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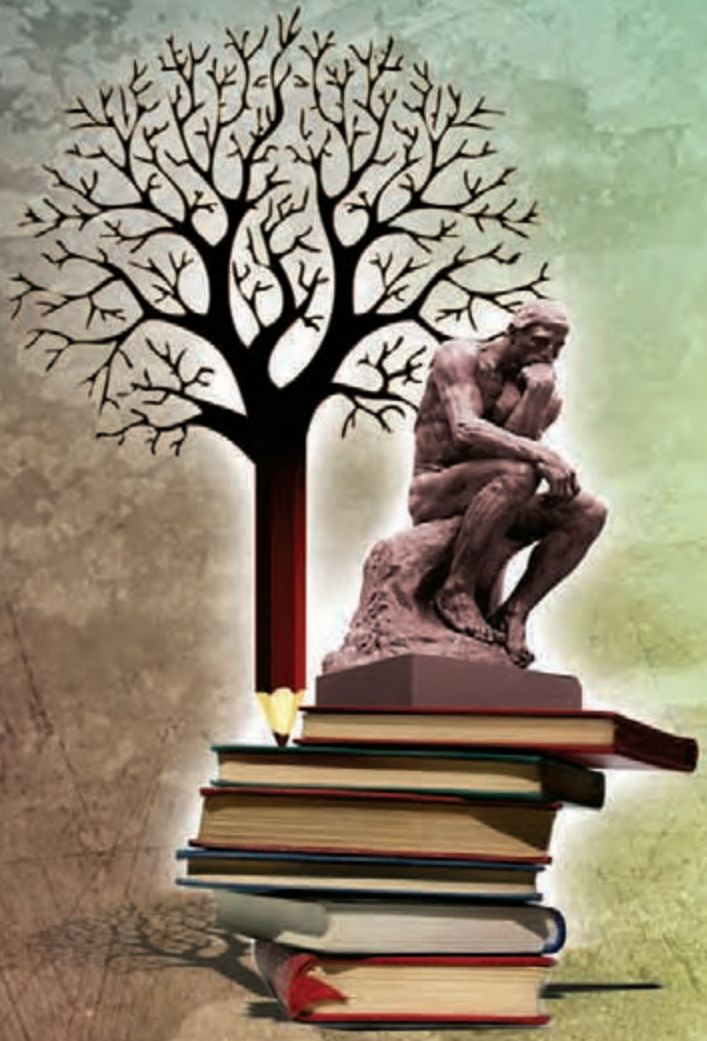

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BRIEF CONTENTS

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TEACHING AND LEARNING NATURAL SCIENCES WITH IBSE METHODOLOGY: A STUDY OUTSIDE CLASSROOM

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Abstract

Inquiry Based Science Education (IBSE) was recognized as an advantageous method in professional updating and improvement for .teachers and educators, through a training course on Natural Sciences educational practices outdoors, part of the Educative Program performed in University of Coimbra Botanic Garden[1]. IBSE lesson plans on plants main groups and their evolution were now applied to two samples of pupils from the 3rd and 5th grade of the basic level of education, with 81 and 89 cases, respectively, having been performed in an outside classroom environment, with direct contact with plants. The aim of this study is to directly contact, listen and question the students involved in the program, in order to understand the impacts of this methodology on Natural Sciences learning, using pre and post questionnaires as assessment tools, completed by students before and after the sessions, respectively.
In addition to good indicators of evolution and enrichment of the knowledge and the skills of the students, their attitudes and final ideas and proposals revealed motivation and interest to increase the resources of the activity to extend its scope as well as their knowledge.

Keywords: *IBSE, experimental methodologies, active learning, Natural Sciences, outdoors spaces.*

1. Introduction

Natural Sciences teaching-learning outside the classroom was promoted by developing a training course for teachers and educators in non-formal school contexts, such as Botanic Gardens, Museums or Science Centres settings, indorsed through Inquire educative European Project (2010-2013) (Regan, E. & Dilon, J., 2013). The course Inquire (Bromley et al., 2013) spread Inquiry Based Science Education (IBSE), a facilitator student-centered methodology of knowledge acquisition and building by research, demonstrating change of educational practices, essentially focused on the accumulation of static knowledge, to active teaching-learning of Science. Advantage of IBSE method outdoors in professional updating and improvement of educational practices has been proved (Regan, E. & Dilon, J., 2013; Tavares et al., 2014; Tavares et al. 2015), being now crucial to directly contact, listen and question the actors at schools, teachers and students, to understand the impacts of this methodology on Natural Sciences learning of the students. The educational IBSE testing materials are part of the Educative Program established for 16 years in University of Coimbra Botanic Garden, and formatted for 4 to 14 years old students, crossing the school curricula of Biology, Geography and Geology on relevant and current issues of biodiversity, climate change and sustainability (Bromley et al., 2013; Tavares, 2011). Lesson plans and teaching materials are used in different outside classroom spaces, being applied by graduates on IBSE, the interlocutors of students when visiting Natural Science outdoors locations, as the school gardens, parks, Botanic Gardens or Science Centres.

The proposed activity to be tested, untitled "The alga who wanted to be a flower", is an IBSE simple approach to the main groups of plants diversity and their evolution (Tavares, 2014). Framed in the current program of education on natural sciences, biodiversity and sustainability to preschool children until the 9th grade students (ages 4-14), this activity is now performed to assess knowledge acquisition

[1]The Educative Program of Coimbra Botanic Garden (Tavares, 2011) contains more than thirty educational activities, especially dedicated to Schools, crossing the programmatic curricula of all grades. The actions are presented through an overview, objectives, target audience, topics and curriculum connections and skills to develop. In a final annex presents the teaching materials, content and produced resources such as materials, lesson plans, guides for educator / teacher and the student.

and the social and attitudinal expressions of 3rd and 5th grade of basic school level students, applying IBSE methodology outside the classroom.

2. Methodological design and tools

Sessions of the IBSE Education Science activity were performed with 170 students, being 81 from the 3rd grade (7-8 years old) and 89 students from the 5th grade (9-10 years old) studying in schools in the central region of Portugal. With an outside classroom scenario and based on the story "The alga who wanted to be a flower" (Tavares, 2013), a film, and a song, the students learned and applied knew knowledge by directly contacting and identifying plants, and through microscopic observations, drawings and writing activities.. The evaluation of students' knowledge on the topic in focus (the major groups of plants, living beings and their evolution) was made by means of the application of questionnaires to the children at the beginning and at the end of each session. The pre-questionnaire has five open-ended questions, that aim to assess knowledge, classifying students' answers as C=correct; I= Incorrect, no answer, not know; PC= partially correct. The post-questionnaire has ten questions. The first four aim to assess students' knowledge, being identical to the pre-questionnaire questions. The remaining six questions aim to collect data on the opinions, attitudes, reactions, ideas and proposals from students. The analysis of the content of all the five pre questions and the ten post questions of the questionnaires was performed and the type of responses were grouped and evaluated accordingly. The same assessment tools were applied in both 3rd and 5th grade samples, identical in number of valid cases: 81 pairs (pre- and post-questionnaires) of the 3rd grade of basic education; 89 pairs (pre- and post-questionnaires) of the 5th grade of basic education, to be designated simply as 3rd grade and 5th grade sample, respectively.

3. Results

3.1. Pre-questionnaires - Assessment of knowledge and students' attitudes and opinions

Five open-ended questions to evaluate knowledge, classifying students' answers as C=correct; I= Incorrect, no answer, not know; PC= partially correct, and the type of answers were assessed. Before the educational activity, children already have the idea that algae, mosses, ferns, plants with cones or flowers are all plants: 82% and 73% of correct answers for 3rd and 5th grade students, respectively. However, within a second level of demand, only 4% (3rd grade) and 10% (5th grade) recognize that all the elements of the previous group, the plants, are living beings. 100% of the children of the 3rd grade and 97% of 5th grade children were not able to identify or distinguish different groups of plants. In what concerns to the existence of a relationship between these groups, 72% of 3rd grade children and 66% of 5th grade children do not know this relationship and the remaining students do not respond correctly.

3.2. Post-questionnaires - Assessment of knowledge

From the applied ten post questionnaires questions, only the more relevant percentages and type of answers will be presented as table. In the 3rd grade, 59% of students give partially correct answers (Table 1) and 6% of students respond correctly (Table 1), learning that there are five groups of plants and identify them as living beings; in grade 5th, 74% of children answer correctly (Table 2) with 43% describing "Algae, moss, fern, plants with cone plants and flowering plants are 5 groups of plants, that are living beings like us" (Table 3).

Table 1. Post questionnaire-2ndQ: correct, incorrect and partially correct answers (3rd grade)

Post questionnaire-2nd Q: correct, incorrect and partially correct answers (3rd grade)	Nº	%
PC	48	59.3
I	28	34.6
C	5	6.2
Total	81	100

Table 2. Post questionnaire-2ndQ: correct, incorrect and partially correct answers (5th grade)

Post questionnaire-2ndQ: correct, incorrect and partially correct answers (5th grade)	Nº	%
C	66	74.2
PC	17	19.1
I	4	4.5
NR/NS	2	2.2
Total	89	100

Table 3. Post questionnaire-2ndQ: type of answers (5th grade)

Post questionnaire-2ndQ: type of answers (5th grade)	Nº	%
Null	2	2.2
5groups / plants / living beings	28	31.5
Algae, moss, fern, pine cone plants and flowering plants / 5 / plants / living beings	38	42.7
Algae / plants / living beings	3	3.4
Confusion among flowers, plants and animals / evolution	3	3.4
There are several groups of plants	15	16.9
Total	89	100

About 35% of the 5th grade students identifies all groups as plants based on the morphological characteristics as "Presence of flower and fruit and pine cone / flower, seed, leaf / flower seed fruit / leaves and seeds found"; only 1% of the 3rd grade students could indicate that "Among the groups, same, have a seed, some not".

Table 4. Post questionnaire-4th Q: type of answers (5th grade)

Post questionnaire-4th Q: type of answers (5th grade)	Nº	%
Null	18	20.2
First appear the algae, then the moss, the fern, the plants with cone and then with flowers	31	34.8
Evolution of plants begin with the algae	6	6.7
Evolution is great and funny	6	6.7
There are several types of plants in evolution	4	4.5
Very important, brutal, interesting	8	9
In one hand we have the evolution, five fingers five corresponding to five plants groups	8	9
Evolution period is a very time consuming period	8	9
Total	89	100

Concerning the evolution of the 5 main groups of plants, 10% of 3rd grade students say that "First appear the algae, then the moss, the fern, the plants with cone and then with flowers" and the 35% of 5th grade student's totally success in this plants chronology (Table 4).

3.3. Overall assessment and student's attitudes and opinions

The educative activity was appreciated by the great majority of the students of 3rd and 5th grade, that feel willing to adopt some new attitudes on nature and plants awareness and that made different suggestions to improve the activity (Table 5). After this educative experience the great majority of the two grades students could expressed a positive appreciation of the activity and also considered to feel more inspired to learn more about the natural world.

Table 5. Post questionnaire-5th to 10th Q: type of answers (3rd and 5th grade)

Post questionnaire-*5th to 10th Q type of answers (3rd and 5th grade): Type of answers*		
Student's attitudes and opinions topics	3rd grade (%)	5th grade (%)
Positive general appreciation of the activity	86	93
Proposing more activities / more stories/ internet programs	16	20
Willing to study how plants evolved	6	77
Be able to talk to a friend about different groups of plants in a garden	47	73
Be able to show ideas about the evolution of plants in a debate or discussion	35	43
Feel more inspired to learn more about the natural world	79	86
Feel closer to nature and think about what may affect it	12	31
Willing to sign up a nature or science club (3rd grade)/ Read more books/magazines on the natural world (5th grade)	10	20
Willing to visit a museum, botanical garden, zoo or park	7	31

4. Discussion and Conclusions

Without comparisons on the application of other teaching-learning methods, the evidence from this activity on "The alga who wanted to be a flower" indicate that some effectiveness was achieved with the educational IBSE methodology used in the learning process of the 3rd and the 5th grade students of basic schools, about the five different groups of plants and their evolution, while living beings, like us humans, as new knowledge was partially achieved by the students. As revealed by the assessed pre and post questionnaires, the level of knowledge of the students before the action on the distinction of plant

groups, recognizing plants as living beings and their evolution was very low and similar in both groups, 3rd grade and 5th grade, respectively, although the majority have already the idea that algae, mosses, ferns, plants with cones or flowers all belong to the plants' group.

The construction of new knowledge was reflected by less than a half of 5th grade children identifying the five groups of plants as living beings and answering correctly describing "Algae, moss, fern, plants with cone plants and flowering plants as the 5 groups of plants, that are living beings like us" and only a fewer part of the 3rd grade children; on plants evolution some 3rd grade students learned this path for plants and more 5th grade students totally successes this chronology.

As the same questionnaires (pre- and post-activity) were apply to 3rd to the 5th grade students, it allows to compare the knowledge and opinions of students relatively to the same questions, regardless of the students' age or the curriculum level in question. Not surprisingly, the results reveal a general advantageous on the learning performance and skills of the 5th grade students comparing to the 3rd grade younger ones, which yet fulfilling the main objectives, what brings the perspective to say that new concepts are possible to be learn whatever age. Students knew that the questions were the same for different level age till 9th grade, as this notification was made when students have doubts in completing the questionnaires, taking the opportunity to explain the lack of response may be an answer, and sometimes there can be no single answer to the same question, which depends on the knowledge and realities of each student and each school. The students themselves realize that their knowledge and skills evolve, as well as the path of life and the path of the five main plants groups they learned. What they do not know or are not able today can learn or do tomorrow.

Besides new knowledge acquisition, the attitudes and opinions of both the 3rd and 5th grade of students also revealed new interests and awareness on plants, globally. As this action is planned to be applied to students up to the 9th grade, the level of demand for the correction was made to this level of education, the one that evaluates this sample, composed of 3rd and 5th grade students, what can probably explain that there had been not a large number of correct responses on the post-questionnaires. Pondering all the factors and evidences, on a general overview, we may consider that the main objectives on this Natural Sciences IBSE activity for learning seem to have been achieved. Some evolution and enrichment of students' knowledge, skills and attitudes were attained, specially reflected on their ideas and proposals to further resources to be use, being willing to extend the activity scope as well as their knowledge background possibilities.

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