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Apples with Science

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Abstract

In the first years of school, Science Education represents the beginning of the scientific methodology, stimulating the curiosity throughout the observation of the world and contributing for a future reflexive, participant and interactive individual and social attitude. However, in the first years of schooling, educators and teachers usually opt for an approach more expositive and, sometimes, decontextualized [1].

To promote active learning in a group of Primary School students we propose a simple approach to an everyday problem - apple browning and the use of the antioxidant products, with the use of hands-on activities and based on a Problem-Based Learning (PBL) [2], which is not a common practice in Pre-school and Primary Education schools in Portugal. Based on a possible situation of the students' quotidian, a fundamental question is raised, which acts as the organizing centre of the activity. This activity is structured and oriented in different phases, promoting the autonomy, reasoning, the ability to organize tasks, cooperative work and scientific literacy.

Therefore, starting from a specific problem, the students will be oriented to explore and acquire the necessary knowledge to identify the study variables; the activity is designed and planned with the participation of students and a prediction grid is suggested; the experiment is performed and discussed based on the student´s records. After the conclusion of the experimental activity, the students may be encouraged to study other variables. We should emphasize that it is necessary to adapt the language to the level of teaching, always keeping in mind the technical and scientific rigor.

We present a proposal for science teaching that is student-centred, contributes to a better retention of knowledge and stimulates motivation for science and for life.

Keywords: *Science Education, Problem-based Learning, Experimental Activities, Scientific Literacy*

1. Introduction

Problem-based learning (PBL) is an instructional strategy that is student-centred, facilitating the acquisition of scientific methodology and promoting curiosity. The student becomes able to observe the surrounding environment and acquires/expands theoretical knowledge [3], enhancing competencies such as critical thinking, decision making, autonomy and social awareness [3, 4, 5].

The PBL methodology is one of the inquiry-based science education approaches recommended by several educational entities [6]. However, in spite of all the recognized advantages and recommendations, it still continues not to be a common practice in Pre-school and Primary Education schools in Portugal [1].

2. Apples with science – an activity proposal

Starting from a daily situation of the Primary School students and using a common hands–on activity used in several levels of education - apple browning, we propose an active learning strategy using a problem-based learning approach.

Teaching sciences in a way that students´ ideas, questions and daily experiences are placed in the centre of the learning experience requires the ability of using their own questions or guiding them to ask the relevant or adequate questions [7]. Moreover, this process should be creative, using, if possible, hands-on activities and should be part of a meaningful context for the children.

In this work, we used as starting point a conversation that is frequent between students that are intrigued by the differences in the browning of a chopped apple with and without lemon juice.

Students are stimulated to discuss and share their conceptions/pre-existing ideas and misconceptions about the observed phenomenon and guided to do research in order to improve their knowledge and to attempt to explain their observations by gathering relevant information.

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Table 1 summarizes the several phases in the development of the activity.

Table 1 – Summary of Proposal Phases

Phases	The student should be able to ask…
Context	• What did I observe? • What happened that made me curious about? ***"My chopped apple is brown"***
Possible explanations ↓ Possible Questions (e.g.) → ↓ Choice of the QUESTION	• Does the temperature influence the browning of the apple? • Are there any substances that prevent the browning of apples? • Can the apple variety influence the browning of apples? • What do I want to know?: ***"Are there any substances that prevent the browning of apples?"***
Identification of study variables (e.g.): • Apple storage temperature (e.g. fridge) • Substances added to apple (e.g. lemon juice) • Apple variety Design of records instruments	• What will I held constant? (**controlled**) – variety of apple; temperature; light, size and shape of the slice; • What will I change (**independent**): substances added to apple • What will I observe/measure? (**dependent**) – the browning of the apple **Grids, tables, etc.**
Design of procedures and required materials ↓ Activity Plan	• What do I need? • How will I perform my activity?
Predictions	• What do I think it will happen?
Implementation	
Observations/results	• What do I observe?
Discussion/Conclusions	• What happened?/Why?/How? • What can I conclude?
Evaluation	• Is the QUESTION answered? • What did we learn?: – concepts – procedures – scientific method

The scientific method can be introduced to students by defying them to test the different explanations achieved and select the most feasible ones. As different explanations lead to different possible questions of study, it is useful to represent them so that the variables of study are correctly identified and the QUESTION could be formulated.

We considered the question *Are there any substances that avoid the browning of apples?* as a possibility of choice by the majority of children as it could hypothetically reflect their experience and it is related to the observation of students that eat their apples with a few lemon drops added.

The activity should be planned with the participation of students, making an organized register that includes the overall process (table 1) – from the definition of the question, identification of variables and procedures, to the prediction and the observation/results grids.

The teacher should lead the students into understanding the sequence of events (what are the causes? What are the effects?), guiding them into the procedures and type of records that can be

used and enabling them to identify the study variables: controlled, dependent and independent variables. The students actively participate in the design of the activity which facilitates the understanding of all the processes that naturally become meaningful to them.
This type of work will contribute to the development of scientific thinking as well as the comprehension of all the concepts related.
Before the implementation of the activity, students are involved in the experimental design, in the selection of materials needed and propose the type of records. Whenever possible, the materials and equipment should be of common use, easy to obtain, appealing, captivating and safe for children to manipulate
The activity is subsequently implemented. Briefly, the effect of four different substances (plain water, natural lemon juice, natural orange juice, vinegar) is tested in the browning of the sliced apple. The samples are labelled 1 to 5 (control+ four different substances). The five slices are submersed in the different solutions for thirty minutes.
Based on the observations grid, each group of students interprets and discuss the results with the class and verifies which of the proposed solutions best answers the QUESTION. To promote autonomy, students must be aware of the competences/skills achieved.
Throughout the activity (from the initial phase of research to the drawing of conclusions) it is possible to work concepts from the areas of biology and chemistry in a language adapted to the age group (Fig. 1).

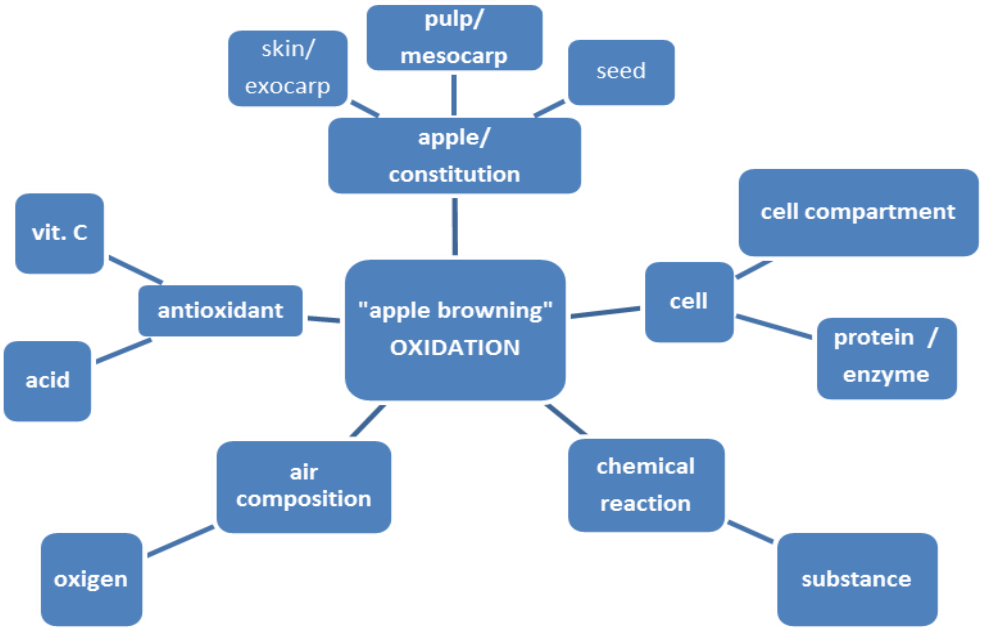

Fig. 1 – Excerpt of a MindMap of the topic of oxidation
In the final stage (evaluation), with the participation of the students, it should be verified if the results allow to answer the initial question and a synthesis of the knowledge (conceptual, procedural and attitudinal) obtained and / or developed through the activity proposed to the group should be done.

Conclusion

We think that this proposal contributes for students to acquire new and a more vast knowledge by solving real-world problems promoting the acquisition of scientific literacy. This process is based on self-recognition of a need to learn and enables new skills to be acquired, such as scientific reasoning and simple laboratory procedures. The fact that these activities usually involve teamwork contributes for the development of social competences and interpersonal communication. Moreover, it improves student self-efficacy and learning outcomes and students become conscientious about their learning. These activities represent a challenge and as any challenge they become much more stimulating for the children.

We consider that simple practical activities, such as the one presented, when worked in accordance with the PBL approach constitute an added value in the learning process of primary school children.

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