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ATINER's Conference Paper Series
EDU2012-0136

Higher Education Biology Students' Conceptions on Botany Teaching: A Brazil – Portugal Case Study

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An Introduction to
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This paper should be cited as follows:

Santos da Silva, J.R., Guimarães, F. and Takeo Sano, P. (2012) "**Higher Education Biology Students' Conceptions on Botany Teaching: A Brazil – Portugal Case Study**" Athens: ATINER'S Conference Paper Series, No: EDU2012-0136.

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Abstract

Generally, the teaching of botany is seen as mainly based on the transmission of knowledge and on empirical-logical thinking, in a context of scientific knowledge and with the purpose of affirming truth about the world. From this perspective, both in Brazil and in Portugal botany is usually seen as a list of scientific names remote from the daily life of students, which might make classes demotivating.

This project was designed with the aim of understanding the prior conceptions of higher education students training to be biology teachers. It was based on a questionnaire that allowed open answers, completed by students in the beginning of their degree. The purpose of this questionnaire was to collect data that would show how students understood teaching in general and botany teaching in particular, and how they conceived the teachers' role in the development of their knowledge of teaching methods.

Data showed that Brazilian students considered the teaching of botany as a theoretical subject that was followed by a practical component. The practical classes were based on demonstration of what had previously been explained in theory. The Portuguese students considered the teaching to be more practical. Teaching was seen as based on practice and classes were more dynamic and fostered interaction. All students said that the teacher was a source of knowledge who also encouraged practice, which made teaching essential for their training. However, Portuguese students stressed that teachers should motivate students to see botany as a field of knowledge.

Keywords: Previous conceptions; Botany teaching; Initial teaching training.

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Introduction

The teaching of biology is devoted mainly to the transmission of currently accepted knowledge and places little emphasis on building scientific procedures (Martins, 2009). This view of teaching has been heavily criticised for its fragmented approach, with the aim of being memorised (Selles & Ferreira, 2005). Learning is transformed into memorising a collection of hard-to-remember names. This approach to biology course content lacks proper contextualisation and raises difficulties in learning core concepts of biology (Meglhioratti *et al.*, 2009).

The teaching of biology is based on an empirical-logical approach that sees scientific knowledge as able to affirm the truths of the world (Guimarães, 2005). Content is a primary concern for teachers when when planning a curriculum (Krasilchik, 2008). Tardif (2009) notes that some knowledge used by teachers in the classroom comes from their initial training, linked to what they experienced in their degrees or at high school.

The teaching method often found in the classroom is oral explanation, mostly characterised by the linear, systematised presentation of content to students. Teachers focus on clearly explaining the content (Busato, 2001). In a survey of primary school pupils about how teaching should be, these pupils described science classes including experiments, visits to museums and other environments, without referring to botany concepts (Caldeira, 2009). With respect to the teaching of botany, Silva *et al.* (2009) report that in primary and secondary education the subject is addressed through lists of scientific names and words that are totally isolated from reality, and so students found it hard to master the concepts. Botany teaching strategies are still linked to oral description, which extends the stigma of the subject.

In higher education, Gil Perez *et al.* (2001) indicate that students have difficulties understanding the process of constructing scientific knowledge and its relationship with society. Biology concepts are tackled out of their historical process of construction. It is important to extend initial teacher training in biology beyond the borders built up in education subjects. According to Guimarães (2005), the field of education cannot be restricted; it is broader and includes culture, cultural policies and day-to-day events that commonly involve aspects related to biology studies. Senciato and Cavassan (2004) underline the importance of holding lessons in natural environments as a teaching strategy that enables the construction of knowledge within a context.

The teaching of botany has concerned various sectors of education, from basic to higher, indicating a need for improvement (Guimarães, 2005; Senciato & Cavassan, 2004; Kinoshita *et al.*, 2006; Silva *et al.* 2009; Towata *et al.*, 2010). Even today, the teaching of botany is characterized as being too theoretical and demotivating for students, and is undervalued within biology and science education (Kinoshita *et al.*, 2006). In addition, despite the recognition of the importance of plants for humankind, interest in botany is so small that plants are rarely perceived as anything more than components of landscape or decorative objects, in what is identified as 'botany blindness' (Wandersee & Schussler, 2001).

This paper presents a study carried out on students from four Portuguese and Brazilian universities with the aim of learning the conceptions of students about the teaching of botany. With this study, it was possible to know what students thought

about education and what they considered most important in the teaching of botany, for themselves and for their development.

Methodology

The methods selected in this study aimed to understand what students thought about the teaching of botany. To obtain meaningful information, a questionnaire including open answers was given to the students. The purpose was to get an idea of how students saw the teaching of botany, but it also had questions on what was important to students as far as the teaching of botany was concerned.

The universities involved in the study are state-funded: three are Brazilian (four different classes) and one Portuguese (two different classes). All students who answered the questionnaire were just starting their degree and had never taken botany as a subject. The universities and students involved in this study were kept anonymous.

The data collected were analysed using the standards established by Strauss and Corbin (2008). Within these standards, concepts are identified through data by the use of a selective encoding model, in which the concepts are the building blocks of categories, an abstract representation of a fact, of an object or an action. These categories represent a selection of data. In this case, all opinions are considered and then grouped by selecting what are the most obvious and relevant facts. This socially constructed knowledge is based on social constructivism and the goal is to understand conceptions that participants have about the situation that is being studied (Crewell, 2007).

After categorisation, the data were quantified and frequencies were found according to the total number of students from each University and from each country. It was thus possible to analyse the data and establish relationships between the conceptions of the Brazilian and Portuguese students.

Data discussion

Student profile

The survey was developed with 221 students of whom 137 (62%) were Brazilian university students and 84 (38%) were Portuguese higher education students. Most of those who answered the questionnaire were 20 years old (74.6%), with 82 (37.1%) being male and 139 (62.9%) female.

Students were asked why they had chosen biological sciences. There was a slight similarity in the answers from students of the two countries. The most often-mentioned category in both countries was related to 'affinity with the field of biology at high school and the fact they liked the subject' (48.42%): 'It is a subject I have been interested in since childhood'; 'I have liked the subject since the first year of secondary education'; 'I have always been keen on science, especially biology'.

Another category mentioned relates to the broad field of professional practice (25.34%): 'I like the main professional area that this course offers; 'Biological sciences subjects are part of a vast area and provide a wide range of options'; 'As I had

no idea of what to choose, I chosed this course with its multiple professional opportunities'.

Some students had narrower conceptions concerning botany as a professional field and selected a specific area that they preferred within biology (12.67%): 'I like studying these subjects, especially topics related to genetics and this degree will let me enhance my knowledge on this topic'; 'I've always been interested in animal life and animal behaviour, since I was young'. It is interesting to note that a small percentage of students went to university with the goal of doing research (8.6%): 'Biological sciences includes a broad area that offers various research lines'; 'I am interested in the area of scientific research, in particular biology; 'I like biology and research'.

Interest for teaching and the teacher's role

Students were asked about their interest in being teachers. The first contrast between Portuguese and Brazilian students was found here, and it was related to the interest in being a teacher (see Table 1). Even with this contrast, most students wanted to be teachers for different reasons (see percentage in Table 1): 'Yes, because knowledge should be transmitted and not just accumulated'; 'Yes, because you don't only teach at schools or universities, the lesson involves explaining something to a person and that person manages to retain what they were told'; 'Yes, because I find it interesting to contribute a little bit to the intellectual development of people'; 'For sure I will teach one day. I don't see any sense in acquiring knowledge without transmiting it to people who can use it. In addition it is something I give back to society'; 'Yes, I want to do research'; 'Yes, I decided to teach biology'.

When asked about the influence of teachers in initial training, students in the universities of both countries responded affirmatively in almost all their answers. Thus, 51.58% claimed that the teachers mainly influence the transposition of ideas and contents, which includes the idea that the teacher must transmit knowledge and, especially, how it was transmitted: 'They are the ones who teach the scheduled course content that will be used in my training. The way the teacher teaches influences the way students learn'; ' The teacher is of great significance for my training, because they are the "bridge" to knowledge'; They are people with more knowledge than us and who have the task of sharing it and interacting with students'.

The second most representative category for university students in both countries concerned the role of the teacher as a supervisor of students' future professional career. In this respect, students felt that they were influenced when they received some guidance outside the classroom, relating to a subject that was not addressed in the scheduled course content (27.6%): 'They advise about the paths to follow, they tell us where to get information and how to use it'; 'The influence of guiding us, offering paths that help us in our development as students'; 'The teacher, in my opinion, completely shapes the academic path followed by students'. The third emphasis given by students (18.1%) indicated teachers as sources of inspiration and as an exemple to follow: 'The teacher plays the role of an advisor, but not only of an "icon" because they are the people students see as trained biologists'; The greatest possible influence! They are like a mirror, the one I want to copy'; 'The teacher is the example of the professional with whom we work every day'.

Teaching design

When asked about what giving a lesson was, the commonest answer, both Portugal and Brazil, was related to the transfer of knowledge. Therefore, teaching was based on transmiting knowledge (39.37%): 'Teaching is passing knowledge on to someone'; 'Passing on knowledge, teaching what you have learned'; 'Teaching is presenting briefly the topics relating to a discipline'. The second most cited category differed from the previous one in that the students recognised the importance of how teaching was tackled, besides transmitting knowledge (21.72%): 'Transmitting knowledge, be it personal or didactic'; 'Teaching is transmitting your knowledge on a certain subject in a didactic manner'. A marked concern for students was how subjects were understood - subjects should not be merely transmitted but be part of a learning process (21.27%): ' It is to make the student to learn a certain subject'; 'It is to make the student realise the subject beyond the knowledge described in books'; '"Teaching" will make a group of students to understand a topic, explaining to them and teaching them'. Following this line of reasoning, some students made the point that teaching was a learning exchange (10.86%): 'A student-teacher interaction in which both exchange knowledge'; 'It is learning by teaching'. A final category was related to the interaction of the individual with knowledge in order to change the perception of a subject (6.33%): 'To produce knowledge favouring the learner; 'Teaching is to transmit knowledge you have, to help someone to form an opinion on a subject (knowledge) learned'.

When asked about how bootany should be taught, the students of the two countries emphasised features of different classes (see figures in Table 2). The most cited category was the second most mentioned by Brazilian students and the category that was most representative for the Portuguese students. Students underlined the importance of practical (over theoretical) lessons: 'It must be dynamic, and students should always have things to do'; 'It should be practical, in order to learn all those terms in an easy way'; 'It must be very comprehensive and practical, for a better learning'; 'It shouldn't be too theoretical, because it gets boring. Teaching should be dynamic'. Lectures followed by practical classes were the most cited by Brazilian students and represented the second most mentioned category in this study: 'Teaching botany must blend lecture when students broach a new subject, with practical classes when the classroom theory subject is seen in practice'; In addition to theory, which is essential to the knowledge of the plant kingdom, it is also important to see the different species mentioned and apply the theory'. This category also includes practical classes that serve as theoretical classroom demonstration.

The third most mentioned category was only specified by Portuguese students. Students mentioned that teaching botany should prioritise dynamic and motivating lessons, which prompt students to find knowledge about the topic: 'Teaching should be motivating'; 'It must above all be motivating, so that everyone can be interested'; 'Above all it must be motivating as it is quite an extensive course unit, and sometimes a bit tedious'; 'Appealing because plants are the target of prejudice from biology students'.

The other categories add up to 30% of the total sample, but represent different ideas and strategies for teaching. Some students observed that botany classes could be related to other biology topics or other related areas: 'The botany course should only concentrate on what is essential for understanding plant structures and on the

relationship between organisms'. Others believed that classes should have a direct relationship with the daily life of students, trying to make the topic relevant to them: 'Facing reality'; 'Dynamic, realistic, involved with the environment in which the student is inserted in'. Another strategy noted by students was related to an information model: 'It must be quite illustrative, because there are lots of details to be conveyed'. The other categories were cited only by Brazilian students and had little representation in this study (see figures in Table 2).

About the importance of teaching botany

Students answered to two questions about the importance of teaching botany: one focused on what would be most important for the botany teacher, and the other related to the importance to students of teaching botany.

In relation to what would be important for students, it was found that course content was the most important issue. Analysing the data we find five main categories: the first one, mentioned by 38.46% of the students, was related to knowledge of plants and their importance: 'To learn how to recognise the role of each morphological type in the balance of nature'; 'The student should have full knowledge of what they have been taught'; 'To absorb as much knowledge transmited by the teacher as possible'; 'To acquire knowledge on botany, about all the plants'.

The second most cited category (20.36%) was connected with practical knowledge in botany, namely to learn to identify types of plants: 'The groups of plants, the evolution of each group, the places where they occur, the ecological importance'; 'To learn to identify plants, the practical and utilitarian facet of botany'; 'To understand the practical importance of botany'. The third category was related to the interaction between reality and the content taught, the relationship with daily life. This was quoted by 19.46% of students: 'The contents covered in the classroom should be contextualised with reality, from observation of systems and natural phenomena'; 'To apply knowledge in everyday life, how to protect nature, knowing the usefulness of plants'; 'I think it is important that the teaching of botany should contextualise it in everyday life'.

The fourth category answered by students (6.33%) was related to the relationship of the botanical knowledge with other subjects: 'A basis to relate this matter with other biological sciences'; 'The interaction between botany and the other subjects, trying to integrate them'. The fifth category was mentioned only by Portuguese students (6.79%) and was related to students' motivation and the ability of the teacher to awaken their interest in botany: 'The important thing is to arouse the interest of the student'; 'Teachers who enjoy what they're doing and who can send the message. Must be people who can motivate students'; 'They should feel it's an area of interest.' Other students did not respond this question (8.14%).

In relation to what was considered important in teaching of botany, students stressed several aspects. Four categories in particular were mentioned. The first was related to knowing the content and the teaching method to transmit knowledge (28.96%): 'Their knowledge of the subject and the way that they transmit it, to awaken the interest of students'; 'To learn how to organise a subject in didactical terms so that students will understand it better'; 'How to explain and how to relate to students, clarifying doubts and giving support to students'. Another category revealed a representation more focused on content, so that students believe teachers should have mastery of course

content to transmit it (27.74%): 'To impart knowledge to the student'; 'For teachers, it is important to be able to transmit all the knowledge they can to the student'; 'To have a clear and thorough knowledge of the various topics of botany'.

The third category was only mentioned by Portuguese students (10.41%). This topic was related to the idea that teachers should interact with students to arouse their interest: 'To know what triggers the interest of students for this area'; 'To motivate students for this area'; 'To keep interaction with students and ensure their understanding'. The fourth category represented only 7.69% of the students and included the representation that teachers should relate knowledge to reality, with context: 'To try to relate life to botany, to some extent applied to everyday life, to awaken the interest of students'; 'To provide students with a broader knowledge of plants and to learn about their ecological relevance and for nourishing the ecosystem'.

When asked about what would be important in teaching botany to students training to be biology teachers, there were many differences between the Portuguese and Brazilian students (see Table 3). Students tended to see teaching botany as assimilation of botany knowledge. The two most mentioned answers concerned different categories based on a content approach. The most cited category was related to the idea that teachers should know as much content as possible: 'Enough to show students their interest in the subject, with precision and clarity; They should know as much as possible. To be good at it, it is essential to know a whole range of the content, to have a full understanding of a subject'; 'Everything that was taught and more than what you're supposed to learn'. The second most mentioned category included the idea that teachers should know the minimum content possible and prefer a broad approach to knowledge: They should have general notions about plant structures, functioning and importance'; 'The need to build knowledge about the subject that gives students a general understanding about the subject'; 'The minimum required by the program'.

The third and fourth category were most mentioned by Portuguese students (see Table 3), and included the contextualisation of knowledge, in which students had to know how to relate the knowledge of plants to everyday life: They must know how to use certain plants in health and for food and know how they influence ecosystems and etc'; 'The various groups of plants and their importance to man'. The fourth category was only mentioned by Portuguese students and related to the ability of students to identify plants: 'To learn to identify different types of plants in the countryside and know their characteristics'; 'They must learn to distinguish types of plants.

The other categories were specified just a few times. However some highlighted ideas that have to be stressed: to know how to answer students' questions about botanical knowledge; the interdisciplinary context of botany; the minimum knowledge to impart to students at university; and to learn how to carry out research.

Discussion

Lectures, referred to as theoretical lessons, were based on a model that deserves to be highlighted. Krasilchik (2008) shows that this model is the one most often found in the teaching of biology. Its popularity is linked to two factors: an economic process, which requires a single teacher to deal with a large number of students; and the teacher's mastery of knowledge of a specific field and being secure in their activity. In

this model the student is a mere receiver, which is a disadvantage. Another widely used model described by the author is practical classes, which encourage students to participate in activities that are developed. The author points out that this option depends on how it is designed by teachers, and remarks that practical sessions geared to the demonstration and confirmation of 'right answers' reduce education to level of a simple manual task. This model was the one most suggested by Brazilian students, that is, lectures followed by practice.

But there is another model: students believe that scientific knowledge is very important for the teaching of botany. Busato (2001) agrees that students need to be aware that they have to delve deeper into learning, to learn how to learn, to learn how to create, to participate, reflect, criticise, construct, operate and innovate. Accordingly, teaching suggests the need for a continuous process of student-teacher interaction, which contains the intrinsic relations between the content being taught and teaching methods used. It is worth noting here that a small number of students sampled in this study, even in the initial stage of training, already reported the importance of such an exchange of knowledge.

In respect of teachers' knowledge mentioned by students, there was a need for the teacher to recognise other knowledge related to the activity of teaching, beyond scientific and pedagogical knowledge. Pimenta and Anastasiou (2010) report that a teacher's identity is built upon training, and involves, in addition to pedagogical and scientific know-how, knowledge related to previous experience as a student and knowledge related to the experience of teaching. Although little mentioned by students, it must be stressed that the teacher figured an inspiration and an example to be followed by students. This demonstrates how much students reproduce attitudes of teachers, thereby building their identity.

Comparing Brazilian and Portuguese students' conceptions, it has to be noted that they differed to some extent. Despite saying that they did not intend to be teachers, Portuguese students cared about the context of scientific knowledge and the motivation of students. Portuguese students were thus not only concerned with the content to be covered in the classroom, they were also worried about the learning and how it could be motivated. Krasilchik (2008) highlights the importance of the contextualisation of knowledge and of a broad approach that focuses on knowledge which facilitates better dialogue between teachers and students, to have more participative students. Silva *et al*. (2009) also reported that students complain of traditional education that is limited to technical terms and not linked to a context. Even though they were interested in being teachers and wishing to have lessons in which students participate to a greater extent, Brazilian students did not mention that this interaction could occur in the classroom, whereas the Portuguese students did.

Conclusion

The differences found between Portuguese and Brazilian students demonstrate the degree of maturity of students in terms of understanding the importance of contextualisation for scientific knowledge. According to the students surveyed, classes should be more practical. This supports the idea that a subject has to be contextualised in order to arouse the interest of students in botany topics. However, there is a concern with scientific knowledge and with the importance of this

knowledge in comparison with other knowledge that can be taught. Do students feel the same way at the end of their degree? This is a question for future research. Of course it is expected that the initial training might promote learning about teaching and on the importance of other knowledge that are inherent to the role of the teacher.

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Table 1. Identification of students with the activity of teaching and students' interest in being a teacher. Data in percentage.

Question: would you like to be a biology teacher?	Students from Brazilian universities	Students from Portuguese university	Total students surveyed
No	31.39	57.14	41.18
Yes	62.77	41.67	54.75
Maybe	5.84	1.19	4.07

Table 2. Categories concerning students' opinions on teaching of botany. Results in percentage.

Question: what should teaching a botany course be like?	Students from Brazilian universities	Students from Portuguese university	Total students surveyed
More practical than theoretical lessons	24.82	46.43	33.03
Theory lessons applied in practice	30.66	14.29	24.43
Classes absorbing. thought-provoking	0.00	22.62	8.60
Interdisciplinary lessons	9.49	3.57	7.24
More realistic and contextualised lessons	8.76	4.76	7.24
Detailed lectures that use images	8.03	3.57	6.33
Lessons without many technical terms	5.84	0.00	3.62
Lessons following an evolutionary line	2.19	0.00	1.36
Theory-practical lessons	1.46	0.00	0.90
Don't know/did not respond	8.76	4.76	7.24

Table 3. Categories concerning what a teacher should know when teaching botany to biology students. Results in percentage

Question: what should biology teachers know in order to teach botany?	Students from Brazilian universities	Students from Portuguese university	Total students surveyed
The maximum content	28.47	27.38	28.05
The minimum content	29.93	16.67	24.89
How to contextualise knowledge	5.11	19.05	10.41
How to identify plants	0.00	16.67	6.33
How to work with students on specific issues	9.49	0.00	5.88
How to relate botany to other topics in biology	5.11	7.14	5.88
Have general knowledge to be used in research	2.19	3.57	2.71
The minimum content for their students to enter University	2.19	0.00	1.36
Don't know/didn't answer	16.79	9.52	14.03