fail."

The motivation issue appears to be a key factor for the teaching-learning process and, sometimes, it goes unnoticed in debates about the subject. The literature points towards two motivational orientations focused on school learning: the *extrinsic* and *intrinsic* ones (Deci, Koestner & Ryan, 2001; Martinelli & Bartholomeu, 2007; Pozo & Crespo, 2009). Extrinsic motivation refers to performing tasks in response to external stimuli, i.e., students are motivated by the possibility of being rewarded (score, compliment, acknowledgement) or of avoiding punishment (failure, being grounded, humiliation). Thus, students are motivated because they aim at meeting orders given by, or the external pressure from, other people (Martinelli & Bartholomeu, 2007).

Intrinsic motivation is innate and concerns self-determination (Deci, Koestner & Ryan, 2001). Students driven by intrinsic motivation pursue challenges and novelties; thus, participating in tasks is their main reward. Consequently, prizes or external pressure are not necessary (Martinelli & Bartholomeu, 2007), since students lean because they like learning.

Although extrinsic motivation is recurrent in the classroom, studies available in the literature have reported that encouraging it can negatively affect intrinsic motivation (Deci, Koestner & Ryan, 2001). Moreover, extrinsic motivation systems depend on the maintenance of rewards and punishments, because students lose their reason for learning when rewards and punishments are withdrawn or lose meaning. According to Pozo and Crespo (2009), extrinsic motivation can generate undesirable results such as making students think that the studied content is irrelevant and show progressive lack of interest in the school subject.

There are few empirical tools and data available in the literature to help better understanding the triggers of intrinsic motivation (Martinelli & Bartholomeu, 2007). Thus, the current study adopted the hypothesis that students' interests in Science and Technology have the potential to boost their intrinsic motivation. Therefore, investigating the interests of young people would give us a tool to boost their intrinsic motivation.

In addition, there is a gap between students' interest and what is presented in Science curriculum (Amestoy, 2015; Swirski & Baram-Tsabari, 2014). The interest of young people is little, or not at all, explored at the time to plan school curricula, after all, as Ravitch (2011, p. 251) pointed out, "[...] contemporary reformers keep on searching for shortcuts and quick answers."

The aims of the current study were to elaborate Brazilian student typologies based on their interests in Science and Technology in order to generate data to be used in order to encourage students' education based on their intrinsic motivation, as well as to use students' interest to generate new interests, in a virtuous cycle of commitment to learning and knowledge.

History of studies about interest in Science

Young people's interest in Science and Technology is not a new subject of study: in 1984, the German Institute for Science Education hosted the first International Conference on Interest Research, which focused on students' interest in Science and Technology (Schreiner, 2006). The conference was so relevant that the topic to be approached in the next conference was decided right away, namely: the relation between interest and sex, which remains a recurring concern in studies conducted up to the present day.

The Science and Scientists (SAS) project was launched in 1996 based on an international partnership network generated in events such as the International Organization for Science and Technology Education Symposium (IOSTE). The study counted on the participation of 30 researchers from 21 countries and generated a questionnaire that, from 1996 to 1999, collected information from 9,350 children in the age group 13 years concerning their interest in, experiences with, and perceptions about, Science and what they learned on this field (Sjøberg, 2000).

Project ROSE (Santos-Gouw, 2013) - a new project that succeed SAS - began to be institutionally discussed in 2001. The aforementioned study was based on a questionnaire comprising 12 sections such as *My Opinions on Science and Technology*, *My Out-of-School Experiences* and *What I Want to Learn*. ROSE counted on the participation of more than 40 countries, including Brazil, whose applications were documented in the doctoral theses by Tolentino-Neto (2008) and Santos-Gouw (2013).

Some particularities about ROSE, such as the substantial number of questions and the lack of items by taking into consideration the regional context where the questionnaire was applied, were observed by researchers around the world. Hence, the project called Brazil Barometer emerged. This project is based on a 4-point Likert scale questionnaire comprising 96 questions, whose scores range from 1 - Disinterested to 4 - Very Interested; these questions approach different aspects of students' interest in, and position about, Science and Technology.

METHODOLOGY

The current study analyzed responses given to section "A" of the Barometer Brazil questionnaire, which was applied to 15-year-old students, at national representation level, in 2014. This section presents questions about students' level of interest in learning certain topics. The responses of 2,404 students were analyzed; 7 students were excluded from the sample based on pairwise comparison.

Our aim was to elaborate the typologies of Brazilian students based on the congruence of two different methodological stages, in which we made the option of using multivariate data analysis, more specifically, the cluster analysis.

The first methodological stage concerned the analysis of how the questions were grouped according to students' responses. The variables to be analyzed in this stage were the 24 questions - a sample comprising a few items to be grouped together. In this case, the literature (Hair, Black, Babin & Anderson, 2009, Ocampo & Tolentino-Neto, 2019) indicates that the hierarchical method is the most appropriate one, since it uses the nearest neighbor agglomeration algorithm and the square Euclidean distance.

The second methodological stage concerned how to group students based on their responses. The k-means was the herein adopted methodology (Hair, Black, Babin & Anderson, 2009, 2012; Ocampo & Tolentino-Neto, 2019), since it was more appropriate to analyze the massive amount of data (2,397 students) collected in the current study. Based on simulations and on our knowledge about the sample, we decided to work with the total of 4 clusters in the k-means method.

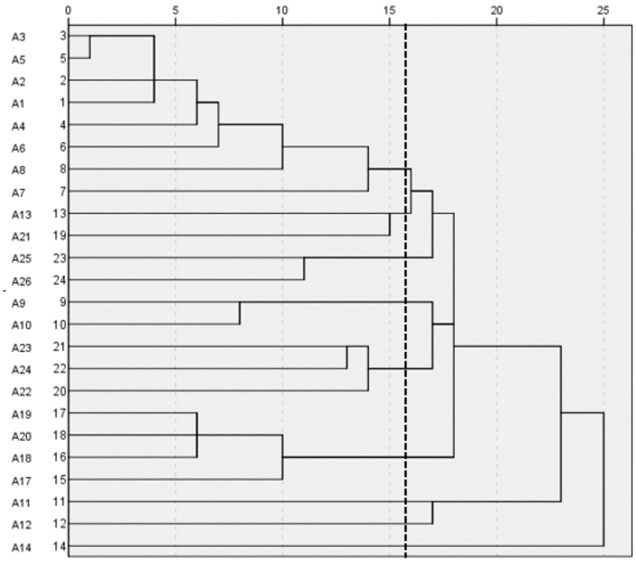
In our opinion, the combination between these two stages is what generated the students' typology. The next items of this manuscript present the results of, and the discussion about, these stages in separate and together.

CLUSTER OF QUESTIONS

The 24 Brazil Barometer questions analyzed in the current study can be empirically grouped based on topics. For example, item A2 "Cancer, what we know about it and how we treat it" can be classified as health-related topic. Thus, we hypothesized that students would respond to the questions according to their field of preference. Cluster analysis was herein adopted to find a statistical basis for this hypothesis.

The nearest-neighbor hierarchical clustering method was herein applied to generate the following dendrogram (Figure 1). We made the option for highlighting (a dotted line in the graph) clusters generated after 15 interactions, based on the good heterogeneity generated in each cluster.

Figure 1 Dendrogram depicting the clustering of questions based on the nearest-neighbor hierarchical clustering method.



Questions A11, A12 and A14 were not clustered into any other question after 15 interactions; consequently, we made the option of disregarding them in our analysis. Thus, the cluster analysis generated six clusters, which were classified based on topics (Table 1). These clusters were very similar to the ones generated by other researchers who worked with both the Barometer and ROSE projects (Schreiner, 2006; Tolentino-Neto, 2008; Chang, Yeung & Cheng, 2009; Santos-Gouw, 2013; Pinafo, 2016). Thus, the clusters generated in the current study were named by taking into consideration the legends used by these authors in their respective studies.

Table 1. Classification of the cluster of questions

Cluster	Questions
a – Health	A1,A2,A3, A4, A5, A6, A7, A8
b – Mystery	A13, A21
c – Scientific innovations	A25, A26
d – Agriculture	A9, A10
e – Science and scientists	A22, A23, A24
f – Technology	A17, A18, A19, A20

Note.Prepared by the authors of the current study, adapted from Schreiner (2006), Tolentino-Neto (2008); Chang, Yeung & Cheng (2009), Santos-Gouw (2013) and Pinafo (2016).

CLUSTER OF STUDENTS

Our first challenge in this stage lied on defining the number of clusters to be used, since the k-means method for clusters analysis requires determining the number of clusters *a priori*. Thus, we searched in the literature and found that Schreiner (2006), whose study adopted the instrument that inspired the development of the Barometer instrument, worked with five clusters of Norwegian students.

After conducting some simulations and data analyses, we noticed that two clusters always emerged: one cluster comprised students presenting above-average interest in Science and Technology, whereas the other one comprised students presenting below-average interest in the topic. Any number higher than two always generated intermediary clusters, which differed from each other based on discrepancies in one or more items, i.e., based on students' high or low interest in specific items. The number of clusters could have been increased by 2,397 so each cluster would represent a student. However, based on the herein obtained heterogeneity, we conclude that four clusters would be sufficient to enable sample segregation and definition.

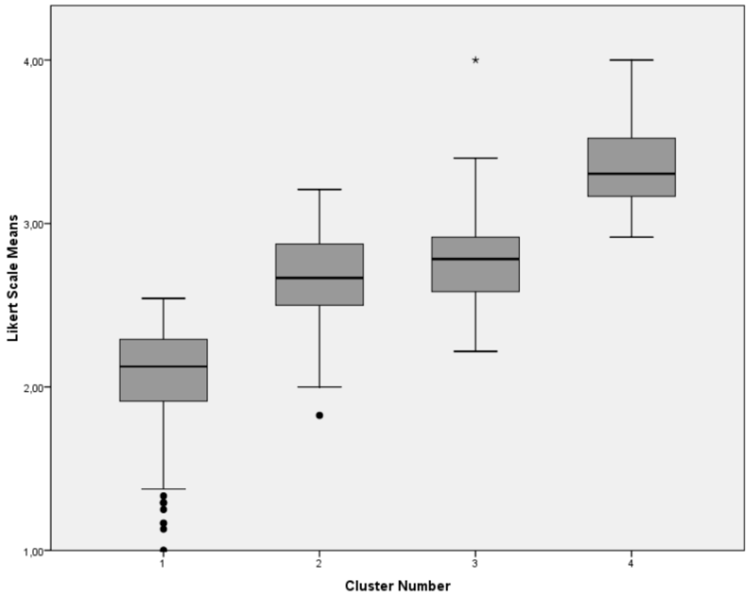
Table 2 Students' distribution per cluster

Cluster	Frequency	Percent (%)	Valid Percent (%)
1	530	22.0	22.1
2	574	23.9	23.9
3	678	28.2	28.3
4	615	25.6	25.7
Total	2,397	99.7	100.0

The number of students in each group did not differ much; there was 6.2% variation between clusters 1 and 3, which comprised the smallest and the largest number of students, respectively (Table 2). Other studies have found clusters with increased unequal distribution. Schreiner (2006) found approximately 13% variation between clusters comprising the largest and the smallest number of Norwegian students.

The clusters generated in the current study were organized according to the mean value attributed to students' responses: the first cluster encompassed students who presented the lowest interest in Science and Technology, whereas the fourth cluster comprised students who presented the highest interest in the topic (Figure 2).

Figure 2. Average and quartiles of interests per cluster



Schreiner (2006) divided Norwegian students in 5 clusters, which were differentiated based on three distinctive features. The first distinction was based on interest, which generated three typologies: *Reluctant*, *Undecided* and *Enthusiast*. The other distinction was based on the variance in students' responses, which generated two typologies: *Unselective* and *Selective*. Finally, the aforementioned researcher differed students based on what she called "Virtually sex-specific" (Schreiner, 2006, p. 128). In the end, Norwegian students were clustered as *Unselective Reluctant*, *Unselective Undecided*, *Unselective Enthusiast*, *Selective Boy* and *Selective Girl*.

Based on this study, we determined the first aspect distinguishing students' typologies: their interest in Science. We made the option of using the terms adopted by Schreiner (2006); thus, Cluster 1 was classified as Reluctant¸ Clusters 2 and 3 were classified as *Undecided*, and Cluster 4 was classified as *Enthusiast*.

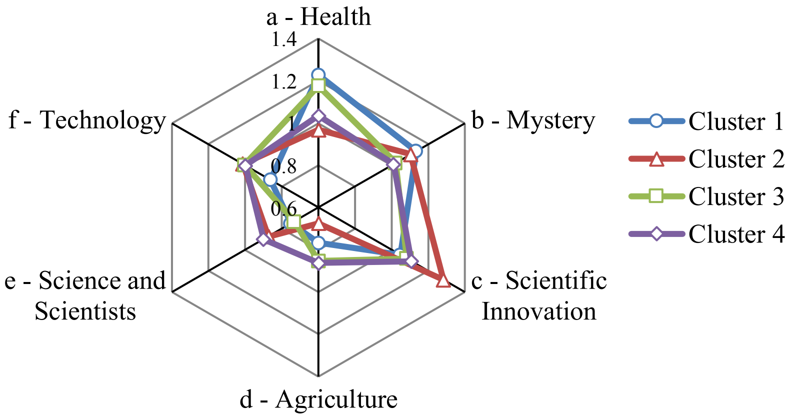
However, it is worth emphasizing that average interest alone was not enough to characterize students' typologies. It was necessary creating a second dimension to enable the elaboration of these typologies based on the fields of interest that most represented the students belonging to these clusters.

TYPOLOGY OF STUDENTS

We observed how members of each of the four clusters behaved towards the topics presented in Table 1 in order to characterize each students' typology. Thus, we herein elucidate these typologies based on students' interest in Science, as well as on the topics differentiating these clusters.

Initially, our concern was to distinguish the fields of interest of each cluster. However, since there were different average interest values, it would be difficult to effectively visualize differences between these fields. Thus, we made the option of weighing the interests in the fields based on the average interest of each cluster; this value was called $\bar{u}_p$ and it was calculated by dividing the interest of students belonging to each cluster in a certain field by the average interest of this cluster. Thus, it was possible overlapping and comparing these values, since each $\bar{u}_p > 1$ represented interest above the mean, whereas $\bar{u}_p < 1$ represented interest bellow the mean. These results are shown in Figure 3.

Figure 3. Comparison between weighted means of interest in the topics.



The center of the radar represents $\bar{u}_p$ = 0.6, whereas the extreme opposite represents $\bar{u}_p$ = 1.4. Each $\bar{u}_p > 1$ represents high interest of students belonging to this cluster in the topic.

The information that mostly stood out in Figure 3 concerned the high interest of students belonging to Cluster 2 in *Scientific innovations*. In addition, it was possible seeing that students in Clusters 2 and 4 had similar views about fields such as *Health*, *Science and scientists*, and *Technology*. Moreover, Cluster 2 stood out because its students presented the lowest interest in *Agriculture*.

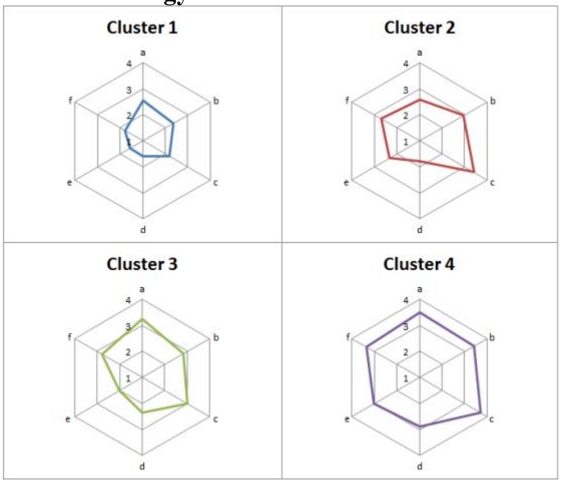
Health was the topic recording considerable interest in all clusters; only Cluster 2 presented $\bar{u}_p < 1$, although it was very close to 1. This outcome corroborates other studies such as the one conducted by Santos-Gouw (2013). However, students belonging to Clusters 1 and 3 showed more interest in the aforementioned topic than the ones belonging to Cluster 2 and 4 (Figure 3).

For illustration purposes, let us imagine a reality where most students belong to Clusters 1 and/or 3; in this case, the use of the topic *Health* in the classroom would have enormous potential, since it would sensitize students' intrinsic motivation. Similarly, if the reality in question does not count on students belonging to Cluster 1, the use of the topic *Technology* should be taken into consideration, since students belonging to the other clusters have great interest in it. Applying the questionnaire and characterizing/mapping the class is a great way for teachers to 'customize' their plans and bring examples and topics of interest to their students.

On the other hand, it is essential emphasizing that it is not the case to stop teaching topics students are not interested in. Teachers would be negligent, or irresponsible, if they failed to address - for example - photosynthesis, in case students did not express interest in botany or in environmental issues. The path to be covered is different, and we agree with Pozo and Crespo (2009, p. 43) who said that "[...] we should start from students' interests and preferences to generate new ones".

Thus, it is important identifying each cluster, which was the reason why we created typologies to name and characterize each of these groups. In order to do so, we took into consideration two aspects - the already mentioned terms based on average interest (*Reluctant*¸ *Undecided* and *Enthusiast*) and the field of greater interest of each cluster (Figure 4) - mainly to distinguish Clusters 2 and 3, which were both classified as *Undecided*. The center of the radar in Figure 4 represents value 1 (Disinterested), whereas the extreme opposite represents value 4 (Very Interested).

Figure 4. – Typologies based on fields: a - Health; b - Mystery; c - Scientific innovations; d - Agriculture; e - Science and scientists; and f – Technology.



The first typology concerned students belonging to Cluster 1. Although they had little interest in Science and Technology, the *Health* topic was attractive to them. Data indicated that the *Health* topic arouses an interest approximately 25% higher than the average. These students did not show interest in topics such as *Agriculture*, *Science and scientists*, and *Technology*. Thus, this cluster was given the *Reluctant* typology, based on the model by Schreiner (2006). *Reluctant* individuals correspond to approximately 22% of Brazilian adolescents in the age group 15 years.

On the other side of the spectrum, some students were very interested in Science. These students belonged to Cluster 4, which represents approximately 26% of the Brazilian population in the same age group. This typology was named *Enthusiast*, since, except for *Agriculture*, all other topics recorded average interest above 3 points, i.e., students belonging to this typology ranged from interested to very interested in almost all Science topics. In addition to the low interest in *Agriculture*, *Enthusiast* students showed high interest in *Scientific innovations*, the average (3.72) was very close to the maximum point. Presenting an optimistic and favorable attitude towards Science and Technology (Anderson, 2006) is characteristic of young people living in countries with low Human Development Index (HDI), which is the reality of a large number of Brazilian citizens; thus, it was not surprising that a significant number of students were given the *Enthusiast* typology.

The two aforementioned typologies comprise a large number of young individuals in Brazil. However, approximately 52% of students belong to Clusters 2 and 3, besides presenting interest close to the average in the 4-point Likert scale (2.5). These two clusters represent what

Schreiner (2006) called *Undecided* typology. Thus, we herein differentiated the two clusters based on the particularities of their interests.

Students belonging to Cluster 2 presented greater discrepancy between responses given to each Science and Technology field than the ones belonging to Cluster 3, as shown in Figure 1. There was 0.301 variance among fields in Cluster 2 and 0.197 in Cluster 3. Thus, students belonging to Cluster 2 were given the *Unselective Undecided* typology, whereas the ones belonging to Cluster 3 were given the *Selective Undecided* one, based on the criterion adopted by Schreiner (2006).

Selective Undecided individuals were very interested in *Scientific innovations* and did not appear to be interested in *Agriculture*. This information made us think about the representativeness of these young students in urban and rural schools, or even in regions presenting high or low population density. Our sample did not enable answering this question.

On the other hand, *Unselective Undecided* individuals were more interested in *Health* and less interested in *Science and scientists*. Previous studies have reported greater interest in *Health* among girls, not only in the Brazilian context (Pinafo, 2016) but also in other countries around the world such as Sweden, Finland, Spain and Ghana (Jidesjö, Oscarsson & Karlsson, 2009; Vázquez & Manassero, 2009; Anderson, 2006). Therefore, we investigated whether there was sex-related distinction in this typology: girls represented 60% of the *Unselective Undecided* students and approximately 44% of the *Selective Undecided* ones. This variation was not as significant as the one found in the aforementioned studies; thus, we did not dwell on this variable at data analysis time.

None of the typologies recorded in the current study showed as much gender discrepancy as the ones reported by Schreiner (2006), who recorded 97% boys in one cluster and 94% girls in another one. Consequently, we did not find it necessary distinguishing Brazilian students' typologies based on *Sex-Variable,* as it was done by the aforementioned researcher.

Thus, *Reluctant*, *Enthusiast*, *Unselective Undecided* and *Selective Undecided* were the typologies herein used to characterize Brazilian young students. Clearly, this is not a rule: generalizations in the education field are dangerous, mainly in significantly heterogeneous countries such as Brazil. On the other hand, these typologies can be used as guideline to develop strategies that take into consideration students' intrinsic motivation to boost Science education in Brazil.

FINAL CONSIDERATIONS

The present study aimed at generating typologies to represent Brazilian young people based on their interest in Science and Technology. Based on aspects quantified through the Brazil Barometer instrument, it was possible dividing them in four typologies named *Reluctant*, *Unselective Undecided*, *Selective Undecided* and *Enthusiast*.

It is essential understanding the existence and characteristics of these typologies in order to boost a teaching process that takes into account students' intrinsic motivations to learn Sciences. Thus, it is possible using students' interests to expand their knowledge about Science.

We concluded that individuals belonging to each of these four typologies have their own interests. *Reluctant* individuals presented greater interest in topics such as *Health*, *Mystery* and *Scientific innovations*. This outcome was similar to the one recorded for students belonging to the *Enthusiast* and *Unselective Undecided* typologies, who showed interest in *Scientific innovations* and *Health*, whereas the ones belonging to the *Selective Undecided* typology presented great interest in *Scientific innovations*.

Besides the individual interests of the herein presented typologies, it is essential investigating the fields arousing the interest of young people belonging to all typologies. Items associated with *Mystery* and *Scientific innovations* were the ones recording above-average interest in all typologies. Thus, we reiterate the potential of these two fields to boost students' intrinsic motivation to study Science, since the four herein investigated typologies shared this interest.

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CONTENTS

SCIENCE TEACHERS CONTINUOUS EDUCATION THROUGH THE THREE PEDAGOGICAL MOMENTS

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This study aimed to evaluate the development of a continuous education course structured through the 3 Pedagogical Moments (PMs) with Science Teachers from Uruguaiana - RS, Brazil. The production of data occurred through numerous instruments. We noticed some limitations in relation to the teachers in following the proposal presented in the formative process, as well as in carrying out the implementation of the teaching plans in classroom.

Keywords: In-service Teacher Training, Teaching Practices, Science Education.

INTRODUCTION

It is increasingly essential for teachers to participate in spaces that foster their continuous education, because from these it is possible to promote reflections about their pedagogical practice, with an exchange of knowledge between professionals working in the same modality and educational levels, to reframe their teaching practice.

Researchers from different areas of education and teaching are investigating new ways of conceiving and organizing spaces for continuous education. In this sense, one of the studied proposals for this purpose are the 3 Pedagogical Moments (PM) that were proposed by the Brazilian researchers Delizoicov and Angotti (1994) as a transposition of Paulo Freire's dialogical-problematizing concept of education and that emerged from a dynamic planned to develop themes previously chosen in a science teaching project in Guinea-Bissau.

The 3 PM can be described the following way: the first PM is called "Initial Problematization" where real questions and / or situations that the students know and experience and that are linked to the content to be developed are presented. At this moment, the teacher will encourage discussions about the subject, allowing the exposition of alternative conceptions of students or instigating the understanding of other knowledge. The second PM is known as the "Knowledge Organization" where students will study the contents necessary to understand the theme and the first PM. The third PM is called "Application of knowledge", designed to perform the synthesis of the knowledge incorporated by the student, analysing and interpreting both the initial situations of the first PM and other situations that can be explained through the same scientific knowledge (Delizoicov & Angotti, 1994).

According to Fagundes (2013), the 3 PMs can be used to organize the lesson planning, contemplating current reality themes, allowing the contextualization of science teaching. On the other hand Muenchen (2010) and Giacomini and Muenchen (2015) mention that the 3 PM, beyond being used as didactic-pedagogical dynamics in the classroom, to build programs and curricula, can also be used to structure training processes, as long as changes are made to meet this proposal.

To work with the 3 PMs, it is necessary be present a theme in focus that is relevant to the social context in which it will be developed. In this sense, medicinal and toxic plants can be a possible topic to be used in science education, since according to data from the World Health Organization (WHO) 85% of people worldwide use these vegetables to treat diseases (Teixeira et al, 2014). Regarding Brazil, according data from the Ministry of Health, in the period from 2013 to 2015, the demand for treatments using medicinal plants and herbal medicines by the Sistema Único de Saúde (SUS) has more than doubled: a 161% growth was recorded (Portal Brasil, 2016). Besides that, the Sistema Nacional de Informações Tóxico-Farmacológicas (SINITOX, 2016) registered 363 cases of poisoning by plants in Brazil in 2016, and that 350 of them occurred in urban areas. It may seem like a small quantity of poisoning cases, taking in consideration the size of the Brazilian population, the problem is that many cases of plant poisoning are not even known.

If an analysis by Brazilian states is made, it will also be possible to check the presence of these vegetables in daily life, such as in the State of Rio Grande do Sul (RS), in which the population uses a variety of medicinal plants, for the most distinct therapeutic purposes (Dávila, 2011). One of the municipalities in which the use of numerous medicinal plants is verified is the city of Uruguaiana, in the border between Brazil and Argentina, according to the ethnobotanical study by Galvani and Barreneche (1994). In this same municipality, there were also several cases of intoxication by vegetables, as shown in the work of Dávila et al (2008) from their ethnobotanical study regarding toxic plants in the city of Uruguaiana - RS.

According to Silva and Santos (2017), the school represents an important space for the dialogue between popular knowledge and the concepts addressed in class, in addition to exercising the role of valuing students' personal experiences. Through the students popular knowledge, the teacher can (re) discover and (re) build knowledge necessary for scientific and technological literacy (Chassot, 2006).

However, has been seen throughout Brazilian academic productions in the Science Education area, that teachers encounter difficulties and / or feel insecure about the use of other teaching strategies. One way of solving this problem can be through the use of continuous education of teachers, since from these spaces you can promote reflections about pedagogical practice, with exchange of knowledge between professionals working in the same modality and educational level, reframing their teaching practice.

This study proposes to evaluate the development of a continuous education course structured though the 3 PMs, where the Toxic and Medicinal Plants theme in association with the 3 PMs was addressed, verifying the potentialities and challenges of a formative process in this format.

MATERIAL AND METHODS

The subjects involved in this investigation were 30 science teachers from the municipal education network of the city of Uruguaiana - RS, Brazil (Image 1). The choice of the study subjects was intentional, since it were the teachers at this location that asked the first author to develop a continuous education course with them. From this interest, an initial analysis of the conceptions of these teachers about science teaching was made in order to structure the course (Dávila, Folmer & Puntel, 2017).

Image 1 – Location of Uruguaiana - RS.

Source: G1 (2011).

The initial idea was to carry out a training process within the monthly meetings of pedagogical training offered by the Secretaria Municipal de Educação (SEMED), to be developed throughout the year, with periodic meetings. However, due to the annual planning of the pedagogical training of this institution, two meetings were authorized and granted. For this reason, the course consisted of two meetings, each lasting four hours, with an interval of two months between them so that the teachers had time to apply the teaching plans in a school context.

We developed a continuous education course, structured though Delizoicov and Angotti's (1994) 3 PMs, as described in the table below.

Table 01 - Continuous training course organized methodologically through the 3 PMs developing the contextualization theme "Medicinal and Toxic Plants" in association to the 3 PMs.

3 Pedagogical Moments	Description
First PM: Initial Problematization	Presentation of the course structure to situate the teachers. Application of initial questionnaire. Questionings regarding the subjects of the course to problematize it.
Second PM: Knowledge Organization	Expositive and dialogic Presentation of the current reality of science teaching; presentation of data from the dissertation in relation to the academic production in the area of science education; explanation of the results obtained with the participating students in the "Medicinal and Toxic Plants" workshop , showing the evolution of the students' answers and drawings regarding Botany and the theme. Explanation of the 3 PMs theoretical references (who they are and how they are organized), using as reference the books "Metodologia do ensino de Ciências" (Delizoicov & Angotti, 1994) and "Ensino de Ciências: Fundamentos e Métodos" (Delizoicov, Angotti & Pernambuco, 2011). Explanation and discussion about the use of themes in classroom, using for that purpose the official Brazilian documents that govern the Elementary School Final Grades (Parâmetros Curriculares Nacionais (PCN, 1998) and the Diretrizes Curriculares Nacionais (DCN, 2013)).
Third PM: Application of knowledge	Elaboration of structured teaching plans in the 3 PMs to develop the "Medicinal and Toxic Plants" theme in a class of their school (realized in the first meeting). In the second meeting, two months after the formative process, the results of the application of the teaching plan were presented in the form of a "Pedagogical Experiences Sharing Seminar".

Source: the author

The final activity (Pedagogical Experiences Sharing Seminar) was recorded and teachers were invited to participate in a semi-structured interview to present their testimony about this pedagogical experience faced in the course of continuous education.

As for the data analysis methodology, we adopted Content Analysis by (Bardin, 2011). For this analysis a triangulation of the data obtained by the different instruments (field diary, questionnaires, teaching plans and semi-structured interviews) was performed.

RESULTS AND DISCUSSION

From the 30 teachers invited, 14 female teachers took part. All with initial formation in their work area, three of them with specialization, with length of professional experience varying from 1 to 20 years.

We noticed that the first PM of the course provoked concerns, a lot of discussion of the topics selected for the continuous education, with reports of situations that occurred in the classroom during their teaching time. It was interesting, because it provided dialogue between the researcher and the teachers with different time amounts of experience in teaching. This dialogue between the subjects involved in the process was also verified by Giacomini and Muenchen (2015) when working with a group of teachers from different areas of knowledge in a formative process also organized through the 3 PMs, considering that the dialogue was mobilized by the teachers' reflection and action.

In the second PM when addressing the scientific knowledge needed to understand the use of the theme and the 3 PMs in the classroom, there was interest in the subject, questionings being conducted when some point of the theoric referential had not been well elucidated.

In the execution of the third PM, some challenges and limitations for the present study appeared. The first challenge was due to the concern of teachers in continuing the curriculum of the school year of the class where the teaching plan of this course that would be developed, because for them, to subordinate the content to the theme, would mean developing a work in parallel and they did not agree with that. A similar occurrence was seen in the reports of Muenchen (2010) interviews with the trainers of the continuous education courses in the municipality of Santa Maria - RS, Brazil, being one of the reasons that some course planning had a more conceptual than thematic focus. This demand was tried to be met, even knowing that this fact could increase the chances of use of the subject only as an example, illustration or a pretext to continue the programmatic contents of that school year, as pointed out by Wartha, Silva and Bejarno (2013).

The second challenge concerns the difficulty of the teachers to relate the theme of the course to any area other than Botany, showing again that they were trying to associate it to school content and not to explain the theme with the necessary scientific knowledge.

The third challenge of the third PM refers to the few teachers who finished the course, of the 14 participants; only seven teachers implemented their teaching plans.

The fourth challenge is linked to the previous one, because it was found that no teacher was able to develop the proposal of the continous education course, classifying the teaching plans (presented at the Experience Sharing Seminar), into three categories:

1st) Subtheme associated with the 3 MPs: within this category were included the works that approached the proposal of the continuous education.

2nd) Subtheme only: activities that used a sub-theme of the theme presented on the course.

3rd) Did not perform as instructed in the course: works that explored neither the theme nor the 3 PMs, but used the theme as an additional classroom task.

In the first category, two teaching plans were contemplated, from a teacher (called P1) who worked in a rural school and the other from a teacher (represented by P2) acting in a school located in a socially fragile area of the city.

Both plans have in common the approach of subthemes, chosen by the teachers, related to the theme presented in the formative process. The teachers understood that they could do it this way because they needed to adapt it to work with the content envisaged for that school year, in which hey had chosen to implement the activity of the training course. It is noticed that the use of themes was subordinated to the syllabus of that year and not the opposite, as is recommended by Delizoicov, Angotti and Pernambuco (2011).

The teachers addressed subthemes that were part of the students' reality, that besides contemplating the specific programatic contents of that year, had cultural issues, social problems and that had the potential to motivate further study by the students.

When comparing these data with the classification used by Silva and Mortimer (2010) when developing the conceptual, contextual, phenomenological and epistemological aspects of chemical content in the classroom, it is suggested that the teachers of this investigation, to chose subthemes from a contextual dimension, because they aimed to approach scientific content with a social, technological, environmental or historical context.

Next, the teaching plans of teachers P1 and P2 are described.

Teacher P1's teaching plan – Subtheme: Drugs derived from toxic plants and their effects on the nervous system

1st PM – Awareness: Videos about drugs, their effects on the nervous system, the risks to the body, and withdrawal crises were used and after that there was a talk to discuss.

Establish relationships between drugs and their effects on the nervous system: class discussion, and notes on the subject.

2nd PM – Explanation and notes on the nervous system, its anatomy and physiology; visualization in models and boards of the main organs and functions.

Group research on the main plant-derived drugs, their effects on the nervous system and the effects of withdrawal.

3rd PM – Organization of data and construction of information panels on the main plants that give origin to legal and illegal drugs and their main effects on the body.

Presentation of the work carried out to classmates in the form of seminars.

Resumptiom of the videos of the 1st PM.

Discussion of some questions.

Explaining though the use of scientific knowledge.

Teacher P2's teaching plan – Subtheme: Mate Herb

1st PM – Questions and discussion about where the Mate Herb they buy from the market comes from.

2nd PM – Historical, cultural and geographical approach to Mate Herb.

Before introducing scientific knowledge of sciences, students had to answer a questionnaire that contained the following questions: "Do you have the habit of drinking mate?; How many times a day do you take mate ? Do you know any benefits of mate? Do you know any harm of mate?".

Students had to apply this questionnaire to 15 people in their neighborhood and bring the data in the next class.

Creation of graphics with the data collected from the questionnaires.

Discussion of results.

Approach of the questions and answers of the questionnaire with the contents of the human body.

3rd PM – Application of recreational activities (crosswords, question-and-answer game related to the theme, memory game) to students as a way of evaluating the subject.

Regarding the second category "Subtheme only", was composed by only one teaching proposal. The teacher (represented by P3) launched the theme in the classroom to reflect on it, because according to her, already worked with themes in the classroom, but the students chose them. By developing in this way with the theme "Medicinal and Toxic Plants", students ended up leading the approach to "Energy", because they were interested in the process of photosynthesis.

In the last category, four teaching proposals were included, that used the theme "Medicinal and Toxic Plants" as a complementary task to the content that had been addressed by the teachers, in which students should conduct a group research on the subject and after that, present it to the class in a seminar format. All teachers in this category have claimed that the time was a limiting factor to implementing their planned activities.

The activities carried out by each teacher are identified below:

Teacher P4 – from the theme proposed in the training course, she extracted a subtheme of it to carry out a work complementary to the content of human physiology. The chosen subtopic "Substances extracted from vegetables: Caffeine and THC (extracted from marijuana)" was due to an association with the History teacher who wanted to deal with the subject of Coffee. The activity developed by the students corresponded to the elaboration of a folder and a parody, both about caffeine and THC. Four questions were given to guide the work: "what were the drugs Caffeine and THC?"; "where they were found?"; "what are the effects of these drugs on the human body, both beneficial and harmful?" and "a curiosity about these drugs". The history teacher asked for the history of coffee. Students had to present these activities in the classroom.

Teacher P5 - Had the understanding that she should approach the concept of a plant and its structures before the theme, therefore, the demonstration activity was developed before, but even so, she did not finish her planning, went no further than the proposal that will be described. She took a plant and asked the students to observe it and compare what was there of similarities and differences with the human body. Soon after, she placed a plant in water with dye and another plant in a container with water without dye and asked them to observe and write what would happen to the plant that was in the dye. The students made graphs of the hypotheses of what would happen to the plant that was in the dye. After a few days, they looked again at the plant that was in the dye and wrote down the reasons for the vegetable to be showing colored petals, which were initially white. The students made assumptions regarding photosynthesis, that the plants had a "small pipe". After this practical activity, she made a comment in in the classroom about what medicinal plants were and which could become toxic and from this moment on she was unable to carry on working with medicinal and toxic plants.

Teacher P6 – She covered with the students the content of plant morphology to later address the theme, as she believed that students needed prior knowledge to later study the theme. She developed a research activity related to medicinal and toxic plants, that she had found in the textbook, with the students. After researching it in pairs, they had to present it in the classroom.

Teacher P7 – Divided the class into groups and each had a topic about plants (terrarium assembly; plant experiment in the dark; conducting vessels; plant reproduction; root development; germination) and a group with medicinal and toxic plants. The teacher, as well as the others in this category, believed that the students should first have a theoretical background in botany, because she considered her students immature, in the sense that they had no idea what a plant is.

When interviewing teachers about the elaboration and execution of teaching plans, it was found that the teachers had difficulties during the time allotted for this activity. The first one was related to the time to execute the teaching strategy in the classroom. It was found that two months had been a short time to implement their teaching proposal with the students. This hindered the development of plans as discussed in the continuous education course, leading all teachers not to implement the theme “Medicinal and Toxic Plants”, but to unfold it in subthemes and depending on the teacher, to approach it from the 3 PMs or not. This difficulty of lack of time to organize, plan and implement the teaching plan may be linked to the current conditions of teaching work, as evidenced in the study by Donatelli and Oliveira (2010) with basic education teachers in RS.

Another factor present in the teachers' statements that may have limited the execution of the teaching strategy in a satisfactory way: the current curricular organization in schools, which developed a feeling of imprisonment to school content among teachers, becoming a challenge for the implementation of the theme from the perspective of the 3 PMs, limiting the investigation of the potentialities of the proposed theme.

It may be that in this study, the short duration of the training process has failed to change teaching practice. Sauerwein (2008) emphasizes that courses with this characteristic may not allow the increment of this in the permanent education of the teacher, perhaps using it for a short time in their pedagogical practices. However, Neto (2014, p. 13) points out that although this training format “does not seem to offer enough time for the processes of understanding and acceptance to materialize, they are important as they present alternatives, they motivate, they show ways of how, why, where and when to use a particular activity”.

It can also be seen through the interviews, that even teachers did not use the theme as initially proposed in the training process; positive results were obtained regarding the implementation of teaching plans. Although the theme was unfolded in different sub-themes or developed as a complementary activity to the sequence of contents that the teachers were addressing, if it succeeded in instigating the students' curiosity, giving subsidies to promote a dialogue between teacher - student, student - student and between popular knowledge and scientific knowledge. Moreover, through these plans, it can be ascertained that contents and developments can emerge from the theme “Medicinal and Toxic Plants” and serve as a subsidy for future planning, where the theme can be seen as the object of study that disciplinary contents are organized from, opening possibility for an articulation of the different areas of knowledge to work around a common objective.

FINAL CONSIDERATIONS

It was found that the formative process presented did not allow teachers in the 3rd PM to elaborate and execute teaching plans in which the school content was subordinated to the theme, requiring a continous education course like this, which is structured in 3 PM, to be developed with a longer duration and longer meetings, giving a greater support to teachers. However, it provided, as far as possible, the discussion of the pedagogical praxis of teachers as well as a greater interaction between university and school, offering a space for sharing knowledge and getting closer to the academic material.

Another aspect that may have interfered with the success of the 3rd PM was the teaching conception and curriculum of the teachers in this study, as they were shown to be “imprisoned” to the school contents of the current curricular organization of school..

Even with the challenges faced in this continuous education, teachers were active subjects in this training process, in which their concerns, teaching knowledge and doubts were heard and discussed, through the promoted dialogue, in addition to bringing the subjects involved to reflect on their pedagogical practices, studying a different teaching methodology and trying to develop a teaching plan different from their usual.

The theme "Medicinal and Toxic Plants" allowed immersion in different social contexts, as seen in the work implemented by the teachers, but it is believed to have a much greater potential if we have public policies giving subsidies to have greater curricular flexibility in school institutions.

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