Empowering Graduates for Knowledge Economies in Developing Countries

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Abstract. Professional, transferable, or 21st century skills such as life-long learning, problem solving and working in a multi-disciplinary team are vitally important for graduates entering knowledge economies. Students in the developing MENA countries have been identified as weak in these skills, which are challenging to both teach and assess. This paper describes the creation and application of the Computing Professional Skills Assessment (CPSA) in the United Arab Emirates (UAE), an IT specific instrument to assess students' abilities in the professional skills, administered using a Learning Management System (LMS). As part of this research students were surveyed on their perceptions and the results revealed a positive response regarding the benefits of the CPSA. It is suggested as an effective and applicable blended learning method in developing countries to better enable students to learn and apply 21st century skills. The use of this method in regions with limited IT infrastructure is discussed.

Keywords: Professional skills · Learning outcomes · Performance task · Online discussion · Assessment · Learning management system

1 Introduction

Learning Management System (LMS) supported e-learning initiatives in developing nations have been shown to face specific challenges due to the digital divide [1]. These include ineffective maintenance strategies, insufficient user/technical support, usability issues of learning management systems and poor internet connectivity. In this paper we present a method that is implemented in an LMS and that we believe can be effectively used in a developing nation despite the challenges mentioned above.

The engineering and computing disciplines around the world place importance nowadays on graduates being enabled with 21st century non-technical skills, also known as professional or transferable skills. These skills include teamwork, communication, critical thinking, ethical and social considerations, and have become a focus of university programs as measurable learning outcomes. They have also become critically important as developing countries make the transition to knowledge economies, and studies show

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employers value them more than disciplinary knowledge [3]. Globally, graduates are weak in professional skills, particularly in the MENA region [4].

Teaching and assessing these critical skills is challenging and even questionably impossible [2, 5]. Within engineering and technology disciplines, the technical learning outcomes are more confidently met by programs [2]. To address the difficulties of integrating professional skills, accreditation bodies such as ABET, the international Accreditation Board for Engineering and Technology, have sought to improve program quality to increase student attainment of learning outcomes, with some success. A 2006 study found that graduates from 2004 were better prepared than their 1994 predecessors due to the emphasis on professional skills [5].

There are six non-technical outcomes which have been identified by ABET as key graduate skills:

- Ability to analyse a problem and identify solutions;
- Ability to function on multidisciplinary teams;
- Understanding of professional and ethical responsibility;
- Ability to communicate effectively;
- Understanding of the local and global impact of technology;
- Recognition of, and ability to, engage in life-long learning.

To assess these skills simultaneously, the Engineering Professional Skills Assessment (EPSA) was developed by a team in Washington State University's College of Engineering led by Ater Kranov, one of the authors [6]. The EPSA is based on the performance assessment model, which is an effective way to measure student performance on simultaneous learning outcomes in an interdependent way [2]. Prior to the CPSA the EPSA was the only method in the literature which could assess all of these learning outcomes directly and concurrently for engineering programs, thereby increasing the validity of the assessment [7]. The various methods used to assess professional skills previously, such as e-portfolios and internships, were found to be limited in their efficacy to assess all of the skills in an integrated and rigorous way. The EPSA consists of a real world engineering scenario to generate discursive analysis in forty-five minutes, and these responses are then recorded and evaluated using a rubric.

Inspired by the concept of EPSA, Zayed University (ZU) conducted a study in the ABET accredited College of Technological Innovation (CTI) to develop a method for assessing computing programs in the Gulf region in terms of professional skills. (Zayed University is a federal English-medium institution for Emirati Nationals with gender-segregated campuses in the UAE). The ABET key learning outcomes for computing were adopted and the scope of the project included the development of appropriate region-specific scenarios, a rubric named the CPSA and an implementation strategy which utilized blended learning with an LMS and asynchronous online discussion forums as the platform of the performance task. The use of discussion forums in a LMS is a significant enhancement to the method over the earlier EPSA.

We believe that this method can be used effectively in the developing world as it does not require a sophisticated level of technology. Provided there is access to the internet and access to a discussion board, the method may be employed. While we used the Blackboard LMS any system that provides a discussion board may be used. Minimal

bandwidth is required and intermittent dropouts are acceptable as there is no synchronous communication. During the connection to the internet the user just needs to read the posts of others and upload a post, which could be composed offline. As the users of the CPSA will have an IT background not much technical support should be required by the students or instructors.

2 CPSA Method

CPSA was conceived in 2014 for computing related disciplines with the writing of technology related scenarios, development of the CPSA rubric and the use of asynchronous online discussion forums as the delivery strategy and main platform for student interactions and production. The adoption of online discussion technology was due to its strengths as a communication tool and stage for students to utilise the ABET professional skills. Online discussion has become widely integrated in education, and has been shown to allow for discourse in a more reflective way than oral discussion [8]. The skills of working in a team and co-constructing knowledge develop strongly through online discussion, and it's particularly important in a non- native learning environment to allow time for reflective responses [9]. There are three stages to the CPSA; a discipline related scenario, student analysis of the scenario, and a rubric to grade the analysis, which will be explained further.

The scenarios consist of approximately 700 words regarding a current issue in technology and were created by the research team using criteria from EPSA to maintain reliability and validity, and conform to a Level 12 Flesch-Kincaid Readability Scale for students working in a second language. The scenarios include local and global technology related content, the perspectives of various stakeholders, and overriding issues such as security or privacy, and use credible news sources and academic articles. Each scenario has a set of question prompts, which are crafted to guide the students' thinking process in alignment with ABET's professional skills. It's imperative that the scenarios contain sufficient facets and complexity to generate analysis according to these prompts. Examples of successful scenarios which have generated meaningful discussion may be found in a previous paper [10].

As the method and the use of asynchronous online discussion is new to the students, the CPSA process is supported by an in-class presentation and walk-through and then a trial run to familiarize students. During the presentation and walk-through the method is explained and groups of 5–6 students discuss a scenario. This is followed by a 12-day semi-guided online discussion board facilitated by the instructor to ensure participation and on-task responses. Students are given instructions on how to interact within the online discussion, and regular readings and postings are required for task fulfilment. During the trial run the instructor provides guidance in the online discussion, with the aim of facilitating an independent student-led discussion. Students become conversant with the process and the expectations of this performance task. To ensure participation by all students the activity is a mandatory graded course requirement.

Following the trial run a new scenario is presented to students and the method runs over 12 days with the instructor monitoring rather than participating. The forum responses are then evaluated using the CPSA rubric, which has been developed in an iterative process over a two year period, and is now a reliable and valid tool. The first version of the CPSA rubric was developed from the EPSA model as this was proven in terms of validity and reliability. Deployment of the rubric involves a team who work towards calibration through norming sessions, initially with a discussion of the rubric, aiming for levels of consensus between raters of 70% or greater [11]. Raters work towards standardisation of rubric use by analysing student responses and comparing ratings in groups against the criteria, and detailed examples from the discussion text to support ratings. To arrive at the final ratings, scores from individual raters are calculated for the mean, with rounding applied, to generate overall scores. An example of the results from a rating session may be found in a previous paper [12]. The CPSA was run with a number of student groups and the results are given in a previous paper [10]. The results showed that we were able to identify areas of strength and weakness for those student groups in relation to the six ABET outcomes. As the assessment is for program level the data we obtained showed that the areas of problem solving, impact of computing and professional development needed considerable improvement; the areas of teamwork and ethics needed improvement to a lesser degree; and the area of communication was on target.

3 Survey

During the implementation of CPSA, the efficacy of the scenario and online discussion forum as a valuable learning activity emerged. The use of a scaffolded asynchronous online discussion forum as a tool for students to respond to the technology specific scenarios and utilize their 21st century skills was highlighted as a valuable teaching method. Students were afforded the opportunity to participate in group problem solving from mobile devices and various locations, with the benefit of time to create reflective responses. As the research team has decided to trial adapting the method for teaching input was sought from the students on their perceptions of the educational value of this performance task. The particular class of students surveyed consisted of 29 native Arabic-speaking females, in their early 20's, who were studying a 3rd year core course.

Once the online discussion board had closed, students received an anonymous online questionnaire with eight closed-response Likert scale items and three open- ended items. The open-ended questions asked respondents what they liked about the activity, what they didn't like and how it could be improved. The closed-response items were adapted from the Australian Course Experience Questionnaire (CEQ), a survey addressing quality in tertiary education. These CEQ questions align with the ABET professional skills. On a scale of (1) Strongly Disagree to (5) Strongly Agree students evaluated if the activity helped to develop their ABET transferable skills, and responses were ranked from highest to lowest according to the mean shown in Table 1 below.

Table 1. Analysis of survey responses

Question	Mean	SD
The activity helped to develop my ability to analyse problems	4.21	0.68
The activity helped to develop my problem-solving skills	4.11	0.63
The activity helped to improve my skills in written communication	4.03	0.78
The activity helped me to develop my understanding of ethical, legal and social issues	3.97	0.50
The activity helped me to develop the ability to analyse the impact of computing on the world	3.93	0.59
The activity helped me to recognize the limits of my knowledge and the need to continue to learn more	3.79	0.68
As a result of the activity, I feel more confident about tackling unfamiliar problems	3.75	0.75
The activity helped me develop my ability to work as a team member	3.55	1.02

The results clearly indicate that respondents felt the CPSA method offered a valuable opportunity to develop and practice the professional skills. The respondents were particularly positive about the benefit of the method for developing their analytical and problem solving skills, and communication skills. The open-ended items also generated positive responses related to the opportunity to develop skills for team work, and the use of online discussion forums, pointing particularly to the allowance for reflection. The comments included: *it gave us time to think before we talk which resulted in great discussions; it helped us as a team to engage one another and understand different points of view; my group was going deep into problems; I like the whole idea of a discussion board because it gave us time to think before we talk which resulted in great discussions.* (The comments have been edited for grammar and spelling to enhance readability). With a number of comments such as *everything was good and helpful, I liked this activity*, the overall response was confirmatory and pointed to developing the CPSA method as a teaching strategy in addition to assessment.

4 Discussion

Observations of the CPSA method, and positive responses on the survey demonstrated that CPSA offers a rich opportunity for students to practice and improve their use of transferable skills simultaneously. The period of 12 days worked well in allowing students adequate time to collate and share ideas, to conduct further research, to explore the issues presented in the scenario in depth, and to reflect upon and formulate written responses. The strength of the method is in its ability to offer the students a means to utilise and develop all of the six ABET identified professional skills in relation to their discipline.

To address the gap between workplace requirements in the knowledge economy and the transferable skill abilities of graduates, CPSA is suggested an innovative blended delivery performance task for teaching the professional skills at all levels of the curriculum, with the possibility of development for other disciplines. Additional LMS features

allow for the mining of response data which can be used for both accreditation and continuous improvement reporting purposes. The refinement and improvement of the CPSA is an ongoing process and it will be made freely available.

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