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COMPARISON OF GAMIFICATION TOOLS FOR EVALUATING THE ETHICAL, ENVIRONMENTAL AND PROFESSIONAL RESPONSIBILITY SKILLS IN SCIENCE DEGREES

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Abstract

In the last two years the Universitat Politècnica de València (UPV) has implemented the evaluation of key transversal competences in its degrees. The objective is to offer an added value both for UPV's graduates and their employers. Nowadays, labour market is demanding not only professional skills but also personal and transversal competences development. However, evaluating these skills may require evaluation methods and techniques different to traditional ones. The authors have worked with gamification tools to help assessing student's performance in "Ethical, environmental and professional responsibility" skill. The experiences described have been developed in the frame of an Innovative Educational Project Improvement during the academic years 2014/2015 and 2015/2016. The aim of this paper is to compare the performance of two gamification applications, Socrative and Quizbean, for evaluating the above mentioned skill. Both applications can be used in the classroom with different devices such as laptops, tablets or mobile phones, and are based on creating questionnaires. These applications also share other characteristics such as high number of questions allowed, relatively high number of students in the classroom, instant results, etc. Socrative was used in Thermodynamics and Chemical Kinetics course in the first year of the Bachelor's degree in Biotechnology. Quizbean was used in Groundwater management subject in the fourth year of the Bachelor's degree in Environmental Sciences. To increase student motivation, game rules were included to encourage competition. The questionnaires were designed and classified according to 3 possible levels of acquisition of the key competence, these levels are fully described in a specific rubric that was explained beforehand to the students. Both applications performed successfully and the specificities of each gamification tool are described in the results. Students were satisfactorily involved in the activity, and some examples are included to show different levels of competence acquisition.

Keywords: gamification, Socrative, Quizbean, transferable competences.

1 INTRODUCTION

The implementation of the competence-based approach required by the European Higher Education Area (EHEA) has involved important changes in educational frameworks of University. The Universitat Politècnica de València (UPV) has been included several key competences in the curricula of Bachelors and Masters degrees to address these changes. The aim of these innovative educational adaptations is to prepare UPV's graduates to their labour market integration. Nowadays, modern society and labour market are demanding not only professional skills but also personal and transversal competences development. This new educational approach needs a major organizational and teaching effort that requires innovative teaching techniques different from the techniques performed up to now [1]. This paper is focused in "Ethical, environmental and professional responsibility" skill [2] evaluation problem. A new assessment approach is proposed based on gamification tools to determine student performance in mentioned skill. Moreover, a secondary aim of the authors is to change the perception of the mobile device as an attention disturbing element to a useful assisting educational device.

In recent years, more and more students attend their classes with mobile devices (phones, laptops and tablets) [3]. These elements, which *a priori* could be distracting, could promote and foster the development of basic transversal skills if integrated properly in the process of teaching and learning in the classroom [4]. Thus, mobile devices offer a number of possibilities regarding the use of educational resources available on-line, which include student response systems in the classroom. These systems (e.g. Socrative and Quizbean) are fundamentally electronic tools that allow an instructor to poll their students in real-time. These systems have been traditionally used to engage students in lectures and the benefits of integrating them into lectures involve harnessing the

Millennials' need for immediacy as well as their obsession with technology [3]. Universities usually have a good wireless network connectivity, which is free, which is an additional advantage to using these devices at no cost to the student.

1.1 Objective

The aim of this paper is to analyse the performance of two gamification applications, Socrative and Quizbean, for evaluating the "Ethical, environmental and professional responsibility" skill. The experiences described have been developed in the frame of an Innovative Educational Project Improvement, which was developed during the academic years 2014/2015 and 2015/2016.

2 SOCRATIVE AND QUIZBEAN BASIC FEATURES

Socrative (Mastery connect) and Quizbean (Bluehouse group) are two student response systems with similar characteristics. Both have a free version on-line that is useful for trial or basic use. Socrative also offers free applications for mobile devices (iOS, Android and Windows Phone). The paying versions allow more students participation and other improved characteristics. The free version of Quizbean offers unlimited classes while Socrative allows just one. Both systems can include different type of questions in their test: true or false, multiple choice and multiple correct. The questions can be complemented with videos or image, and also can include the explanation of the right answer. Another important feature shared in both systems is the scramble choice to prevent students from copying. The reporting and analytics feature is key in both systems as it enables student feedback (average score, wrong/right answers, time of delivery of the exam). In addition, quiz results can be exported in different formats (PDF, Excel, etc.)

3 SOCRATIVE AND QUIZBEAN GAMIFICATION EXPERIENCES

Socrative has been used since Academic Year 2013/2014 (3 years) in the lectures of "Thermodynamics", which is a first-year subject of the Bachelor's Degree in Biotechnology (Universitat Politècnica de València). This course has an average enrolment of 116 students, divided in two theory groups (Standard and High Academic performance, English as a medium of instruction). In these lectures Socrative was used once a week at the end of each lesson.

Quizbean was used the Academic Year 2015/16 in the lectures of "Groundwater Management in the Coastal Zone", which is an elective fourth-year subject of the Bachelor's Degree in Environmental Sciences (Universitat Politècnica de València). This course had an enrolment of 16 students. In these lectures Quizbean was used at the end of the semester.

The main differences among Thermodynamics students and Groundwater management students were the group size and students age (first and fourth year students, respectively). Thermodynamics group size was bigger and students younger so a more continuous evaluation option was selected. The problems associated with the misalignment among lesson duration and student attentions spans are further compounded by the prevalence of very large classes in many introductory undergraduate subjects [3]. Then the continued use of response systems can help in increasing attention level. At the end of the courses, the students' point of view was evaluated through an opinion poll. Almost all the surveyed students considered these tools as innovative and useful. A high percentage of students stated that the use of these tools encourages their participation in the classroom, promotes active learning (> 90% positive responses) and makes the lectures be more dynamic (> 95% positive responses).

Gamification strategy and competition are key to increase student motivation. We set for each round of questions a very tight time, as solving questions in a timely manner is a factor that should be valued. In fact, these systems compile information about time of delivery of the exam that could be used to reward early right solutions. The scramble choice was active to prevent students from copying, as we are assessing the ethical skill of students, copying will denote no ethical competence. We set three rounds of questions of increasing complexity that demonstrate a different acquisition level of the "Ethical, environmental and professional responsibility" skill (Level I, II or III). Students must correctly answer all questions in a round to move on to the next. The last round overcome indicates the level of competence acquired.

4 CASE STUDY: “ETHICAL, ENVIRONMENTAL AND PROFESSIONAL RESPONSIBILITY” SKILL ASSESSMENT

In this section the experience with Quizbean in “Groundwater management” lectures for assessing “Ethical, environmental and professional responsibility” skill is explained in depth. The key step is the design of questions that demonstrate a different acquisition level of the competence. We took advantage of our participation in the working group from Universitat Politècnica de València that elaborated a rubric for evaluating this competence, which can be adapted to all the Bachelor’s and Master’s studies. This rubric was taken as a guide for designing the quiz questions. The rubric was divided in 3 levels of competence acquisition, for each level several indicators were included with descriptors for 4 states: not reached, under development, good and excellent (exemplary). Showing up examples for each level. It is very important to highlight that transversal skills were not disconnected from the specific skills and worked in the lectures. Thus, answering the questions properly required a comprehensive knowledge of the subject.

The First round questions belonged to the first level of competence acquisition, Level I: understand the need to assess the consequences of professional actions in social, environmental and economic impact, and act accordingly. The following figure shows examples of level I questions.

<p>You are environmental technician and you work for the promoter of a landfill. The environmental agency of government has determined in the Environmental Impact Declaration that the environmental monitoring should include monitoring the quality of groundwater. The promoter, ie, your boss asks you to install the monitoring piezometer contrary to the groundwater flow direction. Your response to this instruction is:</p> <ol style="list-style-type: none"> 1. He is my boss so I do what he tells me to because the responsibility is his. I have no responsibility as technician 2. The Environmental Impact Declaration should have specified the location of the piezometer,3. so it is the responsibility of the environmental agency if monitoring of groundwater is not effective 3. I have responsibilities under my profession and qualifications, so you should inform the developer that option is inadequate regardless of whether the Environmental Impact Declaration is not foreseen in its indications location. 	<p>The urban development of the coastal area south of Alicante has led to the overexploitation of aquifers in the interior. To overcome this exploitation has been carried out a transfer between two rivers Júcar-Vinalopó</p> <ol style="list-style-type: none"> 1. The transfer should not have been built if there is insufficient water supply should be cut to coastal municipalities (45% of consumption) and even get to abandon these 2. The transfer should not have been built if there is not enough water inland agricultural crops (55% of consumption) should be abandoned and encouraged migration to the coastal areas with higher economic activity 3. The transfer was necessary because the administration gives some water rights in the past that led to this development and now can not retreat, but should not be the only measure 4. The transfer was not necessary because desalination plants could have been built to carry water into the province of Alicante and meet irrigation needs
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Fig. 1 Examples of Level I questions

Fig. 2 shows the results of the first round, which was conducted by all the 16 students. Statistics can be exported as Excel or pdf files.

QuizBean Quickly Create Online Quizzes For Free

Name	Class	Group/Company	Score	Date Taken
[redacted] Samuel			100%	2015-11-27 1:51 pm
[redacted] cristina			0%	2015-11-27 1:43 pm
[redacted], Vicent			0%	2015-11-27 1:43 pm
[redacted] Fran			100%	2015-11-27 1:43 pm
[redacted] Philip			50%	2015-11-27 1:43 pm
[redacted] Bianca			100%	2015-11-27 1:43 pm
[redacted], Blanca			100%	2015-11-27 1:43 pm
[redacted] daniel			100%	2015-11-27 1:43 pm
[redacted], Gemma			50%	2015-11-27 1:43 pm
[redacted] Marco			100%	2015-11-27 1:43 pm
[redacted] Samuel			50%	2015-11-27 1:42 pm
[redacted] Mercedes			50%	2015-11-27 1:42 pm
[redacted] wenjing			0%	2015-11-27 1:42 pm
[redacted] Jo			50%	2015-11-27 1:42 pm
[redacted] benedict			100%	2015-11-27 1:42 pm
[redacted] Marco			0%	2015-11-27 1:42 pm

Fig. 2 First round results examples (students surnames have been hidden because of privacy)

The Second round questions belong to the second level of competence acquisition, Level II: design, organization and implementation of integrated actions friendly to the social, economic and environmental framework. Fig. 3 shows examples of level II questions.

<p>You are environmental technician and you work for the promoter, you must make a proposal for monitoring the quality of groundwater for the Environmental Impact of a landfill. What do you should specify in your proposal?</p> <ol style="list-style-type: none"> 1. observation piezometer location 2. observation piezometer depth 3. variables to be measured, for example, pH 4. None of this should I specify, is the responsibility of environmental management 5. I should specify only variables, because to avoid law violations is the administration who determines de location of piezometer 	<p>The urban development of the coastal area south of Alicante has led to the overexploitation of aquifers in the interior. These aquifers also have great pressure due to agriculture. Which measures would you recommend for improving the aquifer resources depletion?</p> <ol style="list-style-type: none"> 1. Controlling illegal wells 2. New desalination plants for urban supply 3. New desalination plants for inner areas 4. Controlling leaks in pipelines and increasing efficiency 5. Increasing freshwater cost only for agriculture because they are the cause of the problem 6. Increasing freshwater cost only for urban supply because they are the cause of the problem
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Fig. 3 Examples of Level II questions

The Third round questions belong to third level of competence acquisition, Level III: coordinate and evaluate integrated actions in the professional field, respectful with the social, economic and environmental framework. Fig. 4 shows examples of level III questions.

<p>You work as an environmental technician in administration and participate in the development of zonal waste plan which determines the forecast for the location of new landfills</p>	<p>The urban development of the coastal area south of Alicante has led to the overexploitation of aquifers in the interior. These aquifers also have great pressure due to agriculture. You are environmental technician and you work for the administration. You need to design a freshwater management plan to alleviate the overexploitation situation in this area.</p>
<p>1. I will attend only to technical criteria for the design of the proposal because they are the only valid. For example, one of the most important is the presence of a confining layer of impervious sufficient thickness, and hence low vulnerability of aquifers</p>	<p>1. Public participation processes are important for taking into account all stakeholders interests: farmers, industrial, urban developers, environmentalists, etc.</p>
<p>2. As a technician it is my responsibility primarily serve society. Therefore I will focus more on criteria such as nearby urban centres who may suffer discomfort and so will avoid protests that could delay the approval of the Plan</p>	<p>2. I will have into account alternative freshwater resources: desalination, treated wastewater, transfers</p>
<p>3. The social criteria is added technical criteria to be considered along with environmental criteria and other criteria such as proximity of transport infrastructure to facilitate transport</p>	<p>3. I cannot implement public participation processes, because there exist important conflicts of interest so I should do the best just from technical point of view</p>
<p>4. The social criterion is not technical criteria to be taken into account. Along with environmental criteria need only consider other criteria such as proximity of transport infrastructure to facilitate</p>	<p>4. I will have into account alternative freshwater sources, but diversion from other watersheds never can be a solution</p>

Fig. 4 Examples of Level III questions

After completing the quizzes, the second part of the gamification exercise was developed. At this point students had to argue their responses, which allowed the teacher to define the competence degree for each level as not reached, under development, good or excellent. In small groups this phase can be done orally. However, for bigger groups other possibilities have been explored, such as using short answer questions.

5 CONCLUSION

Student response systems such as Socrative and Quizbean can help in designing gamification strategies for assessing “Ethical, environmental and professional responsibility” skill. An evaluation rubric of the competence is a very good basis for designing questions adapted to different learning levels. These tools have an added value as they increase student motivation and attention during the lectures.

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