Enhancing botany teaching and learning with Problem/Project-based Learning (PBL) approaches at a federal institution in Sao Paulo State, Brazil

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Abstract

Botany contents, specifically taxonomy and morphology, have been reported as extremely difficult, uninteresting and even irksome by Brazilian undergraduate Biology and Biological Sciences students. Recent systematical reviews of several vegetal groups, mainly the angiosperms, still do not appear in textbooks, which generally present outdated information and might hamper its learning. By contextualizing botany in real life and placing students as the core agent of their own knowledge-buildup, with the application of PBL (Problem/Project-based Learning) approaches, we have realized a significantly higher level of learning of botanical subjects. Various and diversified activities, such as projects, group work, field trip inventories, on-line material composing etc., have been employed for the last three years at the Federal Institute of Education, Science and Technology of Sao Paulo, campus Sao Roque (Sao Paulo State, Brazil). The campus botanical collections, principally the IFSR Herbarium (and fungi, wood and seed/fruit collections as complimentary materials) and the arboretum, are important resources to aid students in their PBL tasks. Research work and didactic/educational application activities have shown that students get interested in studying, researching, and producing materials with plant groups and their morphological features. Random tests containing curricular botanical subjects have been applied and results have been very satisfactory, with over 80% of average approval rates. Students have proposed the implementation of other facilities to be built at the campus, such as a butterfly nursing house and a medicinal plants garden. Further investigation of how PBL activities might improve contents of botany is necessary. Spatial and activity amplification of the campus facilities would enhance better use of its functions.

Keywords: Problem/Project-based Learning (PBL); Botany contents; Botanical collections; Learning

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Introduction

Botany has been reported as a difficult and uninteresting subject to teach and learn (Faria *et al*., 2011; Marbach, 2004; Pollan, 2001; Sundberg, 2004; Uno, 1994). Recent systematical reviews of several vegetal groups, mainly the angiosperms, still do not appear in textbooks, which generally present outdated information and might hamper its learning (APG, 2009).

Santos (2009a; 2009b) has pointed out the lack of contextualized materials regarding the teaching and learning of Botany, and some alternatives to adequate them for basic education students. Cachapuz and collaborators (2005) have also stressed the urgent need for a new conception of science teaching, thus aligning their ideas with those proposed by Morin (2000) and Pinheiro (2009).

Education in Brazil (more particularly in basic education levels, i.e., elementary and high school cycles) has experienced a mixed scenario of traditional approaches and those centered in students (Aikenhead, 1985; Gil-Pérez, 1991). The traditional approach can be understood as a set of practices, with a central focus on the teacher/professor; usually, classes are informative, directed to students with the use of expository units of classes, with little or no participation of learners. Thus, this kind of teaching and learning tends to consider students as mere containers into which knowledge is to be sowed. On the other hand, centered-student approaches (Scribner and Cole, 1982) consider students are active and important agents of their own learning, being teachers/professors mediators of such process. In such view, students participate actively in their decisions, and teachers supply them with enough conditions to build their own knowledge. Proposals to implement syllabi with a less content-centered focus, hence more emphasized on competences, skills, and demands of the 21st century (such as communication, critical thinking and entrepreneurship) are sparse and not so much enhanced, though necessary (Driver, 1988; Rubba, 1991).

PBL (Problem/Project-based Learning) is an education approach that has gradually been adopted by schools worldwide (Kelman, 1996; Layrargues, 1999), with which fictional or real problems of the community, local place or surroundings are the start-up to learn. In such philosophy, students actively search for solutions instead of relying on the instructor for passive learning of any content. Thus, PBL incorporates a philosophical thinking that places students as the core agents of knowledge build-up, being motivated to search contents, solve problems, as well as interact collaboratively among themselves and with the educator (Marçal *et al*., 2006). Investigations like NRC (1992) have shown that it is possible to hold activities linking academic knowledge and its transposition into classrooms. Moreover, we can emphasize the fact that although educational technologies are indeed tools to enhance learning and teaching (Auler et al., 2009; Rezende and Struchiner, 2009; Rubba, 1991), they are not essential for granting a high-quality educational level. Teaching training is far more important when one considers that, by knowing which objectives and targets are involved in their classes, teachers may direct the process of knowledge build-up so that students actively take place thoroughly, i.e., they are not merely vessels of passively transmitted skills. So to say, pupils are encouraged to search for contents, solve problems, interact collaboratively among themselves and with instructors, as well as search for solutions for local community demands (Unesco, 2003).

PBL has been adopted in some Brazilian schools gradually. Some educators have considered its approaches deeply. In such perspective, fictional or real problems of the community are the starting point for apprenticeship, which takes place practically with the search of solutions held by students. So, PBL incorporates a more student-centered pedagogical approach on active production. Instructors are given a more mediating role (Murphy and McCormick, 1997). It is possible to consider alternative methods with which teachers are not linked to a model that solely reflects a teacher involved with expository classes, activity writing, test corrections and so forth. Tests, in a more traditional view, are generally used to measure and grade mere punctual, memorizable, and decontextualized knowledge.

By contextualizing botanical subjects, we have been working with Biological Sciences undergraduate students at a Brazilian federal institution to address the following: a) Can PBL really aid students improve their learning of botanical curricula?; and, b) Do the botanical collections at the campus play a role in such approach?

Material and methods

The campus of the Federal Institute of Education, Science and Technology of Sao Paulo (hence referred to simply as IFSP-SRQ) is located in a peripheral area of Sao Roque Municipality, Sao Paulo State (Brazil). Its online homepage is http://srq.ifsp.edu.br/. Geographical coordinates are 23°33'S and 47°09'W. The campus area covers approximately 36,000 m^2. Its average altitude is 826 m above sea level (Figure 1).

Figure 1. Aerial view of the study area; geographical coordinates were taken with GPS at the yellow spot. Marked sites: 1= Marshy land and water stream; 2= Greenhouse facilities; 3= Laboratories complex facility; 4= Backyard site with disturbed vegetation and organic orchard; 5= Greenhouse facility and arboretum of native species; 6= Woodland with various angiosperm families representatives; 7= Administrative and educational complex facilities (library, classrooms etc.); 8= Access motorway (Rodovia Prefeito Quintino de Lima – see text); 9= Disturbed vegetation and parking facility. GoogleEarth® Program, ©2013 Map Link, Digital Globe (Santos, 2013, p. 53).

Various and diversified activities have been employed for the last three years at IFSP-SRQ with Biological Sciences undergraduate students. These activities include projects, group work, field trip inventories, and on-line material composing, mainly.

Projects are part of the work carried out at the IFSP-SRQ Botany Laboratory: the campus botanical collections comprise principally the IFSR Herbarium (and fungi, wood and seed/fruit collections as complimentary materials) and the arboretum; these are important resources to aid students in their PBL tasks (Figure 2).

Other surrounding sites, such as a remnant of the Atlantic Rain Forest and a fragment of a tropical forest, have also been targeted complimentarily as field trip inventories have been done on fungi, ferns, and angiosperms check-list surveys. Several papers have been published as direct results of such surveys (Santos, 2017).

Figure 2. Logotypes: Botany Laboratory (A) and IFSR Herbarium (B).

Projects involving surveys of the arboreal flora within the campus, as well as the build-up of pedagogical games with botanical contents, are encouraged and take active part of the Biological Sciences course curriculum, specially "Botany 1" and "Botany 2" mandatory disciplines. These two disciplines deal with major taxonomic/systematic and morphological botanical topics, including Cyanobacteria, unicellular and multi-celled algae, fungi, and plants. Students enrolled in these two academic subjects are invited to actively develop any project previously discussed with the author. Current projects are surely encouraged, but new proposals are also accepted. The general guidance with which students are engaged include group work and on-line material composing.

Random tests containing curricular botanical subjects have been applied and results have been very satisfactory. These are based not only on traditional, content-oriented multiple-answer tests, but also on contextualized, more challenging activities (Bertagna, 2002). Moreover, questionnaires before and after activities have been applied to detect how PBL and the use of the campus botanical collections may be indeed a real aid in their knowledge build-up and acquisition.

Results and discussion

Common answers include a positive perspective to learn botany, a growing interest to investigate how plants influence life and the environment, and a high level of concern about the importance of plants in a routine life.

Part of the activities included a survey of the trees occurring within the campus (Santos, 2013), the publication of a visual guide of trees occurring at the central area of Sao Roque (Santos, 2015a; 2015b), a visual guide for microscopic botany semi-permanent glasses, and an online key to the arboreal trees occurring within the campus (Figure 3). Such publications involved students directly as coauthors.

Final considerations

Students have proposed the implementation of other facilities to be built at the campus, such as a butterfly nursing house and a medicinal plants garden. The first location would be devised as an interdisciplinary project involving the selection of host plants and their butterfly feeding and pollinating species, and the second one as a practical project to involve all of the campus community and even external public. Spatial and activity amplification of the campus facilities would enhance better use of its functions.

Figure 3. Publications originated with PBL activities having Biological Sciences students as active agents and coauthors: trees at the central area of Sao Roque (A); visual guide for botanical glasses (B); online key to the trees of the campus (C). (Homepages are accessible, respectively: http://www.fernandosantiago.com.br/laminario.htm ; http://www.fernandosantiago.com.br/guiaarvoressr.htm; and http://www.fernandosantiago.com.br/chaveonline.htm).

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