Revista de Estudos Curriculares nº 8, Vol 2, 2017

BOTANY ON THE SPOT: COLLABORATIVE PRODUCTION OF DIDACTIC MATERIAL FOR ELEMENTARY AND HIGH SCHOOL STUDENTS

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ABSTRACT

Botany is an important area within the Biological Sciences, yet many times neglected by teachers during the official schooling period. Literature has pointed out that teachers generally do not teach botanical contents, or teach them somehow superficially and/or inadequately, during Elementary and High School levels. The present paper brings the results of a collaborative approach applied with undergraduate students from a federal institute in Sao Paulo – Brazil, during an elective curricular subject of Biological Sciences in 2016. We aimed at promoting interaction, sharing of skills amongst students, and enhancing every member's active voice in the group. Various and diversified didactic materials were produced during the application of the approach. We have concluded that students can be enhanced to be protagonists of their own learning and produce didactic material to be applied for learning and teaching of botany. Curricular changes that might absorb alternative ways to teach and learn botany are possible.

Keywords: Botany; collaborative production; didactic material; basic education levels.

Introduction

Botany is perhaps one of the oldest areas of the so-called Natural Sciences, much older than the official biological area (Rochberg, 1992). Botany is a much-consolidated area within Biology, with several specializations: anatomy, ecology, systematics, and so forth (Flannery, 1991).

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Plants have been used since unreported times for shelter, furniture, food, medicinal use, clothing and many other applications (Hershey, 2002; Laws, 2010), and are also important elements of nature, being the initial step of food chains in terrestrial and water environments (Wandersee & Schlussler, 2002).

Santos and others (2012) report that botany and zoology are the central columns of all biological knowledge. Despite their importance, plants and related organisms (namely, blue-green algae, unicellular and multi-cellular algae, and fungi) are generally neglected or given little value when compared to animals. This is due, perhaps, to the fact that animals move and interact more clearly with people, and kids are particularly more interested in something that moves and interacts (Santos *et al*., 2012).

So, by reading the above statements, we might affirm that botany teaching is a complex task, as merely descriptive teaching does not face the demands of the current world, which has been constantly involved in continuous technological advancement (Krasilchick & Trivelato, 1995; Garcia, 2000). Students and citizens in general should understand that plants are present in our routine life, and thus their study is to be enhanced, according to the National Research Council (NRC, 1992). Biotechnological products involving plants and related organisms, such as bio-fuels with green algae, food betterment, and bio-energy, to cite a few, have been currently developed and applied worldwide in various and diversified systems and services (Carrer *et al.*, 2010).

Teachers seem to neglect such vast and momentous knowledge, though. Many researchers, such as Guimarães (2008), Cavadas and Guimarães (2010), and Guimarães and Santos (2011), have pointed out the problems concerning the teaching of botany. Some of these problems include the perspective that teachers have generally faced teaching and learning of the Kingdom Plantae as something difficult, thus uninteresting. This idea is also shared by Kinoshita and others (2006), Santos (2006), Caldeira (2009) and Melo and others (2012).

Brazilian students (both Elementary and High School levels) have reported that botanical content learning is not stimulating, hence tedious and extremely hard (Uno, 1994). Caldeira (2009) has mentioned that even many Biology teachers consider botany as uninteresting. Santos (2009) noted that botanical content has been commonly taught without contextualization with the surrounding reality, thus demotivating; still, such teaching has been extremely focused primarily on the memorization of names and structures. By using games and didactic strategies, teachers might enhance a more dynamic, contextualized, and active way of teaching botany (Campos, 2002).

The present paper reports the collaborative production of didactic material aimed at teaching botanical contents on the perspective of its betterment, focused on an interactive and collaborative teamwork. Our guiding questions were: a) How can a collaborative approach

enhance the active voice of each of the teamwork members?; b) Elementary and High School level students can be benefited with materials produced by a collaborative teamwork?

1. Botany in the Formal School Curriculum

School textbooks are important elements due to their role in shaping the way contents are to be taught; thus, they are a way of dealing with the pedagogical knowledge. Textbooks articulate aspects related to the sequence and rhythm of knowledge transmission, being crucial pedagogic and didactic tools that propose activities and ways of assessing the accomplished acquisitions (Guimarães, 2010).

School textbooks are significant pedagogic, cultural, and ideological instruments that contribute to the transmission and consolidation of knowledge, thus assuming an important role during the learning of contents and working methods (Guimarães, 2010).

Although textbooks play important roles within schools, they should be analysed critically. Molina (1988) stated that textbooks are also limiting factors when teachers only reproduce certain contents without contextualization and/or understanding of their historical development. Without a critical view, textbooks may sometimes present information that is not updated, omitted or, even worse, scientifically wrong or inadequate.

According to the Brazilian national fund for educational development (FNDE), Brazil has a national initiative of distributing textbooks to all public schools through the National Program of Brazilian Textbooks (PNLD), which has been active since 1929, though with other designations (FNDE, 2012). Textbook collections, for all educational levels, are scrutinized by a board of specialists and only approved titles may be available for distribution nationwide after schools choose their collections (Garcia, 2014).

Botany in basic education in Brazil, comprising Elementary School – 2nd Cycle (6th to 9th grades) and High School, is generally split into separate compartments: morphology and anatomy, taxonomy, physiology, and ecology. Such divisions are repeatedly presented in textbooks as individual blocks, which do not bring a contextualized and integrated approach; thus, the way that a certain group of plants is introduced may lead learners to consider it as a single part of the entire ecological and natural organization of life, instead of seeing it integrated to nature (Silveira, 2011). One of the possible difficulties of such approach is that students tend to think that botany is an endless list of memorizing names and complicated scientific vocabulary (Santos, 2006).

An alternative way of teaching and learning botanical contents is through investigating phenomena. This is our topic of the next section.

2. Investigating and Learning

For many years, researchers have claimed that many countries have a mixed scenario of traditional approaches (teachers are the focus of the process) and student-centred approaches (teachers are mediators of the process). Though necessary, proposals to implement curricula targeted to less content-oriented focuses and more emphasis on competencies, abilities, and other demands of the 21st century, are still sparse and little disseminated (Driver, 1988; Rubba, 1991; Cachapuz *et al*., 2005).

Worldwide, many schools have adopted the so-called Investigation through Research (IR), as pointed out by Kelman (1996) and Layrargues (1999). It aligns with other approaches, such as Problem/Project Based Learning (PBL). IR places students as central and active agents of their own learning processes by making them solve problems of the routine life instead of depending passively upon the teacher. Thus, students are encouraged to search for contents, answers for their questions, and to interact collaboratively with other students and teachers (Murphy & McCormick, 1997). Some authors defend that it is possible to work with activities that link academic knowledge with its transposition to the classroom (NRC, 1992; Kinoshita et al., 2006).

Educational Technologies are tools that might enhance learning and teaching, but they are not essential to guarantee high levels of educational quality (Auler, Dalmolin & Fenalti, 2009; Rezende & Struchiner, 2009). According to the United Nations Educational, Scientific and Cultural Organization (UNESCO), training teachers is much more important when knowledge build-up processes are taken into consideration so that students can work actively, i.e., they are not mere containers of knowledge transmissible passively (UNESCO, 2003).

Alternative methods that motivate teachers to develop less explanatory classes and depend minimally on test correction and endless exercises are possible. Contextualized material regarding the teaching and learning of botany and some alternative ways to adequate it to elementary level students have been studied (Santos, 2009). Cachapuz and others (2005) have also emphasized the urgent need to a new conception of teaching that might be aligned with the proposals of others researchers (Morin, 2000; Pinheiro, 2009).

Teamwork is a very important condition within the educational reality that promotes student-centred approaches and focuses on the demands of our current world; several abilities, such as discussion of ideas, opinion comparison and task completion, are also worked with (Arisa, 1987; Alarcão, 2003; Arruda, 2004; Amorim, 2004). These concepts are briefly discussed in the next section.

3. Learning Collaboratively

Collaborative work might facilitate many enriching possibilities: experience exchange, ideas, projects and life reports, professionally and personally. Collaborative productions

encourage teachers to share common problems and work on a cooperative basis, similarly to a research community that measures its values and beliefs (Burns, 1999).

Lopes and Silva (2009) state that collaborative (or cooperative) learning is a type of methodology that fosters students to help one another during their learning processes, acting as partners among themselves and with the teacher. Freitas and Freitas (2003) consider that cooperative learning is a very important teaching method, as students are seen as central elements throughout the whole process of learning and teaching. Such approach enhances learning, interpersonal relationships, and self-esteem.

Collaborative learning is one of the most important tools to guarantee students' success. It reaches both cognitive and acquisition levels, thus stimulating their social competences (Fontes & Freixo, 2004). These authors also state that such competences should be emphasized so that cooperative work is best developed. Still, social competences do not appear intuitively and, then, should be worked with correctly and neatly.

Five elements should be present during a collaborative class or activity: positive interdependence, individual and group responsibility, stimulating interaction, social competences, and group assessment (Freitas & Freitas, 2003; Johnson & Johnson, 1989 apud Lopes & Silva, 2009).

Students should be given some autonomy so that cooperation amongst groups might be established (Lopes & Silva, 2009); students should also be able to handle with autonomy. Thus, by assigning roles to students, teachers guide them towards an equal level of cooperation (avoiding that some students cooperate and others do not).

Moreover, the teaching of Sciences (extended to botany) is still seen as a mere transmission of knowledge to students. Sequeira (2004) mentions that teachers focus on transmitting contents of what is present in textbooks; students, then, supply teachers with answers to questions also present in textbooks. However, students can grasp natural events more easily and get more interested in Sciences in an active way if they have the opportunity to manipulated materials and observe various phenomena (Sequeira, 2004).

The members of a collaborative teamwork show individual and institutional respect amongst themselves. This is an essential condition for an autonomous self-guidance (Kinoshita et al., 2006). Autonomy is responsible for avoiding a more 'traditional' and dictatorial profile of the group, offering it true partnerships through the intellectual and affective availability of all the members. Thus, hierarchical positions tend to be less consistent; as decisions are taken collaboratively and coordinate efforts to reach previously targeted objectives are enhanced (Schreiber, 2007).

Collaborative learning is, therefore, very important for Science teaching as it develops certain competences treated as significant to learn about Sciences (Santos & Guimarães, 2014) because students get involved more actively in activities that allow idea sharing. Science

teachers should make use of collaborative learning during their classes so that students are more able to investigate, question, build knowledge, and get more autonomous.

4. Methods

During the second semester of 2016, a group of 20 undergraduate students (Biological Sciences) of a public Brazilian institution enrolled in a curricular, elective discipline called *Botany in Context*. A specific *Facebook*® group was created for registering actions and inserting materials, such as files, photographs, reports and so forth.

The two-class discipline was offered weekly, in a total of 19 weeks. Students were presented with the general objectives in the first class; a survey of their motivations and reasons for enrolling in the elective discipline was carried out. One of the students was democratically elected 'supervisor' (that is, a monitor), and he should report all of the group actions, as well as coordinate collective decisions together with the teacher in charge.

All students agreed to work throughout the semester guided with a collaborative approach aiming at promoting interaction amongst them, sharing skills and knowledge, and enhancing the active voice of each member.

At first, participants decided to share a *GoogleDrive*® folder on-line, where reading materials (articles of periodicals and journals specialized in botany teaching, collaborative productions, PBL etc.), classroom materials and, later, productions of the group could be stored.

Students read the articles stored in the shared folder and searched other sources on botany teaching for two weeks. One of the classes targeted the discussion of the reading material.

After reading the articles, participants decided to analyse several school textbook collections currently adopted in Brazil for both Elementary and High School levels (Sciences and Biology, respectively), so that contents usually present in those materials could be verified. Textbooks were chosen by considering two points: publication dates (only materials published after 2014), and dissemination on a national scale (PNLD, 2016). Students organized spreadsheets with information on the main contents of botany found in such textbooks (mainly, books of the seventh curricular year for the Elementary level, and of the second year for the High School level).

During the other classes, all participants attempted to decide on botanical themes of their own choice, and what types of didactic materials could be produced; yet, they chose how such materials would be disseminated (online, printed version etc.) and how teams should work thereafter. Work teams were not rigid and fixed, i.e., many teams regrouped according to the kind of theme and methodological approach chosen.

Every three classes, approximately, each team presented their productions to the whole class, followed by a discussion in-group. Suggestions, positive criticism, and alternative ways to the final project build-up were developed during those preliminary exposition classes.

Participants decided to expose the material produced in a public event. The discipline monitor suggested that the exposition should be settled inside the central hallway of the institution, and everyone promptly accepted his suggestion. The event was named *Botânica+Legal* ("*Botany+Cool*"). A 20 m2-stand was built on a bamboo framework covered with green clothing. The event was catalogued as an institutional, extension project, visited by 103 people during ten hours of exposition.

Participants of the curricular discipline answered an online survey focused on all actions developed, decision-making processes, collaborative work and other related issues.

5. Didactic Productions

All participants produced and presented several diversified didactic materials during the semester. Collaborative production and group discussion was the general guidelines of such work. Investigation on the materials was carried out with the use of research in various electronic sites, such as *Scielo*®, *Portal Capes*®, *Academic Google*®, academic online dissertations and theses portals, as well as articles and other sources previously shared in the *GoogleDrive*® folder.

Diversified materials were produced during teamwork (Table 1). These materials were printed and some have an on-line version as well. Copyright implications do not allow complete dissemination in this article, though. This is the case of the on-line magazine of fruits and seeds, which is currently in process of publishing.

Name of material	***Target***
Teacher's guide: exploring botany	Sciences teachers and Biology teachers
Teacher's guide: why study botany?	Sciences teachers and Biology teachers
Botanical curiosities	Students of Basic school levels
Glass slides	Students of Basic school levels, Sciences teachers and Biology teachers
On-line magazine: fruits and seeds	Students of Basic school levels, Sciences teachers and Biology teachers
Models: botanical *Pokemons*®	Students of Basic school levels

Table 1. List of materials produced by students.

The teacher's guide on how to explore routine botany (Figure 1) aimed at contextualizing it to students, thus enhancing curiosity. It was devised having the Elementary School – 2nd Cycle in mind.

Figure 1. Front page of the teacher's guide on how to explore routine botany.

The objective of the teacher's guide on the reasons for studying botany (Figure 2) was to supply teachers with some interesting and contextualized aspects that might foster the teaching of botany.

Figure 2. Front page of the teacher's guide on why to study botany.

The student's book on botanical curiosities (Figure 3), as the name itself explains, aimed at bringing some fun facts and other general curiosities of the Plantae Kingdom, in a non-complicated jargon.

Figure 3. Front page of the student's book about botanical curiosities.

A semi-permanent glass slide collection (Figure 4) of botanical structures (fruit, flower, seed, stem and root) was produced to supply teachers and students with real plant structures. This material may be a supplementary element for learning morphology and anatomy.

Figure 4. Front page of the semi-permanent glass slide collection (on the left), and physical collection (on the right).

The models in semi-permanent synthetic material for botanical *Pokemons*® versions (Figure 5) were produced so that students who are familiarized with these characters may get interested in studying botanical features with them. A complete guide of the characters and their botanical correlations is part of the production.

Figure 5. Botanical versions of *Pokemons*®.

6. Final Considerations

Freedom of expression ensured during the course was crucial for every student to work certain areas of botany chosen according to individual needs; moreover, didactic materials were produced for own apprenticeship, for other teachers, and for current and future students. The answers of the online survey clearly show that participants consider a collaborative approach an appropriate way of teaching and learning.

All classes promoted interaction amongst students. Such interaction was crucial for students to share their knowledge, experiences and other skills collaboratively.

The active voice of each student was also fomented. It is important to notice that many self-called introverted or shy students eventually participated actively during classes, expressing their opinions and participating in group discussions.

The build-up of didactic materials focusing on botany consists of aiding tools for teachers working with Sciences (Elementary levels) and Biology (High School levels). While preparing their materials, students could investigate several subjects that are sometimes considered uninteresting or hardly learned, with which they will work in future Sciences or Biology classes.

The public exposition of the material produced during the elective discipline was a right decision, considered by the group as something of great relevance, as visitors could have the opportunity to notice that it is possible to produce high-quality didactic materials to be used by teachers and students.

The group could not finish two previously discussed productions (a video-class about pollination, and a 2017 calendar with flowers and fruits). These productions failed because of lack of appropriate equipment (film recorder, studio, microphones etc. in the case of the video-class), and lack of commitment and motivation (in the case of the calendar). Future versions of the curricular discipline may engulf such productions, if so decided by participants.

The importance of the discipline monitor, chosen by the group of students, was crucial for participants to organize their productions according to the schedule assigned for 19 weeks. Moreover, the monitor played a key-role in organizing the public exposition, creating and analysing the answers of the online survey.

We consider that students may be protagonists of their own learning processes; producing didactic materials collaboratively is a way of supplying teachers with subsidiary tools with which to work in a more contextualized scenario, bringing botanical subjects to routine life (Rubba, 1991; Schreiber, 2007).

Thus, we conclude that curricular changes that might absorb alternative ways to teach and learn botany are possible, tangible, and easy to implement.

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BOTÂNICA EM FOCO: PRODUÇÃO COLABORATIVA DE MATERIAL DIDÁTICO PARA ALUNOS DE NÍVEL BÁSICO E MÉDIO

RESUMO

A Botânica é uma área importante inserida nas Ciências Biológicas, embora seja, muitas vezes, negligenciada por professores durante o período escolar regular. A literatura mostra que os docentes geralmente não ensinam conteúdos botânicos ou, quando os ensinam, o fazem de maneira superficial e/ou inadequada para os alunos dos níveis básico e médio. Este trabalho analisa os resultados de uma abordagem colaborativa aplicada com alunos de Licenciatura de uma instituição federal de São Paulo – Brasil, durante uma disciplina curricular eletiva de Ciências Biológicas, em 2016. Foi nosso objetivo promover a interação, o compartilhar de competências entre os estudantes e a motivação para que cada membro do grupo tivesse uma voz ativa. Vários e diversificados materiais didáticos foram produzidos durante a aplicação desta abordagem. Concluímos que os alunos podem ser incentivados na construção de sua própria aprendizagem, além de produzirem materiais didáticos possíveis de serem aplicados no ensino e na aprendizagem de botânica. Vislumbramos, também, a possibilidade de mudanças curriculares que porventura absorvam maneiras alternativas de ensinar e aprender botânica.

Palavras-Chave: Botânica; produção colaborativa; material didático; níveis educacionais básicos.