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Active Learning of Plants Biology - Report on an Effort to Educate Science Teachers in Brazil

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Abstract

There is no question that plants are an important part of ecosystems. Knowledge on the more than 300,000 species of Embryophytes known today is available through different sources and scopes, as systematics, taxonomy, morphology and ecology. However, studies point to the lack of enough contextualization and engagement of students in basic education when exposed to plants biology subjects at school. Reasons are many, going from motivational factors on the students' side, to lack of preparation of instructors to teach about plants, a phenomenon referred by many authors as "plant blindness". This paper will describe an effort to educate Brazilian Biology educators towards more effective ways to teach plants biology. Between 2017 and 2019, we held workshops and activities with teachers and grad students at the University of Sao Paulo (Brazil). These workshops focused on describing systematic ways of organizing classes and activities on topics related to plants biology. Based on this experience, we report the planning of project-based classes on topics like plants life cycle, plants anatomy and physiology and plants evolution and taxonomy systematics. Activities developed during the workshops, as well the responses from the teachers taking the discipline will be discussed, and with this we present a paper providing examples on how to tackle "plant blindness" and achieve more effective outcomes when teaching plants biology.

Keywords: *Plant Science, Active Learning, Science Education, Teachers' Training, Basic Education.*

1 Background

The LDB law from 1996 [1] had an important impact on national curriculum development in Brazil, acting as a scaffold for many other actions. The BNCC (National Curricular Common Base) was one of these actions, guiding teachers and school administrators on what and how to teach [2]. For the Science curriculum in particular, the thematic unities are suggested for each of the nine years of the basic education, and three years of high school. Although the BNCC is successful in suggesting abilities and competences that must be fostered during the school life, it does not bring many concrete examples of activities that can be used in class to reach these goals.

This can be a potential problem when the contents being taught are of difficult engagement. Within natural sciences, plants sciences classes are frequently reported as a difficult and less engaging topic, both by students and teachers [3] [4]. The main challenges teachers face when designing botany classes include plant blindness [5] and *zoocentrism* [6], difficulties in engaging an evolutionary context to the teaching approach and lack of access methods and activities designed for an effective teaching and learning [7]. This paper describes an effort to educate Brazilian Biology educators towards more effective ways to teach plants biology, hoping to cover the lack of access to teaching methodologies reported in the literature.

2 The Workshop

2.1 Workshop organization and implementation

The workshop was held at the University of São Paulo (Brazil), in August 2017. The discussions were recorded with consent of the participants and transcribed through 2018. Fourteen students from the department and teachers working at public schools in São Paulo joined the discussions. Prior to the beginning of the workshop, participants were inquired about their expectations through Google Forms. Also, participants were asked to suggest one topic in Plants Biology they would like to develop into a class activity. The workshop was 4 hours long, and divided in two main parts: a lecture and discussion on Active Learning and classes design methods; followed by a group activity applying the concepts discussed on the first half of the workshop.

On the first half of the workshop, participants were exposed to the concept of Active Learning and some studies discussing the effectiveness of the methods. After this, a system for designing classes

was introduced, and participants were informed that they would follow this system on the second half of the workshop. The system provided to participants suggested: (1) deciding a theme or topic accordingly to the time and resources limit; (2) listing goals for the activity to be designed; (3) stablishing the required skills for the effectiveness of the activity (including cognitive, practical and attitudinal skills); (4) setting the expected outcomes of the activity; and (5) planning the materials, methods and chronogram for the activity. Finally, participants were exposed to four examples of activities designed using the five steps described before. Participants were, then, divided in groups for the second part of the workshop.

2.2 Activities design

On the second half of the day, participants were divided in three groups and asked to design an activity on a common topic: plants life cycle. To support the activities design and to facilitate the implementation of the methods exposed on the first part of the workshop, participants received a framework with the five design steps explained above, and a supplementary table with a series of suggested active learning methods (Table 1). The supplementary table included methods organized by (1) name, (2) time for implementation, (3) target group size, (4) goals, and (5) a brief description of the method. The methods included in table 1 were adapted from the "+15 minutes" booklet [8]. The requirement was for participants to implement at least one of the methods described on table 1.

2.3 Feedback

Participants worksheets, including the activities developed during the workshop, were shared and discussed between groups at the end of the day. Finally, the worksheets were collected and compared to the initial expectations reported in the pre-workshop questionnaire. Transcriptions of the discussions, the pre-workshop questionnaire answers and the two final worksheets were used for discussion in the following section.

3 Outcomes

3.1 Pre-workshop questionnaire

When inquired about the expectations towards the workshop, participants replied with both conceptual and practical reasons. The most common answers (9 respondents) showed intentions towards the praxis: i.e., intentions to "learn new methods", to "learn how to plan active learning classes", and to "learn how to apply AL methods to classes". Additionally, half of the entries (i.e., 7 respondents) mentioned an intention to learn about the concept of active learning, and only 3 respondents (2 PhD students, and 1 undergrad student) showed an academic interest on the research supporting these strategies.

The second question of the pre-workshop questionnaire asked participants to suggest one topic in Plants Biology that they would like to use as a basis for the development of a class activity. Within the obtained answers, "Evolution and Plants Diversity" was the most common topic, present in 8 of the responses. "Ecology of plants" (2 entries), "plants reproduction" (1 entry) and "plants cytology" (1 entry) were also responses obtained. This evidences a need within the participants for an approach based on critical thinking and process skills that can be used to explain concepts in Botany [9].

3.2 Work sheets

3.2.1 Group 1: Mosses (and allies) life cycles

School year: 5^{th} – 9^{th} grades, basic education

Goals: To learn the concepts of spores and gametophytes; to learn how to formulate hypotheses; and to develop skills for abstraction through reading of visual models of the life cycle.

Chosen Methods: Buzz-groups, Snowball

Methodology: Students are exposed to images of life cycles in plants, without any labels describing the different generations and structures observed. In groups of five, students are given 15 minutes to think on a description of the figure ("Buzz-groups" method). After this, the instructor brings "trigger questions" to guide students' descriptions ("Snowball" method). Groups receive 10 minutes to discuss on the trigger questions, and then additional 15 minutes to label the life cycle figure with concepts provided by the teacher. In the final 10 minutes, each group gives a small presentation on the completed life cycle figure.

Table 1: Model table provided for the activity design. The original table (in Portuguese) also included a description of each method. Participants were asked to refer to this table and use at least one of the suggested methods in their original activities.

Method	***Time***	***Target***	***Goals***
Think-pair-share	5 – 20 min	Pairs	• To discuss and fix concepts • Projects • Problem solving
Buzz groups	5 – 20 min	Groups	
Snowball	10+ min	Groups → whole class	• Projects • Problem solving • Development of complex ideas
Corner exercise	20+ min	Pairs or groups	
Peer-Review	15 – 30 min	2-3 students	• Revision • Development of academic skills
Mutual-class method	20 – 40 min	Pairs	• Discuss and fix concepts • Challenges
Minutes paper	5 – 15 min	1-2 students	• Feedback activities
Revision table	5 – 15 min	1-2 students	
Worksheet	5+ min	1-2 students	
Brainstorming	10 – 20 min	1-2 students	• To apply concepts • Develop academic skills
Word webs	20 – 30 min	Groups	• To review/ Fix concepts • To connect concepts
Jigsaw	30+ min	Groups → whole class	• To solve questions • Hypothesis design • Teaching skills development
Case study	30+ min	Pairs → groups	• To solve questions • Development of academic skills • To recognize/ understand concepts
Problem Based Learning	1 hour	Groups	• Development of academic skills • To recognize/ understand concepts • Hypothesis design • Research project
Poster section	30+ min	Free	• Communication skills • Discussion skills

3.2.2 Group 2: Embryophytes life cycle

School year: 1-year University

Goals: To discuss evolutionary trends in embryophytes' life cycles; to make evident the diplobiont condition of embryophytes' life cycle; to understand and interpret visual representations of life cycles.

Chosen Methods: Word Webs, Jigsaw or Corner Exercise, Case Study

Methodology: Using the "Word Webs" method, students first discuss and review the concept of "diplobiont life cycle", and then are divided in six groups. Each group receives a set of examples of life cycles and have some time to study it. After this, students are shuffled between groups in a "Jigsaw" or "Corner Exercise" model, and have to explain the life cycles to other groups' members. In the sequence, the instructor brings some case studies, and open space for discussion.

4 Reflections and Conclusion

Both activities designed by the groups start with an exposition of the student to the problem to be discussed (Introduction), move to one of more activities that bring additional layers to the topic

(Development), and finish with a summary or reflection of the activity (Conclusion). During the initial 10 minutes of workshop, both groups focused on deciding a topic and setting goals and requirements for the activity to be designed.

The analysis of the transcripts shows that the group working with high education struggled when narrowing down topics for activities. Concerned with the idea that in high education classes need to cover broad topics in a deep approach, participants of this groups spent the first 10 minutes diverging in opinions of what topic to decide for. The table with suggestions of activities provided by the workshop (table 1) proved useful for this group: the table aided participants on focusing their ideas towards the educational goals they had in mind. As the workshop facilitator, it was interesting to observe participants of this group scooping activities from the table based on their needs. This is another evidence that systematic ways to teach sciences (like the resources presented here) can be very useful to teachers.

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