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The engineering behind the technological-based educational innovation

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Learning technologies [1] or technologies applied in education [2-3] have been widely tackled from both a scientific point of view and an innovation perspective. If we refer specifically to engineering education is also true. Moreover, engineering and innovation are inseparable concepts [4], and innovation in the teaching methods in the engineering scope has been yet presented in other issues [5].

Now, we are worried about the engineering products that supports the technological artefacts we use in our educational innovations.

Technological aspects are important in learning technologies of course, but we claim these technological advances are nothing if they do not imply a real impact on teaching, innovation and learning processes in engineering subjects.

Educational innovation may be defined as the process to change teaching or learning activities that produce improvements in the learning outcomes [6]. However, in order to consider this process as educational innovation, it should respond to some needs: 1) it should be effective and efficient; 2) it should be sustainable over time; and 3) it should produce transferable outcomes beyond the particular context in which it arose.

The impact of an innovative technology may be oriented to four different scopes, which are not fully separate [7]: 1) the institutional scope, oriented to increase the quality and competitiveness of the educational organization [8]; 2) the institutional third mission scope [9], which looks for transferring the knowledge to the society and also helps the most depressed social groups; 3) the development of students' transversal competences, usually called soft skills [10]; and 4) the subject scope [11], in which one most of the educational innovation are oriented from the faculty perspective.

Engineering artefacts may be presented in all these educational sectors, but only have interest if they have a real educational impact in their application area.

This special issue is centred on the engineering behind these educational innovations, but including both the technological or innovative value but also their impact in the engineering education in the broadest sense.

The special issue call had a huge acceptation, 66 contributions were received and after a double-blind peer review process with 3 rounds at least, 16 papers were finally selected. These papers may be classified into four groups.

The first group of three papers is related to the use of mobile devices for educational proposals. Mobile devices have a great penetration in education in general [12-14] and in Engineering field specifically [15]. Joo Nagata et al. [16] describes the creation and educational effectiveness of a digitally-enabled learning module. The module is linked to the implementation of several Mobile Pedestrian Navigation and Augmented Reality features (MPN-AR), which are used to carry out training processes. Particularly, the delivered contents are related to territorial information on several relevant STEM (Science, Technology, Engineering and Mathematics) disciplines [17]. The paper includes both technical issues (regarding architecture, functionality, user interface and implementation) and empirical evaluation of the developed artefacts. Hendeby et al. [18] present a platform for sensor fusion consisting of a standard smartphone equipped with the specially developed Sensor Fusion app. The article describes the app and a laboratory exercise developed around these new technological possibilities. The laboratory session is part of a course in sensor fusion, a signal processing continuation course focused on multiple sensor signal applications, where the goal is to give the students hands on experience of the subject. This is done by estimating the orientation of the smartphone, which can be easily visualized and also compared to the built-in filters in the smartphone. The filter can accept any combination of sensor data from accelerometers, gyroscopes, and magnetometers to exemplify their importance. This way different tunings and tricks of important methods are easily demonstrated and evaluated on-line. Humanante et al. [19] aim to make a diagnosis on access to and use of electronic devices and the web tools by students of the degree of Systems Engineering and Computer Science at Faculty of Engineering at the National University of Chimborazo in Ecuador, from the viewpoint of PLE (Personal Learning Environments) [20-21]. A methodological level corresponds to a quantitative and non-experimental research, ex-post-facto. The results show certain trends in the types of devices and their frequency of use, as well as their preferences for the tools to obtain and to find information, not only to create but to edit content and communicate with others, where they prioritize the use of certain social networks and some tools of synchronous and asynchronous communication.

The second group is related to gamification [22-23] and game-based learning [24] are other interesting topics with a growing presence in the innovative educational movement in engineering specially oriented to achieve more engagement and motivation among the students [25]. Four papers compose this group. Jurado and Echeverría [26] make a proposal to develop Adaptive Educational Games that uses adaptation rules that take into account Gamer Profiles to engage students in the use of the educational tool and Learning Styles to help the system to determine the teaching/learning methods, learning-objects and learning-services that best suit each particular student. Gallego-Durán et al. [27] present PLMan, a game-based learning activity designed to face problems observed in practical lessons about Computational Logics. Authors describe the analysis and design steps undertaken from the problematic situation to the implementation of PLMan. Experimental data confirms that this intervention reverted the problematic situation, improved learning results, raised student motivation and involvement, and left time for teachers to maintain and improve the system. The third paper of this group is by Ruipérez-Valiente et al. [28], they propose some metrics that provide information regarding the behaviour of students with badges, including if they are intentionally earning them, the concentration for achieving them and their time efficiency. Authors validate these metrics by providing an extensive analysis of 291 different students interacting with a local instance of Khan Academy. Castronovo et al. [29] present evidence to support the contention that educational simulation games can help the learning and retention of transferable problem-solving skills, which are crucial to solve complex construction problems. A sample group of 34 architectural engineering students, from a fourth year construction class, participated in a quasi-experiment where they had to play the three modules of the Virtual Construction Simulator 4 (VCS4). A crossover repeated measures quasi-experimental design assessed the gains in problem solving skills that construction students gained from playing the VCS4.

The third group of papers are devoted to develop some kinds of virtual and remote labs [30-31]. The advances in no physical labs are too much significant for the development of non-face-to-face education in engineering fields [32-33]. Four papers are classified in this group. Ramírez-Hernández and Montesinos-Castellanos [34] show how a remote lab is used to supplement theoretical courses for first- and second-year engineering students. The main concern of the study is that students at this stage are not yet familiar with the equipment. The results showed that the students were more motivated to learn and performed better when they used the remote lab. Supplemented by the remote lab, experiments during class time and as homework, effectively designed activities could improve the understanding and application of some engineering concepts. Moreno Montero and Retortillo Manzano [35] defend that computer networks is an essential area in the training of computer science engineers. Delivery of networking laboratory experiments with specialized equipment is a challenge for computer networks teachers. They present practical teaching materials to be used in networking courses for a Computer Science Engineering degree. This material will allow students to work with real equipment in some cases and with simulation environments in others. Machidon et al. [36] describe the design and implementation of a digital hardware design remote virtual laboratory that provides solutions to issues such as the difficulty in offering access to physical equipment in fields where a practical, hands-on approach is mandatory and also a low effectiveness in resource sharing, due to the fact that traditionally, one hardware equipment can be used by only one student at a given moment. Reconfigurable hardware development platforms are made available online using web services, thus providing easy access for student practice by the means of an intuitive web interface that offers the user the possibility to remotely configure and communicate with its designated hardware resource. Djurica and Minović [37] address setting up virtual laboratories made of widely available, general purpose, operating systems based on Linux that act as a network operating system.

The final group of five papers is devoted to explore the usage of virtual learning environments [38] for the development of both specific subject competences and transversal soft skills. Galanis et al. [39] propose a framework to gather, enhance, organize, evaluate and showcase a user's informal learning using a social approach to engage the learners to use the system by providing valuable recommendations, contacts and feedback. Llamas Nistal et al. [40] introduce new developments in BeA (Blended e-Assessment) [41], a platform that supports the streamlining of the whole cycle required for assessing traditional written exams from preparation to print in paper to grading and review online, to support also on-line assessment and automatic grading of written multiple-choice tests, and communication facilities to allow student-professor communication during the reviewing stage. Using these facilities professors have more options to prepare exams and tests and different assessment processes, including self-assessment, are facilitated in a more comprehensive way. Velázquez-Iturbide and Pérez-Carrasco [42] introduce an extension of the recursion visualization system SRec, intended to support dynamic programming. Conde et al. [43] propose the use of peer review as a methodology that can help students to get more involved and to develop specific abilities has critical thinking. We have successfully used this approach in three different courses in different years (freshman and sophomore) and different studies. Quantitative and qualitative data was collected during these experiences to evaluate students' opinion and performance. Finally, the last paper by Sein-Echaluce et al. [44] propose a model where the student is shown as a knowledge issuer both for their own benefit and for their peers. The key idea is the transfer of knowledge produced by students to organizational knowledge through the knowledge management sys-tem the Collaborative Academic Resources Finder (BRACO) [45].

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