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A Botanic Trail as a Complementary Tool to Master Class in Physiology. A Comparison of Students' Impression in Different Grades

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Abstract

In the last years, European Universities have rearranged their study programs towards more practical contents in order to develop a broader range of competences in the students. In this sense, a group of Lecturers in Physiology of different Degrees (Pharmacy, Biotechnology and Medicine) have developed multidisciplinary activity, included in the problem based learning methodology, and supported on a tool previously established in the University Campus: the Botanic Trail. This tool consists on the identification of the plant species located in the Campus by means of signs with the QR codes, whose capture leads to a website (www.sendabotanicaue.es) containing extensive information about botany, pharmacognosy and the toxicology of each species. The activity started when each group of 4-5 students of the first or second year were assigned a plant found in the Campus. Then, the students should investigate their active ingredients and explain the mechanism of action, pharmacology, medical application and toxicology of at least one of these ingredients. The results of this investigation should be presented in a poster format and explained to the rest of the class. The students' impression about the activity was recorded before and after its development with a questionnaire. The analysis of the data collected shows that, initially, students of the three Degrees agreed with the inclusion of resources, such as the Botanic Trail, as a complement to master classes. However, after carrying out the activity, a different point of view has emerged depending on the Degree analyzed. Thus, Pharmacy-Biotechnology students consider interesting the activity, and useful for complementing the theoretical contents of the course in Physiology. However, Medicine students do not consider that these types of activities make a significant difference on their training, although they do not appear to be against including them. Taken together, these results indicate a different assessment of the inclusion of complementary resources to the master class depending on the profile of the students.

Keywords: problem based learning, Botanic Trail, Health Sciences, higher education, students' profile

Introduction

In the recent years, many changes are affecting the traditional pattern of teaching "teacher-content-student", based on master classes. These learning processes based on the transmission of theoretical aspects do not guarantee their practical application by the student in real contexts (De la Orden, 2004). In the Biomedical area, the *Libro Blanco de las Facultades de Medicina* (Conferencia Nacional de Decanos de las Facultades de Medicina, 2005) suggest different strategies and methodological models, such as the organization of teaching contents in parallel and sequentially, the integration of contents of related subjects or the implementation of problem solving (like activities of Problem Based Learning, PBL). This last methodology, in which students work in groups, encourages critical thinking, teamwork and the ability to translate the theoretical knowledge into practice (Antepohl and Herzig, 1999; Bain, 2007; Gal et al., 2013). Besides, even if sometimes no significantly better academic results and clinical skills are achieved by students learning under PBL methodologies, the enhanced work environment that has been consistently found with PBL is a worthwhile goal (Antepohl and Herzig, 1999; Albanese, 2000). Thus, several studies emphasize that Faculty and policy makers should put substantial efforts into designing curricula that include these types of activities (Khoo, 2003).

Furthermore, the application of an integrative approach is becoming more frequent in teaching (Fogarty, 1991; Harden, 2000). This integration can occur in content (vertical and horizontal integration), methodologies, resources and spaces. This approach allows students to take a holistic view of the reality, and also makes easier the assimilation of knowledge. The integration of content is very relevant in complementary areas of knowledge such as Cell Biology, Genetics, Biochemistry and Physiology (Diaz-Velis et al., 2005). Also, the integration format drives the development of transversal skills, facilitates understanding of the content of traditional disciplines, promotes learning and increases students' motivation (Nandi, 2000).

On the other hand, a constant teaching innovation is needed to bring together content integration, teamwork and learning based on problem solving. To achieve it, teachers have multiple tools that can help, such as Internet and its applications (i.e., *kahoot*) or the use of new technologies and technological devices, such as *Educlick*®, QR codes, wikis or educational gymkanas (Román Gravan and Méndez Rey, 2014). In addition, teaching innovation can also be achieved by using new spaces different to the usual classroom (Hardwick, 2011). In this regard, institutions such as *Facultad de Biología* of *Universidad de Sevilla* are conducting educational activities ("Botánica del Campus", an optional subject during 2008 academic year, http://asignatura.us.es/abotcam/) in open places, using the landscaped areas of the Campus.

For all these reasons, several Lecturers of the *Facultad de Ciencias Biomédicas* at the *Universidad Europea de Madrid* (UEM), teaching in the Degrees of Medicine, Pharmacy and Biotechnology, have developed an activity which aims to promote the horizontal integration of knowledge (in Physiology, Biochemistry and Cell Biology), the use of new technologies (Internet, QR

codes, mobile devices and wikis) and the work in areas different to the traditional classroom spaces (by creating a Botanical Trail at the UEM, www.sendabotanicaue.es, and using the botanical species and the information collected from them).

Material and Methods

Creation of the Botanic Trail

The first step for the creation of the Botanic Trail (*Senda Botánica* in Spanish) consisted on the development of a database in Microsoft Access©, by collecting texts written up by students in different courses, including information on botany, pharmacognosy, toxicology and allergology of previously selected plant species. From this database, we developed a website (www.sendabotanicaue.es) using Joomla© content manager (version 2.5.9). Technical features of the platform include an Apache 2.2.20 web server, a database server MySQL 5.1, supported by PHP 5.3, and an unlimited monthly traffic.

The website was composed of 5 main sections: Home, About Us, How It Works, User Access, Plants (Fig. 1). This latter section allows tabbed browsing to display information about the selected species regarding aspects like: botany, pharmacognosy, allergology and toxicology. The information about these aspects is extracted from students' texts. The tabbed browsing also includes the location of the plant specimens within the University Campus. To locate the plants, most of the specimens in the Botanic Trail were geo-located using a GPS system, and have been represented on the web by a map of the Campus using Google Maps.

Figure 1. *Representative Images of the Website www.sendabotanicaue.es*

The interaction between plants at the Campus and the website was made using QR codes included in signs that were located close to the selected

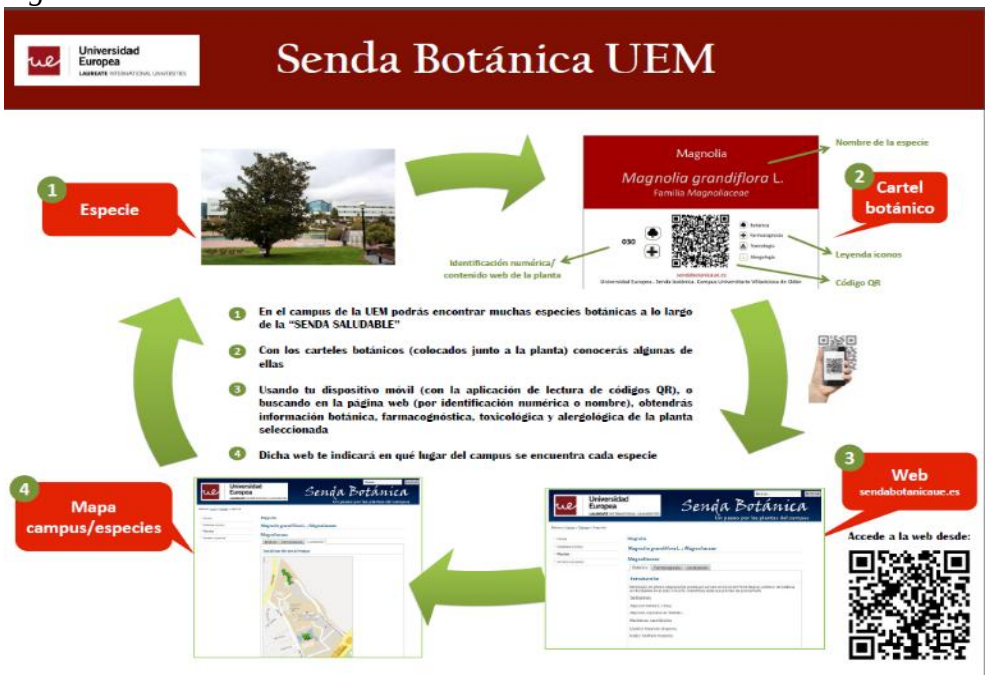
specimens through the Botanic Trail, and whose capture leads directly to the specific page of the plant on the website (Fig. 2).

Figure 2. *Example of Botanical Sign Located Under a Magnolia Grandiflora Specimen along the Botanic Trail within the University Campus*

Moreover, informative totems (Fig. 3) were located in selected points in order to make the Botanic Trail known to everyone in the Campus, to explain the tool, and to promote the involvement of people from different areas (teachers and students) in its use, implementation and improvement.

More information on the teaching tool can be found in Biscaia et al. 2013 and Benítez et al., 2013.

Figure 3. *Informative Totem of the Project, Explaining How the Interaction Signs - Website Works*



Description of the Activity

The activity was carried out by 16 students of Pharmacy-Biotechnology and 123 students of Medicine, split in groups of 4-5 members each. All the students

are enrolled in a subject of Physiology, which lasted 3 months in the Degree of Pharmacy-Biotechnology and a whole academic year in the Degree of Medicine.

Selection of Botanic Species

From all the species of the Campus, the Lecturers made a previous selection of 5 species for the students to work with, basing on its interest according to their active ingredients, physiological effects and pharmacological use.

Formation of Student Groups

Groups were formed following two different methods: a traditional one, where students make the groups in class and give the names to the Lecturer, and a more innovative method, where students use a wiki tool, integrated in the Virtual Campus software, to form their groups.

Activity Development

Each group is randomly assigned a botanic species, and given a representative part of it (leaf, fruit or flower), which should be used to find and identify the plant in the Botanic Trail. Students must take a picture of the plant, and scan the QR code that will lead them to the website, where they can obtain more information about the plant. Identification of the species must be confirmed with the Lecturers. This process has a limited time to be achieved (normally one week).

Afterwards, each group starts to look for information, in the website, specific books and databases (such as PubMed or Medline). Search for topic reviews is recommended. Students must focus on information about: the main active ingredient of the plant, mechanism of action, toxicology and medical use. A meeting with the teacher will be scheduled at midterm to follow the progress of the activity, although students can ask for more meetings if needed.

Work Presentation

Work is presented in a poster format, and must include:

a. Picture of the plant specimen found in the Botanic Trail and QR code.
b. Main active ingredient of the plant.
c. Mechanism of action.
d. Toxicology and medical uses.
e. Scientific references (in Vancouver style).

Poster exposition has a limited time of 5-10 minutes.

Evaluation Rubric

Only one poster per group should be presented, and every member of the group will have the same grade. The evaluation is made by means of a rubric, as follows: plant and active ingredient identification, 1 point; mechanism of action, 3 points; toxicology and medical uses, 3 points; references, 2 points; presentation and general organization of the poster, 2 points.

Surveys

Students' expectations and satisfaction with the activity were evaluated by means of two surveys: an initial one, before carrying out the activity, and a final one, after the activity was accomplished. Both surveys contain rating questions (following Likert-type scale), non-exclusive questions, and yes/no questions. For rating questions the scale was: 1, strongly disagree; 2, disagree; 3, undecided/neutral; 4 agree; 5, strongly agree.

The initial survey consisted on 10 questions, from which we consider the most relevant ones to discuss are:

- Q1/ Do you consider interesting/important to have educational activities related with this course outside the traditional classroom?
- Q2/ Do you think that the use of new teaching technologies as QR codes, wikis, and *kahoot*, can be educational and useful?
- Q3/ Mark the corresponding option (QR codes, wikis, and *kahoot* or none) if you have ever used one of the following teaching technologies. You can mark more than one.
- Q4/ Do you think it could be useful to use the botanic species in the Campus as a teaching tool in a course of Physiology?

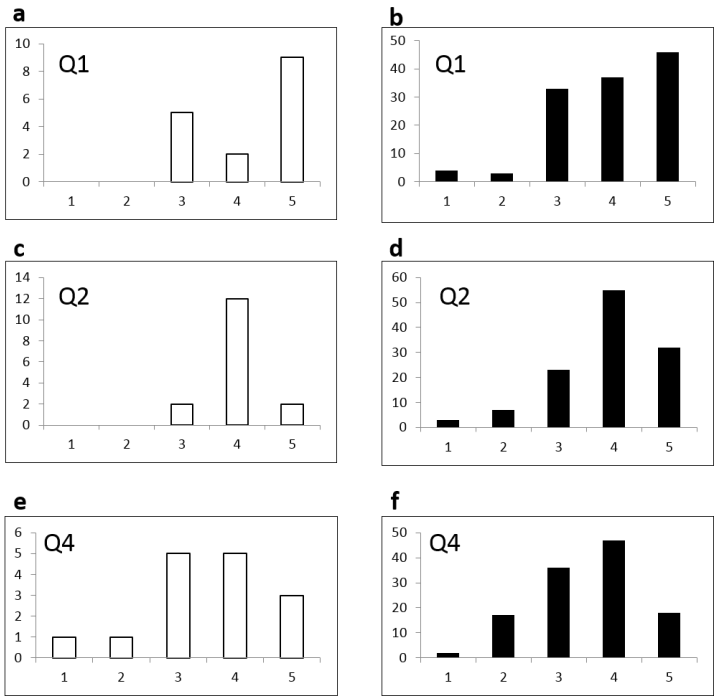
The final survey consisted on 10 questions, from which we consider the most relevant ones to discuss are:

- Q11/ Do you think that having educational activities related with this course outside the traditional classroom has been interesting/important?
- Q12/ Do you think that the use of new teaching technologies as QR codes, wikis, and *kahoot*, has been educational and useful?
- Q13/ Do you consider relevant for the objectives of a Physiology course to have worked on different aspects of the botanic species in the Campus?
- Q14/ Has the presentation of your research work in poster format been useful for you?
- Q15/ Do you think the poster format has advantages over other methods (as power point)?
- Q16/ Evaluate the educational tool "UEM Botanic Trail".

Results

Results are shown as a comparison between Medicine and Pharmacy-Biotechnology students' answers to the surveys. Fig. 4 shows answers to Q1, Q2 and Q4, included in the initial survey. Regarding Q1 (Do you consider interesting/important to have educational activities related with this course outside the traditional classroom?), both groups of students show high expectations about this type of activities, as most of them rated the question with 4 or 5 (69% of Pharmacy-Biotechnology and 67% of Medicine students).

Figure 4. *Comparison of Pharmacy-Biotechnology and Medicine Students' Answers to the Initial Survey*



Vertical axis represents the number of students, horizontal axis represents the rating scale being 1, strongly disagree; 2, disagree; 3, undecided/neutral; 4 agree; 5, strongly agree. Empty bars represent Pharmacy-Biotechnology students (graphs a, c, e); solid bars represent Medicine students (graphs b, d, f). Q1, Q2 and Q4 are previously described in Materials and methods section.

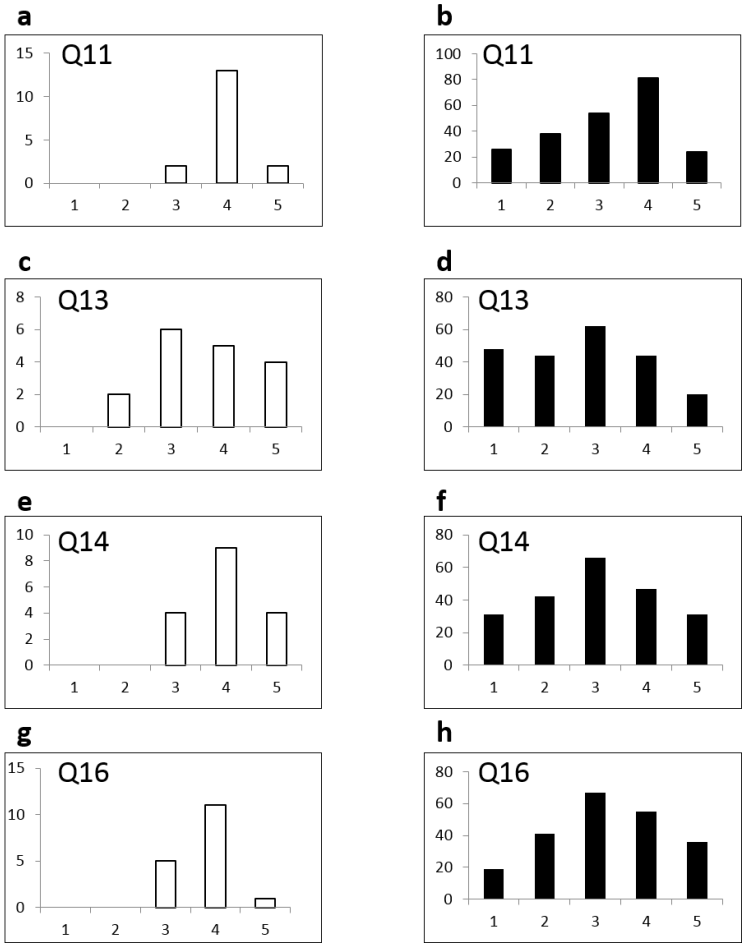
For Q2 (Do you think that the use of new teaching technologies as QR codes, wikis, and *kahoot*, can be educational and useful?), there was again a similar distribution of answers between groups, as most of them rated the question with 4 or 5 (88% of Pharmacy-Biotechnology and 87% of Medicine students).

Regarding Q3 (Mark the corresponding option, QR codes, wikis, and *kahoot* or none, if you have ever used one of the following teaching technologies) we obtained different results for the Pharmacy-Biotechnology and Medicine groups, being the wiki tool the most widely used among the first group and QR codes for the second one (data not shown). It is important to remark that a high percentage

of students have not used any of these technologies: 30% of the Pharmacy-Biotechnology students and 45% of the Medicine students.

Finally, the Q4 (Do you think it could be useful to use the botanic species in the Campus as a teaching tool in a course of Physiology?) gave again similar results, as both groups rate it mostly with 3 or 4 points (63% for the Pharmacy-Biotechnology group and 67% for the Medicine group).

Figure 5. *Comparison of Pharmacy-Biotechnology and Medicine Students' Answers to the Final Survey*



Vertical axis represents the number of students, horizontal axis represents the rating scale being 1, strongly disagree; 2, disagree; 3, undecided/neutral; 4 agree; 5, strongly agree. Empty bars represent Pharmacy-Biotechnology students (graphs a, c, e, g); Solid bars represent Medicine students (graphs b, d, f, h). Q11, Q13, Q14 and Q16 are previously described in Materials and methods section.

Results for Q11, Q13, Q14 and Q16 are shown in Fig. 5. In this survey, filled by the students after accomplishing the activity, we find more differences between the two groups. In general, answers are more heterogeneous in the Medicine group, as the rating is distributed among the 5 rating points, while in the Pharmacy-Biotechnology group answers are still grouped at a determined rating point. Also, in the Medicine group, the rating is displaced to the 3 rating

point (undecided/neutral), while in the Pharmacy-Biotechnology group it remains in a high rating point (4, agree). Only in the Q13 (Do you consider relevant for the objectives of a Physiology course to have worked on different aspects of the botanic species in the Campus?) we observe a displacement of the answers towards the rating point 3 in the Pharmacy-Biotechnology group.

Concerning Q15 (Do you think the poster format has advantages over other methods (as power point)?) the Pharmacy-Biotechnology students show more interest on this tool, as 41% rate it with 5 points, while most of the Medicine students are more neutral, as 61% rate it with 3 points (data not shown).

Finally, the Q16 (Evaluate the educational tool "UEM Botanic Trail"), which evaluates the general assessment of the activity, shows different results in both groups. While the 69% of the Pharmacy-Biotechnology group rate the activity with 4 (agree), the 54% of the Medicine group rate the activity with 3 (undecided/neutral).

Discussion

The work presented here is based on the use of the Botanic Trail as an alternative tool for teaching Physiology to students of different Degrees, in particular Medicine and Pharmacy-Biotechnology. Our data expose the students' impression about the development of this activity out of the classroom, and their assessment of its usefulness as a complementary resource for teaching Physiology in their Grades. Taking advantage of the different plant species in the University Campus, a Botanic Trail was created, providing students with scientific information about the distinct botanical species through QR codes located by the plant and linked to the website http://sendabotanicaue.es/. Supporting on this tool, we designed an activity with the objective that students relate the active ingredients of some therapeutic drugs with the plant they are extracted from, and with their mechanism of action in our organism. Students' satisfaction with this activity was evaluated and analyzed by means of a survey, answered both before and after carrying out the activity.

Previously to be done, the activity was presented to Lecturers from our University, who considered very interesting its implementation, and encouraged us to use it as part of our teaching activity (Mohedano et al., 2016). We consider that some of the strengths of this activity are its integrative and applied character. Integration of basic subjects is a tool with a growing interest nowadays in many Universities worldwide (Bonaminio, 1998; Schmidt, 1998). Although the purpose of the current activity is that the students deepen on the knowledge of Physiology, the study and search for the mechanism of action of an active ingredient usually includes contents from other disciplines (i.e., Biology, Biochemistry, Pharmacology), achieving by it an integrative character. For this reason, it would be interesting to collaborate in this activity with Lecturers of other areas in the future. In this sense, PBL has been showed as a good way to trigger students to set learning objectives in basic sciences (O'Neill, 2000).

Students of the first years commonly complain about the lack of applied contents in most of Health Sciences Degrees. In this sense, some studies have already highlighted the importance of the application of contents learnt in master classes from the initial courses of Health studies, as a proper way to reinforce the understanding of those contents. Notably, a number of studies have shown that an important part of the basic science knowledge learned in the traditional preclinical phase of the medical course is lost during the final, predominantly clinical, years (Custers, 2010). In his study, Harris and coworkers (2013) concluded that, when knowledge gained is not directly relevant or applicable to clinical contexts, it is lost rather quickly. For that reason, numerous studies have attempted to incorporate integrated activities to the students' curricula in order to favor retention of basic science knowledge through applicability and perceived clinical relevance (Malau-Aduli et al., 2013). With this activity, we intended to approach to the students' professional profile, for both Biotechnology, in whose professional development they would have to investigate drugs and their potential use as treatments, and Pharmacy and Medicine students, who will have to prescribe and/or recommend drugs to their patients.

One thing that is important to notice is that the activity was carried out with students of different courses: Pharmacy-Biotechnology students are in the second course, whereas those in the Grade of Medicine are in their first course. This is an important point for some aspects that have been evaluated in this activity, as their feedback could be influenced by it. For example, Biotechnology students have previously used technologies such as wikis or *kahoot*, and therefore they are used to them, whereas only a few students of Medicine have already used them. That is the reason that probably justifies why Medicine students seem to be more reticent to the application of new technologies as an additional tool for their learning, as they would need to invest more effort and involvement to use them.

A similar result can be observed when the students are asked for their assessment on the use of botanical species as a learning tool in Physiology (see Results, questions Q4 and Q13): whereas Pharmacy-Biotechnology students keep thinking that the Botanic Trail has contributed to learn new concepts related to Physiology, Medicine students do not. Taking this into account, probably we should reconsider the planning and objectives of this activity for students in Medicine in the future, in order to increase their degree of satisfaction and their perception of an improved learning with this tool. In this sense, probably the learning objective of this activity is closer to the Pharmacy-Biotechnology students (intracellular mechanism, active principles of therapeutic and toxicological botanic species) than to Medicine students, who might consider that this activity, as it is planned, is not really helpful for approaching their professional career. This hypothesis agrees with one of the main problems encountered with PBL, that is the fact that its implementation sometimes is not consistent with the current insights of learning (Dolmans et al., 2005). Thus, it is possible that the answers given by Medicine students could respond to a poor relation with what they consider is the main purpose of their learning. The adaptations of activities based on problem solving depending on

the students' profile has also been stated, not only referring to the Degree or the academic year they are enrolled in, but also referring to their cultural and ethnic backgrounds (Khoo, 2003). This study also points to the need of a proper design of the objectives of the activity, to make it relevant and interesting for the students.

In general, our results show a great interest of students to make activities out of the classroom and to work in new spaces, taking advantage of the possibilities and resources that the University Campus offers. In fact, students consider important, both before and after accomplishing the activity, to do activities out of the classroom. This agrees with other studies emphasizing the aptitude of the students for this kind of activities and the fact that this concept of teaching improves the engagement of students in self-directed learning and their perceived sense of Campus community (Kuh, 1995; Deepwell and Malik, 2008; Elkins et al., 2011). The high acceptance of these out-of-class activities by students encourages the inclusion of new teaching methodologies as a complement to master classes, in a try to develop new skill and abilities on students (Antepohl and Herzig, 1999; Deepwell and Malik, 2008). In this sense, Newble and Clarke (2009) provide evidence of a deeper acquisition of knowledge in medical students taught under problem based learning methodologies than those who study within the traditional lecture based learning, who got a more superficial knowledge. However, after doing this activity, we find that the number of students of Medicine that are satisfied with this out-of-class activity is lower than Pharmacy-Biotechnology students. Again, this result leads us to thinking that, when designing this kind of complementary tools, it is important to consider the profile of the students to adjust the objectives of the activity to the distinct Degrees (see Results, questions Q1 and Q11 in the survey).

To evaluate how the students had carried out this activity, we decided to use a poster format, as it helps them to develop abilities such as synthesis capacity, data organization or communication skills. The development of these abilities on students is a major objective of the current Higher Education, and many actions are being done in this direction in health professional education (Ladyshewsky and Gotjamanos, 1997). Most of our students stated to be familiar with poster format for the results presentation, and have positively valued this way of evaluation. Following the same reasoning argued before, the opinion of the usefulness of a poster to present their results vary from Biotechnology to Medicine students, and in the same way, the first ones consider very positive to use it whereas the last ones do not. However, we do not believe that these results should be considered a negative point, but more like a normal process in the critical and intellectual maturity of the students and the perception that they have of their own learning process (Zhang et al., 2011).

Another fact that could explain the different general results obtained in the different Degrees could be the length of the activity. While Pharmacy-Biotechnology students did it during a trimester, for Medicine students it lasted the whole academic year, and most of them admitted not to have worked on it until the very last minute. Thus, at the end of the year, when working under

pressure, and with a lot of duties and exams to do, their perception of the whole activity could be biased by a stressed mood.

Altogether, we can conclude that the inclusion of the Botanic Trail as a teaching tool is considered positive for most of our students. However, we have found that the general assessment depends on the profile of the students. Thus, Pharmacy-Biotechnology students found these kinds of activities more interesting, since they promote investigation, discussion and creativity; on the contrary, Medicine students enjoy more applied procedures. For all the above mentioned, we can conclude that, although the inclusion of resources as a complement to a master class could be positive, it is important to take into account the specific profile of each group of students to accomplish the planned goals. In the future, we will adapt the objectives of the activity to the demands of each Degree, and we will try to work together with the Lecturers of other disciplines, in order to integrate different complementary areas for achieving a more complete knowledge on students.

References

Albanese, M. 2000. Problem-based learning: why curricula are likely to show little effect on knowledge and clinical skills. *Medical Education*, 34:729–738.

Antepohl, W., Herzig, S. 1999. Problem-based learning versus lecture-based learning in a course of basic pharmacology: a controlled, randomized study. *Medical Education*, 33:106–113.

Bain, K. 2007. *Lo que hacen los mejores profesores universitarios* [What the best university professors do]. Valencia: Editorial Universidad de Valencia.

Benítez, G., Biscaia, J. M., Mohedano, R. B., Escribano, J. J., Díez, J., Herrera de la Mata, S. 2013. Use of botanical species on the campus as a teaching tool. *International Conference on Education and New Developments*. Lisbon.

Biscaia Fernández, J. M., Mohedano del Pozo, R. B., Benítez Cruz, G., Escribano Otero, J. J., Diez Niwa, J., Herrera de la Mata, S. 2013. Utilización de las especies botánicas del campus como herramienta docente: análisis de la colaboración profesor-alumno, transversalidad, nuevos espacios y motivación en educación [Utilization of campus botanical species as a teaching tool: analysis of teacher-student collaboration, transversality, new spaces and motivation in education]. *X Jornadas Internacionales de Innovación Universitaria*. Madrid.

Bonaminio, G. 1998. The challenge of integrating the basic medical sciences. *Basic Sci Educ*, 8(1&2): 13-15.

Conferencia Nacional de Decanos de las Facultades de Medicina (2005). *Libro Blanco de Medicina* [White Paper on Medicine]. Madrid: ANECA.

Custers, E. J. F. M. 2010. Long-term retention of basic science knowledge: a review study. *Adv Health Sci Educ Theory Pract*, 15(1):109-128.

De la Orden, A. 2004. Producción, Transferencia y Uso del Conocimiento Pedagógico [Production, Transfer and Use of Pedagogical Knowledge]. En *Temas fundamentales de investigación educativa*. Buendia, L., Gónzalez, D., Pozo, T. (Coords). Madrid: La Muralla, pp. 15-29.

Deepwella, F., Malik, S. 2008. On campus, but out of class: an investigation into students' experiences of learning technologies in their self-directed study. *Research in Learning Technology* 16(1):5–14.

Díaz-Velis, E., Ramos, R., Mendoza, C. 2005. Un reclamo necesario, la integración de los contenidos en la carrera de Medicina [A necessary claim, the integration of the contents in the medical career]. *Educación Médica* Superior. Vol. 19 (nº1). ISSN 0864-2141.

Dolmans, D. H. J. M., De Grave, W., Wolfhagen, I. H. A. P., Van Der Vleuten, C. P. M. 2005. Problem-based learning: future challenges for educational practice and research. *Medical Education*, 39: 732–741.

Elkins, D. J., Forrester, S. A., Noël-Elkins, A. V. 2011. Students' perceived sense of campus community: the influence of out-of-class experiences. *College Student Journal* 45.1:105-121.

Fogarty, R. 1991. Ten ways to integrate curriculum. *Educational Leadership*, 49(2), 61-65.

Gal, B., Fernández-Santander, A., Palau, L., Sánchez, A. 2013. Integrar asignaturas básicas en primero de Medicina: análisis cuantitativo y cualitativo de una experiencia piloto [Integrar asignaturas básicas en primero de Medicina: análisis cuantitativo y cualitativo de una experiencia piloto]. *Educación Médica*, 16(4), 225-231.

Harden, R. M. 2000. The integration ladder: a tool for curriculum planning and evaluation. *Medical Education-Oxford-*, 34(7):551-557.

Hardwick, K., Fiedler, P., Lee, L., Pavlik, B., Hobbs, R., Bidartondo, M. 2011. The Role of Botanic Gardens in the Science and Practice of Ecological Restoration. *Conservation Biology*, 25 (2), pp. 265-275.

Harris, J. A., Heneghan, H. C., McKay, D. W. 2003. The rating of pre-clerkship examination questions by postgraduate medical students: an assessment of quality and relevancy to medical practice. *Med Educ.* 37(2):105-109.

Khoo, H. E. 2003. Implementation of problem-based learning in Asian medical schools and students' perceptions of their experience. *Medical Education*, 37:401–409.

Kuh, G. D. 1995. The Other Curriculum: Out-of-Class Experiences Associated with Student Learning and Personal Development. *Journal of Higher Education*, 66(2):123-155.

Ladyshewsky, R., Gotjamanos, E. 1997. Communication skill development in health professional education: the use of standardised patients in combination with a peer assessment strategy. *J Allied Health*, 26(4):177-86.

Libro Blanco de las Facultades de Medicina, 2005.

Malau-Aduli, B. S., Lee, A. Y. S., Cooling, N., Catchpole, M., Jose, M., Turner, R. 2013. Retention of knowledge and perceived relevance of basic sciences in an integrated case-based learning (CBL) curriculum. *BMC Medical Education*. 13:139.

Mohedano, R. B., Biscaia, J. M., Benítez, G. 2014. Valoración del proceso enseñanza-aprendizaje en la creación de la Senda Botánica UEM [Assessment of the teaching-learning process in the creation of the UEM Botanical Path]. XI Jornadas Internacionales de Innovación Universitaria: Educar para transformar. Madrid.

Nandi, P. L., Chan, J. F., Chan, C. P. K., Chan, L. P. K. 2000. Undergraduate medical education: comparison of problem-based learning and conventional teaching. Hong Kong Med J, 6: 301-6.

Newble, D. I., Clarke, R. M. 1986. The approaches to learning of students in a traditional and in an innovative problem-based medical school. *Medical Education*, 20:267–273.

O'Neill, P. A. 2000. The role of basic sciences in a problem-based learning clinical curriculum. *Medical Education*, 34:608–613.

Román Graván, P., Méndez Rey, J. M. 2014. Experiencia de Innovación Educativa con Curso MOOC: los Códigos QR Aplicados a la Enseñanza. Profesorado, 18(1), pp. 113-136.

Schmidt, H. 1998. Integrating the teaching of basic sciences, clinical sciences, and biopsychosocial issues. *Acad Med*, 73(9 Suppl):S24-31.

Universidad de Sevilla, 2008. http://asignatura.us.es/abotcam/ (April 5th, 2014).

Zhang, G., Zeller, N., Griffith, R., Metcalf, D., Williams, J., Shea, C., Misulis, K. 2011. Using the context, input, process, and product evaluation model (CIPP) as a comprehensive framework to guide the planning, implementation, and assessment of service-learning programs. *Journal of Higher Education Outreach and Engagement*, 15(4):57-84.