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Embedding Online Based Learning Strategies Into the Engineering Technology Curriculum

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Embedding Online Based Learning Strategies into the Engineering Technology Curriculum

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Prior to joining ODU in 2013, Dr. Ayala spent three years as a Postdoctoral Researcher at University of Delaware where he expanded his knowledge on simulation of multiphase flows while acquiring skills in high performance parallel computing and scientific computation. Before that, Dr. Ayala hold a faculty position at Universidad de Oriente at Mechanical Engineering Department where he taught and developed graduate and undergraduate courses for a number of subjects such as Fluid Mechanics, Heat Transfer, Thermodynamics, Multiphase Flows, Fluid Mechanics and Hydraulic Machinery, as well as Mechanical Engineering Laboratory courses.

In addition, Dr. Ayala has had the opportunity to work for a number of engineering consulting companies, which have given him an important perspective and exposure to industry. He has been directly involved in at least 20 different engineering projects related to a wide range of industries from petroleum and natural gas industry to brewing and newspaper industries. Dr. Ayala has provided service to professional organizations such as ASME. Since 2008 he has been a member of the Committee of Spanish Translation of ASME Codes and the ASME Subcommittee on Piping and Pipelines in Spanish. Under both memberships the following Codes have been translated: ASME B31.3, ASME B31.8S, ASME B31Q and ASME BPV Sections I.

While maintaining his industrial work active, his research activities have also been very active; Dr. Ayala has published 90 journal and peer-reviewed conference papers. His work has been presented in several international forums in Austria, USA, Venezuela, Japan, France, Mexico, and Argentina. Dr. Ayala has an average citation per year of all his published work of 29.50.

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Embedding Online Based Learning Strategies into Engineering Technology Curriculum

Abstract

Various blended learning strategies have been implemented at engineering technology programs to facilitate different learning styles and different time constraints given to faculty. Some of these efforts are related to the effective use of online tools such as online course management systems, ePortfolios, narrated presentations, web-based polling systems, tutorials and educational materials posted before the class and asynchronous learning methods. As technology changes, some of the online learning methods are getting more advanced which is enabling more innovative approaches and data compression. Various distance learning programs started with having access to videos of recorded lectures (on VHS tapes, or CDs) and further they went to use of new media which followed the use of online based strategies such as online management systems, use of social media, podcasts, and other means of communication to deliver the instruction. It became easier to share videos to a wider audiences and enable easier access to state of the art in development in new engineering areas. Accessing pre-recorded educational modules is now easier with new wireless gadgets, with widespread networking capabilities on campuses and outside the campus. In this way, students have opportunities to spend more time in interacting with faculty in class, not only in their assigned office hours. These teaching and learning methods are emphasizing a not so new educational principle, the Socratic method. This concept is especially important for universities with diverse student population which include working adult student population, students who are with the military, students who have families and all other which are non-traditional students who do not live on campus. In this paper, embedding online based learning strategies into the classroom efforts in Engineering Technology department at one midsize institution is discussed.

Introduction

A variety of teaching methods which have been designed and implemented in last century are relying on the basic principles of Socratic Method which focused on curriculum directed and teacher directed teaching and learning methodology (Fischer, 2015). Recent development in instruction methods have led to the implementation of slightly different approach which engages the teacher in the conversation with students. One of the main idea of Socratic principles of learning is focusing on systematic questioning method (Overholser, 1993). This method is specifically important for different liberal art fields such as in law (Hawkins-Leon, 1998; Kerr, 1999), psychotherapy (Overholser, 1994) and other fields. Questions as sole method of teaching emphasizes involving students in conversations in which they would discover limits of their knowledge and get inspired to learn more (Paraskevas & Wickens, 2003). Moreover, application of constructivism principles which focuses on arguments, discussions, debates, conflicts and dilemmas, sharing ideas with others, working towards the solution, creating reflections, addressing student needs and connecting what is learned to the real life examples are not always present in courses (Tenenbaum, Naidu, Jegede, & Austin, 2001).

In teacher driven instruction, all decision about what has to be learned about some subject are driven by the instructor, students have rather passive role in the learning process, as the teacher

is there to give them resources and instruction. This is quite different from instruction driven by activities and guided experience. Difference between different learners has also been noted, since they do not perform equally well in these two educational settings considering their age and previous life and professional experiences (Paraskevas & Wickens, 2003). Specialists in the adult education have noted that four instructional places: instructor, learner, context and curriculum have should promote and encourages interaction and discussion (Tessmer & Richey, 1997). Hence, recent educational trends in online learning strategies have moved to more learner centered environments.

Different Online Strategies for Engineering Technology Education

Current trends in education are leading to more online courses as some studies report that even around 32 % of students are enrolled in at least one online class (Angelone, 2014). Trends in distance education are changing instruction from conventional approach which was more focused on constructivist approaches to learning which are relaying on use of interactive communication technologies (Tenenbaum et al., 2001). The main emphasis is on students having more control over their learning experience. Learner centered instruction focuses on higher levels of learning such as problem solving not only testing based on outcomes which rely on short and long term memorization. However, this learning process have to be guided through the instruction which are opposing the argument that people learn best in unguided or minimally guided environment, which is especially important for novice learners and their cognitive architecture (Kirschner, Sweller, & Clark, 2006). Minimally guided approach has been noted as problem based learning (PBL), inquiry learning, experimental learning or constructivist learning (Albanese & Mitchell, 1993; Kirschner et al., 2006; Savery, 2015). One example of such action research (AR) problem solving learning strategy is given in Figure 1 (McKay & Marshall, 2002).

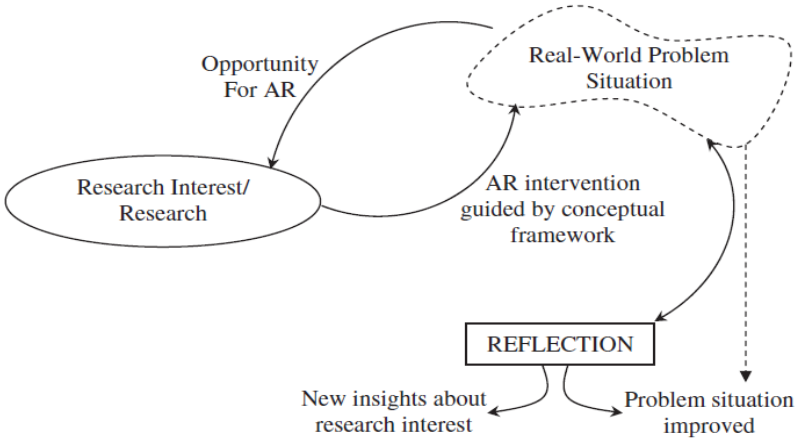

Figure 1: Action research (AR) teaching and learning approach (McKay & Marshall, 2002)

One problem which might happen when novices are engaging in problem based learning activities that they might learn about process of finding a solution, but due to the lack of their content knowledge and previous experience, solutions for authentic problems might not be adequate in the real world situation. Furthermore, focusing only on facts replication might increase performance on known procedures and examples and might leave students without skills needed to produce a solution when needed if it is out of the scope of what was covered in previous

education (Kirschner et al., 2006). These problems are even more important in online learning and teaching since they are related to the technology acceptance constructs: perceived usefulness and perceived ease of use (Al-Azawei & Lundqvist, 2015; Albayrak & Yildirim, 2015). As student engagement in online learning community is essential for student learning since it is not that hard to feel disconnected, researchers have developed Online Student Engagement scale (OSE) with which students can self-report their engagement level and make instructor aware of some underlying problems that might occur (Dixson, 2015). Engagement has various affective and behavioral components as shown in Figure 2.

Item Distribution Across Factors

Skills	Emotion	Participation	Performance
Study regularly	Put forth effort	Have fun in online chats	Do well on tests
Stay up on reading	Find ways to make materials relevant	Participate actively in forums	Get good grades
Look over class notes	Apply to my life	Help fellow students	
Be organized	Find ways to make material interesting	Engage in online conversations	
Listen/read carefully	Really desire to learn	Post regularly in forum	
Take good notes over readings, PPT, video lectures		Get to know other students	

Figure 2: Behavioral and affective components of student engagement (Dixson, 2015)

Online Course Management Systems

One of the negative effects which was detected in online learning environments is that often new generation of learners can behave as "butterflies fluttering across the information on the screen, touching or not touching pieces of information (i.e., hyperlinks), quickly fluttering to a next piece of information, unconscious to its value and without a plan" (Kirschner & van Merriënboer, 2013). Some researchers do not agree that today's learners are digital natives and efficient multitaskers, who learn best if the specific learning styles are catered or they learn as self-educators (Kirschner & van Merriënboer, 2013). Some even suggested introducing courses which would help them learn skills needed to successfully complete online courses (Angelone, 2014) or developing set of adaptable modules which would focus on information literacy for learning management systems (Mune et al., 2015). Students who spend more time using the course management system, students who reported that they used more interactive functions and perceived them useful learning tool did have better grades in online discussion, exams and group projects (Wei, Peng, & Chou, 2015). A similar study concluded that high performers accessed all course materials significantly more often than their lower performing peers and they were more prompt in submitting their work on time (Lawanto, Santoso, Lawanto, & Goodridge, 2014). Regularity or irregularity of log-in intervals is shown as a good predictive of learning performance (Il-Hyun, Dongho, & Meehyun, 2015). Various course management system platforms such as Blackboard and Moodle have embedded communicative and interactive features but they are still not widely used by instructors and students (Albayrak & Yildirim, 2015).

Use of Social Media in Instruction

A variety of social media mediums can be used as platforms of interaction and engagement in online environments as well as a tools to enable social aspect of student involvement and learning (Albayrak & Yildirim, 2015). One of them is Twitter in which students can post 140 character thoughts, ideas or updates, or re-tweet posts made by other students in their class which engages students in critical thinking (L. E. Rohr, Costello, & Hawkins, 2015). Student tweets can be later searched by using appropriate "tag" assigned by the instructor. One of the application of this social media has been reported in large undergraduate courses where social presence is hard to achieve because of the higher teacher per student ratio in health and wellness classes (L. E. Rohr et al., 2015). Grading and activity tracking tools such as Twitter Evaluation application have been developed to reduce administrative overhead which is related to tracking students tweets (L. E. Rohr et al., 2015). However, it has to be carefully tied to learning objectives and success of its use as an engagement tool will depend of previous usage (L. Rohr & Costello, 2015).

Additional commonly used social media among students today is Facebook which can be used as a communication method for discussion and out of class communication among instructors in students (Albayrak & Yildirim, 2015). It has been reported that students are more prone to use Facebook for their online discussions than collaborative tools which are available in regular course management systems (Miller, 2013). Suggested teaching strategies include the instructor starting a discussion during lecture and encouraging students to continue the discussion after class along with emphasizing the importance of giving feedback. A different researcher noted that satisfaction with the use of Facebook as a learning tool might depend of students' learning styles such as Kolb's Learning Style Model (Chen, 2015). Furthermore, the prominent dimension of student knowledge which is promoted in online discussions over Facebook is meta-cognitive which relies on understanding and comprehension and that often conversations are diverging to off topics discussions which are not related to the learning objectives (Lin, Hou, Wang, & Chang, 2013).

Two social media have been used in Computer Integrated class: fotobabble and SoundCloud. Students were asked to post a photo of themselves and record a voice over message reflecting what do expect from the class. Class was thought to on campus students and to off campus students at the same time through Webex (on campus students were sitting in the classroom with the instructors, and off campus students were logged into the Webex at the same time). This assignment has proven to be a useful method for the instructor to make a better connection through the picture and voice with a distance learning students with whom the interaction is usually through the chat window during lectures or by email correspondence. At the same time, other students could see each other which helped form the sense of learning community.

Flipped Classrooms

Flipped classroom, although not a new idea since it has been used even before the internet with the assistance of distributed videos, is an inverted approach which gained attention in recent years to address a need for more problem based learning and class interaction. It can be also used in online learning if students have access to pre-recorded videos with lectures and during the assigned class time they work on problems and instructor is guiding them to the solutions. This learning strategy focuses on learning activities during the class time, with the teacher as mentor and peer to peer engagement (Roehl, Reddy, & Shannon, 2013). One of the descriptions of such

learning methods is that it matches learning preferences of Millennials who are more technology savvy than previous generations since they are growing up in the internet era (Sarkar, Ford, & Manzo, 2015). Pre-recorded videos have shown to be important for classes with extensive calculation and working in groups (Liwen, Tung-Liang, & Nian-Shing, 2015). Flipped classroom technique has been used in freshman digital circuits' course (Yelamarthi & Drake, 2015). There is a wide diversity of video collections available, such as open-access video website (TED-Ed), PBS etc. (Hsin-liang & Summers, 2015). Various academic fields use available video collections for emulation of flipped based approach and even more commonly is the use of videos recorded by instructors. There are currently 51 videos tagged with the word "robotics" related to talks available on TED-Ed.

One implementation of flipped methodology was used in fall 2015 semester at "mid-sized institution" (blind review) course Introduction to Mechatronics. Students were working on labs which included programing Arduino microcontrollers during the assigned class time. They were given homework to review modules in the Blackboard and prepare for the lab which would be focused on hands on experience in the assigned class time. One such module is shown in the Figure 3 - Introduction to Mechatronics. Students were asked to go through assigned reading from the book and to go over resources posted in the Blackboard before coming to classes. Some relevant videos which describe relevant concepts and industry examples were posted at these web pages which were accessible by university username and password.

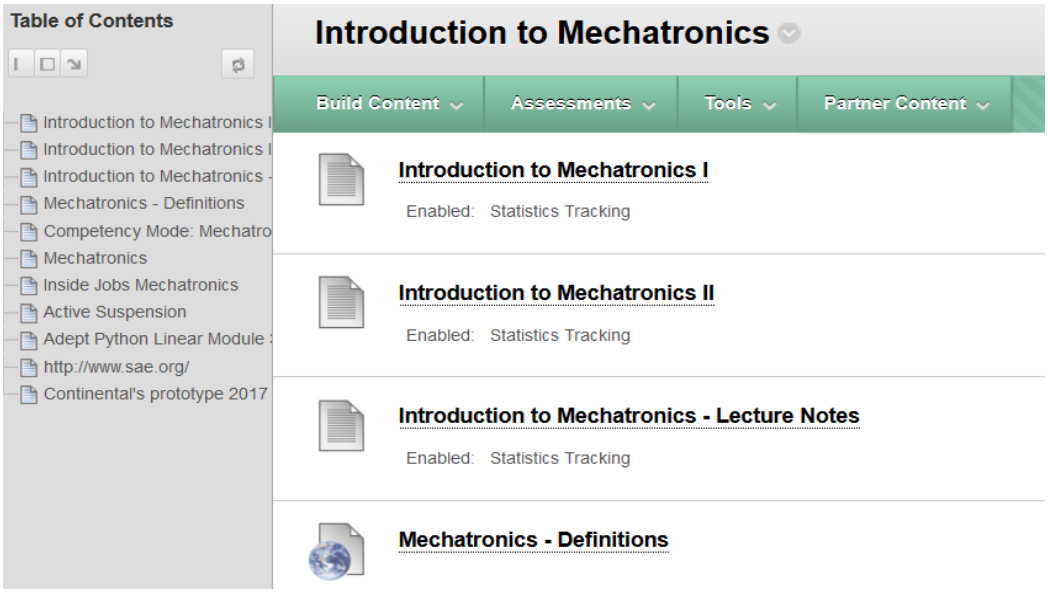

Figure 3: Introduction to Mechatronics module at Blackboard course management system

One lab example is given in Figure 4 - reading of the temperature sensor. Instructions related to how to do the lab and perform the task were given to students using the educational module which came with the mechatronic kit Sparkfun Inventor Kit provided to students along with guidance provided to them by their instructor. This way, students learned about sensors and what they measure during their work on this assigned didactic task. Students were asked to record a video of a working circuit and describe what they have learned while doing it. They were also asked to provide an example from real life where this electronic component can be used.

Circuit 7: Reading a Temperature Sensor

1) Record a video or image of your circuit. Send them to the professor as a responce to this post.

2) Write a reflection about the Circuit, what new have you learned? Provide a image of electrical circuit.

3) For every centigrate degree this temperature sensor reads, what ammount of voltage it outputs?

4) What is the linear temperature sensor?

5) Name one application of push butons in real world application.

Figure 4: Prompts that were given to students in order to capture their learning in one of the labs

Example of one video which is posted on YouTube is shown in Figure 5. Students were asked to embed these videos in their ePortfolios so that they can share what they have learned during this course to their prospective employers.

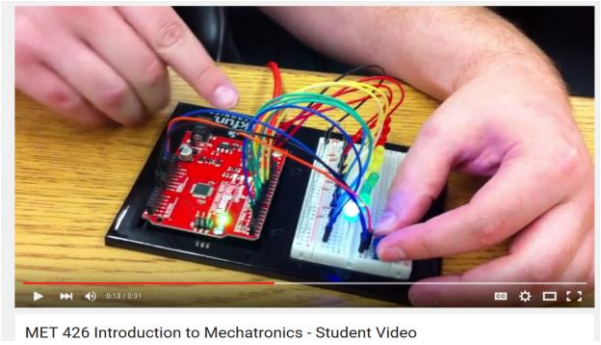

Figure 5: Video created by a student in one MET course

Web-based polling system Polleverywhere

The audience response devices, such as clickers, became lately a very common learning tool in colleges as well as in high schools. A detailed review of the literature related to clickers, their use, practice tips, typical characteristics of questions used and the attitude towards was done by Caldwell (2007). The use of clickers is beneficial in any size class to stimulate students' participation in the class and to get immediate feedback on their understanding of the material. A web-based polling system, such as Polleverywhere, turns out to be even more convenient to use, since it eliminates the need of carrying the clicker devices. Another important benefit is that it can be used not only in traditional face-to face classes but in on line setting as well. Students at any location, in class or accessing the class on line can participate simultaneously to the polling process. The questions are posted on line and the students can either access a website to send their answer or they can use a smartphone to simply text their answer. There is very little training necessary for the use of the software, only an account is needed for the instructor to start creating the question sets, and the students only need directions for the website to access or the code they need to text. The free version of Polleverywhere does not have a way to identify the person that answers, but as long as grading is not intended, this version is sufficient for getting immediate feedback from the students. The questions can be multiple choice or open answer, and to create a question text, equations and pictures can be included.

The use of Polleverywhere stimulates students' engagement through direct answer to the questions posted and more importantly through the discussions generated after the results of the

polling are posted. As students engage in discussions on how they got the correct or wrong answers, misunderstandings or lack of knowledge are identified and this is a valuable learning time, beneficial for all students, even for those that choose not to engage in discussions and only listen to the debate. The distance learning setting always raised the question of breaking the connection between instructor and students, of missing the direct interaction among students and with the instructor, and in this respect Polleverywhere can become a valuable resource by bringing students together for the polling questions and stimulating them to participate in the resulting discussions.

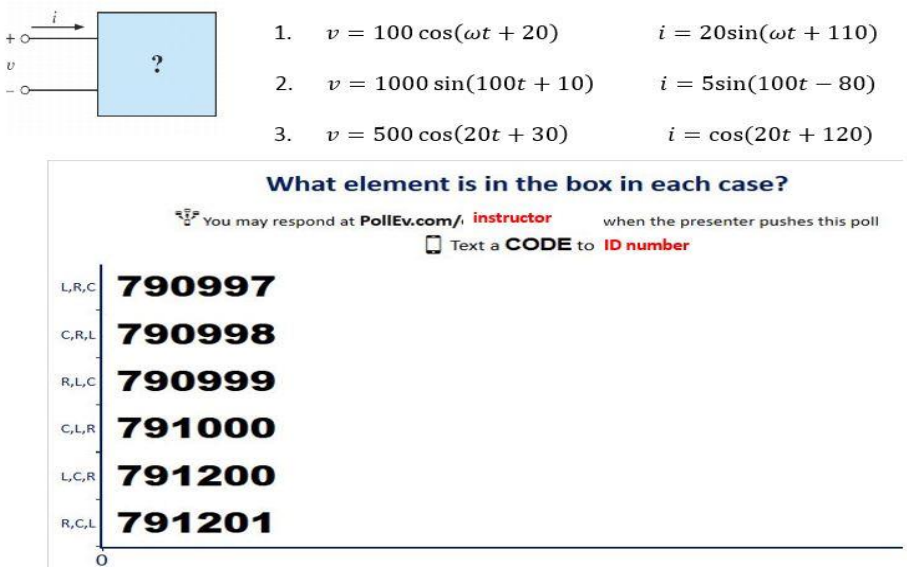

Figure 6: Example of a multiple choice question using Polleverywherein one EET course

Future Trends

Key trends of future challenges, trends, developments and impacts of future technology are shown in Figure 3 (Johnson, Adams-Becker, Estrada, & Freeman, 2015). Some future challenges defined by various researchers were defined as creating more authentic experience and more personalized learning in which teacher role might be more facilitating. These authors argue that in the short-term, more blended learning teaching strategies will be used. Moreover, collaborative learning will be widely used learning methodology. They argue that in the long-term, technology will change how schools work and how a deeper learning can be achieved and complex learning can be achieved. Technology innovations are drivers of more frequent use of technology in various schools such as makerspaces, 3D printing and adaptable learning technologies, and wearable technologies. Different educational online learning tools are shown in this paper. However, there is still a significant numbers of educators who are opposing to such extensive use of technology and they criticize having too much online information available. They suggest that a student can have a “butterfly effect” while only touching some information, without having skills to dig deeper and find out the solution by themselves without extensive step by step instruction.

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