XVII IOSTE SYMPOSIUM

Science and Technology Education for a Peaceful and Equitable World

Braga, Portugal, 11-16 July, 2016

Enhancing botanical contents teaching and learning with Problem/Project-based Learning (PBL) approaches: a report of Brazilian experiences at a federal institution in Sao Paulo State

Fernando Santiago dos Santos[a,*]

[a] *Federal Institute of Education, Science and Technology of Sao Paulo, Sao Roque campus. Rodovia Prefeito Quintino de Lima, 2100, Jardim Conceicao, São Roque – SP. Brazil. CEP 18136-540*

* Corresponding author. +5513988374440; e-mail address: fernandosrq@gmail.com

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reviews of several vegetal groups, mainly the angiosperms, still do not appear in textbooks, which generally present outdated information and might hamper its learning.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 enhancement; Diversified individual/group activities

INTRODUCTION

The Brazilian education has experienced a mixed scenario of traditional approaches, with a central focus on the teacher/professor, and those centered in the student, with mediation done by the teacher/professor (Aikenhead, 1985; Gil-Pérez, 1991; Scribner and Cole, 1982). 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 (Murphy and McCormick, 1997). Investigations like those of Marçal and others (2006) and 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.

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).

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?

2 - Material and methods

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), with Biological Sciences undergraduate students. The campus is located in a

peripheral are of Sao Roque Municipality, Sao Paulo State (Brazil); its online homepage is http://srq.ifsp.edu.br/; geographical coordinates are 23°33'168''S and 47°09'005''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).

The campus botanical collections are part of the Botany Laboratory and 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.

A

B

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 multicelled algae, fungi, and plants. Students enrolled in the 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.

3 – Results and discussion

Random tests containing curricular botanical subjects have been applied and results have been very satisfactory, with over 80% of average approval rates. 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. 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.

4 - 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.

5 – References

Aikenhead, G. S. (1985). Collective decision making in the social context of science. *Science Education*, 69 (4): 453-475.

APG (2009). *The Angiosperm Phylogeny Website*, Version 12. Online access: <http://www.mobot.org/MOBOT/research/APweb/>. Last visit: 08 Sep. 2016.

Auler, D.; Dalmolin, A. M. T.; and Fenalti, V. S. (2009). Abordagem temática: natureza dos temas em Freire e no enfoque CTS. *Alexandria Revista de Educação em Ciência e Tecnologia,* v. 2, n. 1, 67-84.

Bertagna, R. G. (2002). O Formal e o Informal em Avaliação. In: Freitas, L. C. (Org.). *Avaliação*: construindo o campo e a crítica. Florianópolis: Insular.

Cachapuz, A.; Gil-Pérez, D.; Carvalho, A. M. P.; Praia, J.; and Vilches, A. (Orgs.) (2005). *A necessária renovação no ensino das Ciências*. São Paulo: Editora Cortez.

Driver, R. (1988). Un enfoque constructivista para el desarrollo del currículo en ciencias. *Enseñanza de las Ciencias*, 6 (2): 109-120.

Faria, R. L. F.; Jacobucci, D. F. C.; and Oliveira, R. C. (2011). Possibilities for botany teaching in a non-formal educational space in the perception of science teachers. *Ens. Pesqui. Educ. Ciênc.***,** 13 (1): 87-104.

Gil-Pérez, D. (1991). Qué han de saber y saber hacer los profesores de ciencias? *Enseñanza de las Ciencias*, 9 (1): 69-77.

Kelman, H. C. (1996). Negotiation as interactive problem solving. In: Spector, B. I. (Org.). *International Negotiation*: a Journal of Theory and Practice. New York: Martinus Nijhoff Publishers.

Layrargues, P. P. (1999). A resolução de problemas ambientais locais deve ser um tema-gerador ou atividade-fim da educação ambiental? In: Reigota, M. (Org.). *O verde cotidiano.* Rio de Janeiro: DP&A.

Marbach, A. D. G. (2004). Expectations and difficulties of first year college students in biology. *Journal of College Science Teaching*, 33: 18–23.

Marçal, I. *et al.* (Orgs.) (2006). *A botânica no ensino básico*: relatos de uma experiência transformadora. São Carlos, SP: Rima Editora.

Morin, E. (2000). *Os sete saberes necessários à educação do futuro*. São Paulo: Cortez; Brasília, DF: Unesco.

Murphy, P.; and McCormick, R. (1997). Problem solving in science and technology education. *Research in Science Education,* 27 (3): 461-481.

NRC - National Research Council (1992). *Plant biology research and training for the 21st century*. Washington: National Academy Press.

Pinheiro, T. (2009). Bernard Chassot: aprender, mas só com sentido. *Nova Escola*, São Paulo, XXIV, 233, 32-34.

Pollan, M. (2001). *The botany of desire*. New York: Random House.

Rezende, L. A.; and Struchiner, M. (2009). Uma proposta pedagógica para produção e utilização de materiais audiovisuais no ensino de ciências: análise de um vídeo sobre entomologia. *Alexandria Revista de Educação em Ciência e Tecnologia*, 2, 1, 45-66.

Rubba, P. (1991). Integration STS into school science and teacher education: beyond awareness. *Theory into Practice*, 30 (4): 303-315.

Santos, F. S. (2009a). A disciplina de Ciências no Ensino Fundamental II: um estudo de caso com alunos de uma escola municipal de Cubatão, SP. *Plures – Humanidades*, 12, 105-120.

Santos, F. S. (2009b). *A construção de material didático contextualizado como subsídio para as aulas de Ciências do Ensino Fundamental II*: uma experiência colaborativa em Cubatão, SP. Universidade de São Paulo: Faculdade de Educação (PhD Tesis).

Santos, F. S. (2013). Checklist of trees at the Sao Roque campus, Federal Institute of Sao Paulo. *Scientia Vitae*, 1 (1): 52-61. Online access: <http://tinyurl.com/zlzkxgu>. Last visit: 08 Oct. 2016.

Santos, F. S. (2015a). *Árvores de São Roque*: catálogo das espécies da área urbana central do município (fotografias e identificação botânica: Oliveira, EA; Escanhoela, CZ; Valadão, SM). São Roque, SP: Instituto Federal de Educação, Ciência e Tecnologia de São Paulo. Online access: <http://tinyurl.com/gnxkgaw>. Last visit: 09 Oct. 2016.

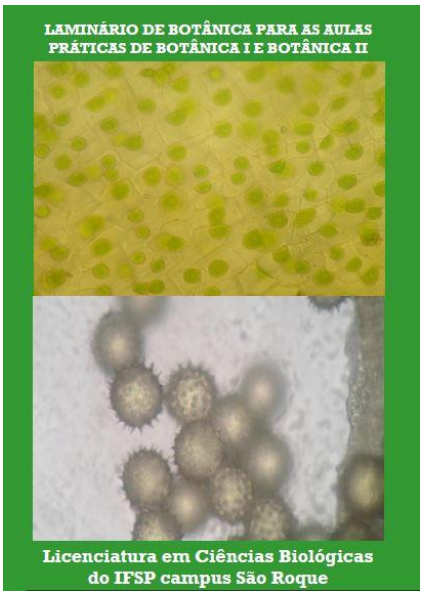
Santos, F. S. (2015b). *Laminário de botânica para as aulas práticas de Botânica I e Botânica II do curso de Licenciatura em Ciências Biológicas do IFSP campus São Roque* (preparo de lâminas e fotografias: Chagas, Bianca Roberta Catani). São Roque, SP: Edição do autor. Online access: <http://tinyurl.com/haevs4j>. Last visit: 10 Oct. 2016.

Scribner, S.; and Cole, M. (1982). Consecuencias cognitivas de la educación formal e informal. *Infancia y Aprendizaje,* 17: 3-18.

Sundberg, M. D. (2004). Where is botany going?. *Plant Science Bulletin*, 50: 2–7.

Unesco (2003). *A ciência para o século XXI*: uma nova visão e uma base de ação. Brasilia: ABIPTI.

Uno, G. E. (1994). The state of pre-college botanical education. *American Biology Teacher,* 56: 263–266.



A

B

CHAVE DE IDENTIFICAÇÃO COM BASE EM CARACTERÍSTICAS VEGETATIVAS DAS ESPÉCIES ARBÓREAS DO CAMPUS SÃO ROQUE EM APLICATIVOS WEB E ANDROID

Apresentação
Esta página faz parte do trabalho de conclusão de curso (TCC) em Licenciatura em Ciências Biológicas de Gabriela Zominhani Sant'Ana, defendido em julho de 2015, orientado pelo Prof. Dr. Fernando Santiago dos Santos, com o título supramencionado. O TCC completo pode ser acessado na biblioteca do campus. O trabalho é constituído de uma descrição das espécies de árvores que ocorrem no campus do Instituto Federal de Educação, Ciência e Tecnologia de São Paulo, campus São Roque, e uma chave de identificação disponibilizada em aplicativo para celulares Android e em modo on-line na internet.

C

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).