

## THE USE OF IBSE AS A TOOL FOR THE DEVELOPMENT OF TEACHERS' CURRICULUM: CHALLENGES AND OPPORTUNITIES OFFERED BY LOTC INSTITUTIONS

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### Resumo

A Europa de hoje discute seriamente o modo de implementar a educação da ciência no curriculum escolar. Na prática, o que se pretende implementar a nível das práticas pedagógicas da escola é o método de aprendizagem ativo (inquiry-based science education IBSE) como fazendo parte da mudança pedagógica na escola. Nesta aprendizagem os professores motivam os estudantes a desenvolverem um pensamento crítico e raciocínios independentes, para além de atitudes positivas e elevada curiosidade perante a ciência. Desta forma o IBSE promove as capacidades dos alunos para testar hipóteses através da experimentação e da reflexão sobre os resultados obtidos.

O Jardim Botânico do Museu Nacional de História Natural e da Ciência da Universidade de Lisboa, está envolvido num projeto europeu, denominado INQUIRE, com mais 17 participantes de 11 países distintos. Durante o primeiro ano foi desenvolvido um curso piloto para professores desenhado para obter os seguintes objetivos: 1) disseminar o IBSE como prática pedagógica; 2) estabelecer uma ligação entre a educação formal e não formal para o ensino da Biodiversidade e das Alterações Climáticas usando o Jardim Botânico como instituição de acolhimento. Este curso certificado tinha um total de 60 horas e contou com a participação de 20 professores de 14 escolas diferentes do Centro e Sul do país. A oficina começou em Janeiro e terminou em Abril de 2012. Durante este período, os professores tinham de aprofundar os seus conhecimentos sobre o método IBSE e saber aplicá-los nos planos de aula de acordo com os temas escolares. No final discutiram-se as dificuldades, limitações mas também as vantagens e desafios que cada professor poderá ter para tirar partido desta metodologia no ano escolar seguinte. Houve uma prática refletiva sobre os resultados obtidos. Os professores foram unânimes em mostrar que estas mudanças pedagógicas levaram a uma maior motivação e interesse para com os assuntos científicos, por parte dos alunos. O IBSE deve ser ainda uma oportunidade para motivar os professores e estabelecer parcerias entre diferentes currículos escolares promovendo ainda a troca de saberes entre disciplinas. Os estudantes seriam globalmente motivados e curiosos deixando de ter uma atitude passiva perante o programa escolar. Os resultados mostraram ainda que a utilização do Jardim Botânico como local fora da sala de aula para aprender e conhecer cientistas não é de todo irrelevante, muito pelo contrário: os estudantes ficam muito mais sensíveis aos problemas e realidades da ciência atual, sabendo motivar e contagiar os seus familiares.

Palavras-chave: IBSE, aprendizagem ativa, instituições extra curriculares, museus, jardins botânicos.

### Abstract

In Europe there is a huge debate on how to improve science education in scholar curriculum. In practice, changing science teaching pedagogies, towards an inquiry-based science education (IBSE). In this approach the teachers engage the students to develop independent and critical thinking skills, positive attitudes and curiosity towards science. Therefore, IBSE promotes the student's capacities for testing hypothesis through experimentation, and reflecting on gathered results.

The Botanic Garden of the National Museum of Natural History and Science of the University of Lisbon (BG-NMNHS) is involved in an EU project, named INQUIRE, with 17 partners from 11 countries. During the first year a pilot course program has been developed for teachers to achieve the following goals: 1) disseminate IBSE as a pedagogical practice; 2) link formal and non-formal education to teach Biodiversity and Climate Change and use the BG as a LOtC institution. This certified program consisted on a total of 60 hours and was attended by 20 teachers coming from 14 schools from South and Centre of Portugal. The course took place from January to April 2012 and during this period the teachers had to develop and apply an IBSE lesson plan using the school themes. At the end, a reflection practice was promoted to discuss the advantages, limitations, breakthroughs and challenges of teachers. The obtained results suggest that teachers and schools should be supported on raising students' motivation and interest towards science. IBSE should also be an opportunity to engage teachers to link different scholar curriculum and to promote a transversal crossing of disciplines, turn students into active problem-solvers rather than just passive-followers. Also, the challenge of using a LOtC as the BG-NHMNS to discuss *in situ* like researchers, do make them feel important, keen in learning and able to motivate their families in their school programs.

Keywords: IBSE, LOtC institutions, museums, botanic gardens.

## 1. INTRODUCTION

Inquiry has been highlighted all over Europe (Osborne & Dillon, 2008) as characterizing good science teaching and learning, particularly directed to biodiversity conservation awareness and education. Inquiry based science education (IBSE) in classroom has been recommended since 1996 (Morrison, 2008) and five features were described and advised to be followed (Barrow, 2006): (1) students are engaged for the creation of scientifically oriented questions; (2) students collect evidences in real contexts to answer the questions; (3) students develop explanations based on evidences; (4) students evaluate their explanations and may include alternatives that reflect scientific understanding; and (5) students communicate and justify the proposed explanations.

Natural history museums and botanic gardens represent ideal "Learning Outside the Classroom" (LOtC) institutions: students have the opportunity of developing fieldwork, collecting natural data, monitoring, and consequently acquiring expertise and daily life knowledge about nature and global changing impacts. Students are allowed to explore on their own, contact evidences related to real contexts (Dillon et al., 2006; Wyner et al., 2010, Gano &

Kinzler, 2011), and develop their knowledge and skills as an added value to their everyday experiences in the classroom (Hofstein & Rosenfeld, 1996).

The Botanic Garden of the National Museum of Natural History and Science (BG-NMNHS) has, within its 4 hectares, an important living collection of almost 1 500 plant species, supporting various fields of botanical research, and presenting to the public and visiting schools the great diversity of plant forms and ecological processes. Moreover, through its herbarium and seed bank, together with national and international projects and partnerships, the Botanic Garden is fully committed to the conservation of plant diversity, both in situ and ex situ, with particular emphasis on the endangered native plant species. The commitment is also extended to the promotion of the inquiry-based method in what concerns science awareness and education on plant diversity and the urgent need for its conservation.

Since 2003, the BG-NMNHS has been assumed as an ideal place for receiving different students during the whole academic year and offering complementary scholar curriculum knowledge. More than 8 000 students per year attend the education programs and follow the learning activities.

BG-NMNHS is also a partner in European projects for promoting the inquiry-based methodologies concerning the production of educational resources or the training of basic schoolteachers for using IBSE in science education. One example of this is INQUIRE ([www.inquirebotany.org](http://www.inquirebotany.org)), a European project (17 partners from 11 countries), which aims to train teachers on IBSE applied to the teaching of biodiversity and climate change. Within the project, BG-NMNHS will train about 50 teachers and their students (10 to 16 years old) from 2010 to 2013.

Several studies have shown that the classroom is not the main source of knowledge concerning biodiversity, with students also admitting they learn little from books or the media, but a lot from their own everyday observations, which enhances the importance of children actually visiting natural environments to improve their understanding of the natural world (Tunncliffe & Reiss, 2000; Lindemann-Matthies 2005; Dillon et al., 2006). It is important, therefore, to evaluate the use of LOtC institutions that can motivate and shift student's attitudes towards a more active problem-solvers rather than just passive-followers. Thus, the aim of this short communication is to evaluate: (i) how important is the IBSE method in scholar education; (ii) the advantage of the BG-NMNHS as a LOtC institution, to help teachers in themes such as biodiversity and climate change.

## 2. METHODS

A Continuing Professional Development (CPD) program was developed by the BG-NMNHS, consisting of a 60-hours accredited course, entitled “The IBSE method as a tool for teaching biodiversity conservation”. The course took place from January to April 2012 and was attended by 20 teachers coming from 14 schools from the Centre and South of Portugal.

This workshop aimed to present the IBSE method, to discuss its role as a tool to improve scientific literacy and to explore the application of the method to the study of biodiversity and climate change. Participants had also the opportunity to discuss how their own pedagogical resources and activities could be changed in order to become IBSE. It was given a great emphasis to the use of botanic gardens as LOtC institutions and to the development of pedagogical activities and resources by teachers and botanic garden’s educators. During the courses, teachers individually developed a lesson plan focusing on the themes of plant diversity and climate change, to apply to their own students. The lesson plans were, in general, divided into three phases: a pre-visit phase, in classroom, where students were engaged with the subject and raised their own questions and hypothesis; a visit phase developed in the botanic garden, where students had to follow their own investigation plan and explore the garden’s resources; and a post-visit phase where students were able to draw their own findings and discuss them with their colleagues, as well as to communicate their conclusions to other students within their school. Through all these phases, the teacher had a key-role in guiding and helping the students, having always in mind the stimulation of students’ curiosity, critical thinking and autonomy.

The evaluation of the course included the observation of group discussions during both teacher’s learning activities and visits to the garden with their students. The evaluation was also composed of pre- and post-questionnaires, which included two open questions about the use of the Botanic Garden as a LOtC institution: “*What counts for teachers after the IBSE course at the BG-NMNHS?*” and “*What was the advantage of using a LOtC institution?*”. Teachers have also presented a portfolio with: (i) the lesson plan developed according to the IBSE method and adapted to classroom’s reality, (ii) the work students developed during the lesson plan, as well as students’ feedback and (iii) teachers’ reflection of the implementation of this new pedagogical method.

## 3. RESULTS AND DISCUSSION

The results obtained showed that at the end of the course teachers had changed their behavior towards both the use of the IBSE method and the need of using LOtC institutions, such as the BG-NMNHS.

*What counts for teachers after the IBSE course at the BG-NMNHS?*

There is evidence that teachers took advantages of the use of IBSE. All teachers were unanimous to answer that after the IBSE course they were enriched with pedagogical knowledge about how to involve students on their own learning process. Teachers developed a better reflection of their own scholar teaching practice and felt IBSE a very useful method to help explain biodiversity and climate changes to their students. As a whole:

- They felt the need to review the type of contents they present to their students and how it is presented (65% of answers).
- They developed lesson plans more centered on the students and adapted to awake their motivation and catch their attention (50% of answers).
- They developed better reflection on educational practices and work load planning (78%).
- They felt engaged, opened their minds and developed their scientific knowledge (100%).

In the context of science awareness and education about biodiversity conservation, the term “Inquiry” and particularly “inquiry-based science education” has been highlighted all over Europe (Osborne & Dillon, 2008) as characterizing good science teaching and learning. Teachers that attended the course already knew the method but it turned to be very important on how to put it on practice. They were able to motivate their students and engage them on the creation of scientifically oriented questions. Alone, or with the help of their parents, students learned the importance of collecting scientific evidences, to critically evaluate them, to communicate and justify the proposed explanations. As it was already described, teachers realized that using inquiry in science teaching engaged the students and improved their understanding (Gano & Kinzler, 2011). And thus, they felt more motivated and able to share their experiences and practicing in a true reflective practice, as it is recommended by the INQUIRE project, through an online platform/forum created to support this practice.

*What was the advantage of using a LOtC institution?*

Many teachers used before the facilities of BG-NMNHS as a support for their teaching activities. However, it was the first time they used the Botanic Garden as a LOtC institution to

apply the IBSE method. Teachers learned how to use the Botanic Garden as a way of contact with real natural contexts and to engage students in the creation of scientifically oriented questions, promoting the gathering of evidences within an investigation plan (Wyner et al., 2010; Gano & Kinzler, 2011).

The results obtained after the evaluation of pre- and post-questionnaires unequivocally showed the importance teachers give to LOtC institutions. All teachers, even when only practicing non-formal visits to these kinds of institutions, were able to recognise Botanic Gardens as places to show and actively learn biodiversity and climate change.. Teachers already knew that within Botanic Gardens they could find:

- Knowledge about biodiversity and climate change (78% of answers).
- Knowledge on plants and new ideas to complement lecturing in classrooms (92% of answers).

Teachers also realized that, besides the two above-mentioned issues, BG-NMNHS could offer them opportunities to know how:

- To work in group, to involve other teachers, to know researchers, and to take profit of crossing different disciplines (43% of answers).
- To motivate students to communicate in public (50% of answers).
- To motivate students to learn and investigate by themselves (65% of answers).
- To implement a better relationship teacher-student and student-student (65% of answers).
- To abolish fear of fruitful discussions teacher-student and student-student (57% of answers).

#### *Some possible limitations*

The above-mentioned results were dependent on teachers, students and school of origin. At the end of the course, very positive results were obtained, with some schools developing new and creative follow-up activities and with students increasing their grades. Nevertheless, in few schools the changes were not these obvious. This does not mean that students were not “affected”. Indeed, teachers were still able to engage students and to influence them in order to be critic on their way of thinking and to obtain the skills to do it by themselves, rather than just be passive-followers.

Nevertheless, there are still some limitations and doubts: many teachers may not feel capable of using LOtC institutions, or even applying the IBSE method. What are the factors we need to discriminate and discuss?

- School curriculum requirements

- School planning and flexibility
- Shortage of time, resources and support
- Fear of making differently from the others
- Teacher's lack of confidence of teaching outside the classroom
- General logistic school problems
- Going against old and strongly implemented methods of teaching in schools

These are some of the factors listed by our teachers and some already described in other countries (Dillon et al., 2006). Apparently these are “normal” limitations in all European education systems.

#### 4. CONCLUSIONS

It is important to recognise that IBSE can be applied in schools in order to increase students' interest on science and curiosity for the unknown. IBSE makes use of LOtC institutions rather than only new TIC or new gadgets. This does not mean that we cannot make use of all of these resources in order to increase the quality of science education. Researchers on science education, with their experience in this field, are able to develop strategies to increase students' knowledge and skills that add value to their everyday experience in the classroom, promoting the crossing of theory with practice. “Outside the classroom” learning reinforces the link between affective and cognitive domains, providing a bridge to a more complex learning.

The important thing to bear in mind is that we need to “awake” students to the threats biodiversity is facing and to the urgency of minimizing global climate change. Students' awareness to these global problems is only possible if they understand the importance of science and the fascination and wonder beyond it, which can be motivated through the use of the IBSE method in LOtC institutions, namely in Botanic Gardens.

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