Sustainable development in higher education: different teaching & learning approaches

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ABSTRACT

Linking the economic, social and environmental aspects of any plan, project or activity is fundamental to act according to the sustainable development goals. These three dimensions are interrelated and interconnected in such a way that it is sometimes very hard to discriminate what their individual effects are, or on the contrary, how their joint effects are synergistic. And if this is generically a difficult task, when it comes to education the difficulty becomes even more significant, as one must be very careful defining concepts in an absolutely clear and undoubtful way. While the specialization is required to educate professionals able to accurately project and build these projects, it is now mandatory that everyone is also able to understand the causes and effects of their actions, towards sustainable development.

In this Track, different teaching & learning approaches have been presented and discussed, aiming to use Higher Education as a *highway* to educate the professionals of the near future as strategic partners for the development of different mindsets, able to tackle the real problems.

CCS CONCEPTS

• Applied Computing → Physical Sciences and Engineering; • Applied Computing → Education; • Computers and Education → Computer and Information Science Education – curriculum, problem-based learning, self-assessment • Social and professional topics→ Sustainability • Social and professional topics→ Model curricula • Social and professional topics→ Informal education • Social and professional topics→ Student assessment.

KEYWORDS

Sustainable development, Higher education, Interdisciplinarity, Multidisciplinarity, TEEM, Transdisciplinarity.

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1 Introduction

Sustainable development and sustainability have played an important and recognized role in higher education, as demonstrated in several declarations on Sustainability in Higher Education. These declarations not only frame the problem and the requirements to address it, but also are the basis of the international regulation on this matter.

It is well known that the research work produced at the universities or by researchers in other outstanding research centers has demonstrated the profoundly negative impacts caused by mankind, namely in what concerns the depletion of natural resources [1] and the frequent irreversible damage caused to environment and to humans [2,3]. Altogether, this has consequences such as one nation may exhaust the resources produced yearly in only one half of that time or sometimes even less [4]. Of course this is unsustainable and therefore universities and researchers feel strong pressure not only to develop more efficient processes but also to be the engine of a dramatic change in people's mind, particularly of those that have higher responsibility towards the community, that is, those that receive higher education. Nevertheless, it is not enough to sign a declaration of intentions, as the implementation of such bumps into a set of barriers and impediments. Fundamentally, it is

mandatory that one has shared purposes and establishes strong relationships, that the organizational systems we build and use to develop our goals are planned aiming sustainability. It is not only a matter of availability of knowledge, but especially a matter of using knowledge as a tool to evolve sustainably [5].

In spite of the increasingly high number of declarations on Sustainability in Higher Education and the correspondingly high number of universities and intergovernmental institutions that have signed them [6,7], implementing sustainability in a university can be quite a challenging and slow task [5].

Sustainability includes a relatively broad range of significances, related to the user expertise, professional experience, ethical and personal beliefs. Furthermore, the human nature is to immediately resist to change, even if later the same change demonstrates to be good. Each individual is entitled to his own interest and vision, and therefore there may be multiple conflicting interests and perceptions of the reality.

Teaching such a vague and complex concept as that of sustainable development must be based on non-conventional approaches, integrating the concepts taught in different disciplines in "classes" where real-people (the students) address real-life problems. The complexity of present systems makes it mandatory to integrate the knowledge of several different disciplines. Nevertheless, there is no longer room for the conventional old fashioned active teacher or to the even more outdated passive students. There is no longer room for only one "owner" of the truth; knowledge must be transferred in both ways, continuously updated. The keyword is now interactivity; students and teachers must actively feel the need to build and share knowledge and thus discover the meaning of sustainable development and its implications not only for each individual but also for the community or the project they are involved in.

While the basis of higher education still may use the traditional (uni)disciplinary approach to educate students when applied to simple and isolated systems that often have a unique solution, its systematic use may constrain the development of a more open mindset, prepared to tackle with complex and real-life open solution problems, that in its nature are multi and interdisciplinary.

The paradigm shift needed in the education for sustainable development demands different approaches, able to add new contributions and solutions to the challenges posed by the sustainable development of a world so populated and developed [8]. However, if academics find it difficult to cooperate in different matters and disciplines (interdisciplinarity), where they need to dialogue and exchange knowledge between disciplines, the cooperation between academics and professionals (transdisciplinarity), that is the trigger for a joint and rich learning process, seems even more difficult. Furthermore, the pluridisciplinary approach of learning is based on justaposing different specialized looks over a problem (the object of study).

Sustainability and sustainable development concepts are intrinsically multi-dimensional issues (as they involve economic, environmental and social aspects, that are interrelated), and therefore they should be taught through several different multidisciplinary strategies (interdisciplinarity, pluridisciplinarity, transdisciplinarity).

Adequate strategies are required to satisfactorily educate on sustainable development, which is a very complex task, and there is not only one privileged approach, rather a combination may be needed.

2 The contributions presented in TEEM2019' Track 7

The contributions in this edition of TEEM'19, Track 7, show the diversity of themes and related approaches in many different domains, and are summarized below.

The theme of knowledge, more specifically that of *knowledge management* in higher education institutions is a factor directly linked to institutional sustainability. According to Yigzaw et al. [9], in the increasingly digitizing world and mainly knowledge-driven economic society, the key position in the success of companies and institutions is knowledge, the most important resource. In the knowledge-intensive institutions such as in higher education this is even more expressive. Its adequate management incorporates three main components: People, Technology and Process, whose coherence determines the success of a Knowledge Management System (KMS). Recently, the advancement in the features of technology hardware and their functionalities have brought more focus on the technology capabilities to serve the human resource beyond representing and processing information. Additionally, the growing of the so called digital-native generation also forms a basis for the application of advancing features of technology into the processes. They efficiently use the knowledge resources for greater educational and research endeavors towards sustainability of higher education. The Systematic Literature review summarized in this work provides analysis of the findings exploring the trend in the application of information technologies in higher education KMS. In addition, authors identified gaps where more research is needed and described lessons acquired for contextual application of KMS in developing countries' higher education [9].

The theme of *energy literacy is* an essential tool that allows citizens to adopt more sustainable behavior. The work by Martins et al. [10] presents *energy literacy* as part of the solution for the problem of climate change and even for the scarcity of fossil fuels. The concept of *energy literacy* brings together three main dimensions: knowledge, attitude and behavior related to energy. Knowledge itself is not synonymous of a good level of *energy literacy*. Most of the knowledge individuals have is insufficient and is acquired in schools, it concentrates on some basics of energy. Knowledge level can be increased in higher education but not all courses include in their curricula the required subjects. Therefore, in this work authors relate the educational field with the levels of *energy literacy*. The results show that the levels of *energy literacy* are moderate, and no significant differences were found across different fields of education analyzed [10].

The project-based learning approach was used by a team of six Erasmus students from several countries in the framework of the European Project Semester at the *Instituto Superior de Engenharia*

do Porto (ISEP) in the spring of 2019. The team of six students, mentored by seven professors, decided to project a solar dehydrator which included to design a sustainable solution to dehydrate and preserve food, build and test the proof-of-concept prototype, while strictly complying with requirements such as the budget, reusing materials and components or European Union directives. In addition, with this problem as a base, the team considered the technological, ethical and deontological, economic and environmental perspectives in the design of the prototype. The main objective of the European Project Semester is to develop teamwork, communication and problem-solving skills through multidisciplinary and interdisciplinary team work [11].

The theme of *teaching laboratories* is again present in the work of Felgueiras et al. [12]. Indeed, teaching laboratories are essential facilities for teaching. There are various types of labs such as traditional hands-on labs, virtual labs, and more recently, *remote labs* have steadily become more established. All laboratories have associated a certain degree of waste production. This paper focuses on the teaching laboratories of electricity and electronics. Remote labs are described as platforms where experiments are real, remotely located, and accessed through a PC. The experiments are carried out in a safe manner, preventing the maximum limits of the components from being exceeded. As the components are not handled by the user, they are not mechanically stressed. In the case of traditional laboratories, the components are used by students who often destroy them either electrically or by mechanical stress. To contribute for sustainable solutions in education, it is proposed the use of remote labs instead only of the traditional hands-on laboratories in every engineering courses. It is also described the use of a remote laboratory named VISIR in a course held at the Polytechnic of Porto – School of Engineering, during the conduction of an electronic experiment. Comments about the importance of sustainability in higher education are presented [12].

Santillan-Rosas et al. [13] presented their educational intervention aiming to improve the skills of citizenship of students in their first semesters of engineering through participatory management of remote laboratories of air quality in eight different zones of Monterrey, Mexico. The students were divided into teams of 4 to 5 members, used equipment to measure the level of pollution in the air in their designated area on 3 different days. A final report was prepared by students who scored the measurements on their area, delivering reports to authorities of local communities. Two focus groups took place, one during the activity and one after the students handed in their final reports. These focus group was aimed at listening to the student's thoughts regarding the activity and the knowledge they acquired through it. Interesting suggestions for future implementations were also an important topic during these focus groups. Raising awareness on the problems of environmental pollution was one of the consequences of this field work.

3 Conclusion

TEEM has consistently discussed the theme of education towards sustainable development. Several different views of the challenges posed and possible approaches used to educate on sustainable development and sustainability issues have been presented in the 7th edition of TEEM. A common conclusion of the works resented in this edition is the recognition of the importance and vast nature of the problem and the need for multidisciplinary and interdisciplinary educational tools to address it. Furthermore, it was also recognized that by dealing with real-life problems, students tend to better understand the problem and propose solutions. Of course these are only a few of the reasons that justify the extreme importance of this theme, and are not the only possible approaches. In spite of the huge importance that has been given to sustainable development by the media, and the raising importance given by researchers to education on the topic, it is not surprising this theme had only a limited number of contributions. The discussions show particularly high multidisciplinary abilities. The path to Sustainable Development is gradually but steadily widening.

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