Application Digital Game Based Learning in Industrial Engineering Teaching and Learning in an Online Distance Electronic Learning Institution

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Abstract

Online learning has empowered students at traditional contact universities as well as those in distance education to transform engineering education. The landscape of higher education, the cultural environment and the competitive ecosystem is changing rapidly and disruptively. Recent events at universities have illustrated this fact. Higher education is rapidly changing and technology is the catalyst for the change. In the new paradigm, students expect to be able to work, learn and study whenever and wherever they are. Consequently, the appeal of digital games based learning (DGBL) has become more attractive and commonplace in lecture rooms. The appeal of DGBL is derived from the unique nature of gaming education and its ability to integrate theory and practice. Gaming has the ability to: 1) capture students interest, 2) to motivate students in progressing to higher and more difficult levels of learning, and 3) to learn from and interact with other students. The research methodology adopted is one of a case study approach. The paper presents a comprehensive example that illustrates the application of DGBL in industrial Engineering teaching and learning, in an ODL setting. Results analysis will display how students benefited from game based learning.

Key words: DGBL; Pedagogy; Online; Learning; technology

1. Introduction

There is evidence that blended classroom models can be effective only when the online elements are active rather than passive, according to a 2010 department of education report, undergraduate students in blended classroom settings had better assessment outcomes than purely online or face-to-face classes. The reason being that blended courses in which the students are spending their time online solving problems, moving through the material at their own pace, and spending half of class time in the online component of the class, have more positive learning impacts than both face-to-face only and purely online only (Peters et al. 2014).

Engineering education academics have always explored innovative teaching techniques, few instructional approaches developed entirely in engineering have achieved widespread acceptance. One that has is cooperative education, which was started at the University of Cincinnati in 1906 (Grayson, 1993). Cooperative programs in which students alternate semesters in school and periods of working in industry continue to be a popular option in engineering education. Another innovation that attracted widespread interest was adaptive digital game base learning (DGBL).

The utilization of gaming platforms is not cutting edge in education any longer, but from the perspective of an online distance electronic learning (ODeL) institution such as Unisa, it is still a few years from becoming the main attraction and common practice in the lecture rooms, as postulated by Bawden & Robinson (Bawden & Robinson, 2012). Online and large-scale multiplayer educational games are being used in course work curriculum to leverage the best skills and techniques required from graduates by industry (Arnab et al., 2012). The best game theory in education leverage teamwork, leadership, discovery and tenacity, and these games are social networking games that compels students to create solutions for real-world challenges (Barseghian, 2012).

The strength of the TFC experiment with Unisa student is in affording ODeL engineering student an opportunity to experiment with and experience the real world problem and more so, to realize how their academic training fits into the working world. Student are required to apply knowledge gained from the modules in their curriculum, i.e. Simulation, Operations research, Production/productivity, Strategy, Quality, Logistics, Workstudy and Operations management.

2. Background

The University of South Africa acknowledges the fact that the generation of student enrolled with the university has changed from working adults to young, fresh out of high school students. This new group of students comprise of a large percentage of restless digital natives, who spend a big portion of their time online. In this changing teaching and learning (T&L) paradigm, the university is challenged to figure out how to use traditional engineering
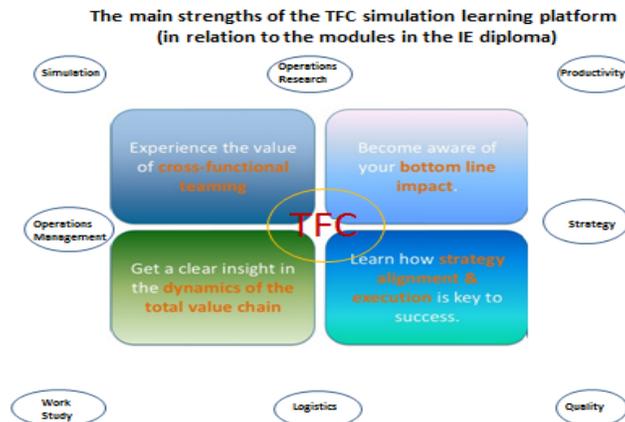
educational content for T&L in a game based setting. This endeavor to apply T&L in a game setting led to the adoption and participation in the TFC.

Educational changes are taking place even more rapidly in engineering technology education.

In an ODeL institution, access is given to all potential students with varying grade 12 scores and therefore different competencies of the basic engineering modules such as mathematics and science. Some student have poor grades, while others have very goods grade, thus in the teaching and learning process, It is not more possible to treat all students in the proliferating range of e-learning users -with very different prior knowledge of the domain, backgrounds, learning styles, interests and preferences - with the "one size fits all" approach. Therefore, adaptation of the learning process and assessment is indispensable.

The TFC is a computer based supply chain simulation competition in which groups of 4 to 5 students participate in a supply chain problem solving online exercise. The exercise provides students with a highly interactive web-based logistics business problem solving simulation that requires students to apply their knowledge of Industrial Engineering theory, in an attempt to optimize a supply chain business.

The University of South Africa provides education online and through distance learning, therefore it provides opportunities for working individuals who are engaged in other things but are keen to acquire a qualification or improve their skills levels through academic interventions. It is therefore, apparent that Unisa is poised to take advantage of the opportunities provided by e-learning. In that an e-learning framework seeks to establish an environment where students start fast with their learning activity by capitalizing on their down time and periods of time which they are not constructively engaged (e.g. riding a bus; waiting in a queue; during lunch and breaks) (Bommarito, 2014) and (Beavis 2015).

The main strengths of the TFC simulation learning platform (in relation to the modules in the IE diploma)

Figure 1: Inter-relationship between TFC and IE curriculum (source: www.slideshare.net/thefreshconnection)

3. Literature review

The dawn of the 21st century came with the realization that we have largely overcome the stigma that games are for playing, which is the opposite of working. Majority of role players in education believe that games are engaging, they can be effective in T&L, and they have earned a place in T&L (Van Eck, 2006). Therefore, it is easily accepted that predictions of university life in the next 10 to 20 years reflect an era of a lot of inter-connected and internet-connected objects packed with information, applied in T&L (Barseghian, 2012).

The new horizon report on higher education predicts that there will be more gesture-based computing and that video games will become for example, how open education resources are disrupting higher education, the proliferation common place in lecture rooms (Barseghian, 2012). The report crystalizes a lot of what is being witnessed in T&L today, of free online courses and the evolution that led to the certification of free online courses (Barseghian, 2012).

Literature survey depicts clearly that ongoing research, for the past two decades has led to the widespread public interest in games as learning tools (Van Eck, 2006) & (Beavis, 2012) and (Beavis,2015). Throughout the decade proponents of DGBL has published essays, articles and books on the power of DGBL (Beavis, 2015), e.g. Beavis (2015): Computer games can get your brain working and Erstad (2013): New literacies and digital epistemologies. Belshaw (2012): Essential elements of digital literacies and Gee: Language and Learning in the digital age.

This body of knowledge resulted in researchers publishing technical and critical work on DGBL, as was postulated by Kuhlthau et al. (2012), about awareness of the knowledge gap for participating in digital games. Routledge (2009) deliberated on digital games being tools designed to transfer knowledge to the player through interaction with the information object and characters or the environment. McLoughlin(2011) postulated that it can be inferred that the use of graphics, movement and sound assist the learner to navigate through the game, therefore enhance the process of learning.

In the same context, Erstad (2013) defined lifelong learning as the ability to continuously reinvent your knowledge and expertise to manage changing problem situations, which is essentially, what a learner does within the context of a game, Prensky (2005). Turkay et al. (2015) closed the argument in support of the use of digital games in T&L, when they put forward that DGBL levels up the information behaviors, just as guided inquiry enhances the development of information behaviors, and consequently learning becomes a learner-centred activity Phillip& Garcia (2013).

It is crucial to recognize that DGBL lecture rooms and paradigms that view digital literacy practices as embedded within DGBL do not recognize the use of digital games as a replacement for the instructor or lecturer. DGBL is aligned with constructivist and socio-constructivist learning theories; the role of a lecturer becomes not one of an expert but of a facilitator and guide (Routledge, 2009). Thus, the facilitator needs to be familiar with the elements and infrastructure of the game, such as rules, goals, levels, and settings, Pivec & Pivec (2011).

4. Conceptual Framework

The research requires a methodology that takes a broader perspective than a single primary research study focused in a particular direction. The goal of the research is to explore and explain with the aid of an example that illustrates comprehensively how the application of DGBL in industrial Engineering teaching and learning (T&L), in an ODL setting, impacts the participating students. Therefore, a qualitative research approach is suitable and appropriate for this research orientation.

5. Research Methodology

Qualitative case study methodology affords researchers opportunities to explore and explain a phenomenon within its context using a variety of data sources (Baxter & Jack (2008). This approach ensures that the phenomenon under study is explored through a variety of lenses which allows an in-depth understanding and allows multi facets of the case under study to be revealed and understood Baxter & Jack (2008).

The case study approach aligns to the goals of this research in that the focus of the study is to explore and explain with the aid of a comprehensive example that illustrates whether and how the application of DGBL in industrial Engineering teaching and learning, in an ODL setting, impacts participating students. This research approach covers the contextual conditions in which the phenomenon under study occurs.

6. Participation in the TFC Game

The TFC engages participants in a simulation that mirrors the real-world situation, it brings to students attention the complexities of challenges experienced in real-world business, such as the challenge of declining profits, demanding customers, stock management and shelf life issues.

In solving these problems student participate in four (4) basic learning themes, these are:

7.1) Supply chain strategy

Fig.2: TFC Strategy (source: www.slideshare.net/thefreshconnection)

This theme enables Unisa to integrate management and industrial leadership modules with SCM and student are able to put theory learned in their IE curriculum modules into practical real-life problem solving situation. The ultimate goal is to teach students the skills required to put strategy into action. That enables student to understand execution revolution.

7.2)   Sales and operations planning

Fig.3: TFC S&OP (source: www.slideshare.net/thefreshconnection)

In the IE curriculum student, engage the theory of logistics management, logistics engineering and production management. This theme enables these students to apply their acquired knowledge to transitioning from S&OP to integrated business planning.

7.3)   Demand Planning and inventory management

Fig.4: TFC Logistics (source: www.slideshare.net/thefreshconnection)

Demand management is learned in logistics and material management modules in the IE curriculum. This theme enables student to apply the theory learned in the modules to transition a real life business from demand planning to demand shaping, in a dynamic context. The skills acquired enable student to appreciate the skills required to manage inventory from fat to fit.

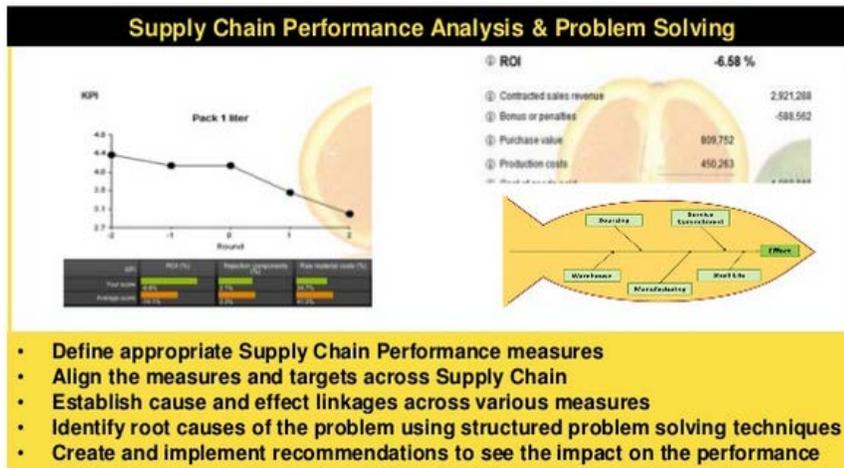7.4)   Supply chain performance analysis and problem solving

Fig.5: TFC SCM (source: www.slideshare.net/thefreshconnection)

In this theme student, apply all their theory learned in the IE curriculum, in that students learn to take a holistic view of the business and clearly identify the in-bound, factory/process and out-bound logistics activities. The goal of this theme is to enable student to acquire skills needed in analyzing supply chain performance and developing required remedies for success.

8.   Results Data Analyses and interpretation

A case study analyses is argumentative by nature, and therefore there is a fair amount of competing hypotheses and evidence that is to be disconfirmed. Once the data collection phase is completed, data analyses commence and various qualitative data analyses and interpretation methods are employed. In this research, the method of data analyses and interpretation employed is replication. Replication is applied as a key analytic method that is used in the analysis of multiple cases. The primary focus of replication is to measure the overall pattern of the results observed and to note the extent to which the observed pattern matches the propositions stipulated in the theoretical framework.

To summarize the data analyses and interpretation, the research follows the theoretical propositions that led to case study, the original objectives, the design of the case, research question and the literature reviews. The research will define and test rival explanations and interpretations.

Research themes for which data is organized and summarized to enable information analyses are as follows:

8.1) Capture student's interest

To measure the amount of time spend on the game, a social media what's-up page was open and all group members were requested to share their time spend on the game (i.e. login and log-out times). All the discussions are held on what's-up, since 80% of participation was done remotely, (i.e. whenever and wherever group members are able to login and participate). In the first round of the competition group members spend, an average of 4hrs each per day, and on the day the first round closed all members logged-in for 6hrs. The amount of time spend on the game, support Turkay et al. (2015), argument that games are engaging and interactive media that promote learning rather than merely a leisure pursuit that happens outside the formal education setting.

8.2) Motivate students in progressing to higher and more difficult levels of learning

The game is played remotely by individual members of a team and their contact for discussion happened on a social media platform (Whats App), therefore student continued participating on the game and in their teams without supervision. Team members were volunteers who never met until the launch of the game, but they handled the game and communication amongst the group members professionally. Sentiments of Kuhlthau et al. (2007), characterize the situation established. Authors indicate that students begin seeking information by immersing themselves with various information sources to gain the learning they need and thereafter decisions have to be made concerning the best information sources available to find solutions and the best information creation tools to communicate learning (Kuhlthau at al., 2012).

8.3) Learn from and interact with other students.

Students are not limited to using DGBL for learning purposes and information seeking endeavors only but through game design experience, they are able to use their digital literacy skills to communicate dynamics of the game to fellow student, therefore constructing and sharing information and knowledge (Walsh, 2010). In this process of sharing Walsh (2010) postulates that, students take the learning that they have made in their own inquiry-learning process and design a game to assist others to learn what they now know about the game (Walsh, 2010). It is quite evident in the interactions of the group that student teams are self -regulating, learning from each other and motivated throughout the DGBL sessions.

9. Findings

The Fresh Connection Business Game - Lived-in experience and Learnings [IE Unisa]

The primary strength of TFC business game experience is a) the value derived when students - Become aware of the impact of cross-functional teams relationships and decisions on the business bottom line. b) students - Learn how develop a strategy and establish a clear insight about alignment and the dynamics of the execution as key to the total value chain success.

Secondary strength of TFC business game is: a) Student realization that they need to agree on an approach for the team. The experience of going through the development of the S&OP. b) as future IE, student learn to appreciate the value of teamwork. Emphasis on cross-functional discussions and value-add and a realization that there is no improvement without cross-functional thinking. Teambuilding exercise, Job rotation of functional teaming, cross-functional discussion, alignment to common KPIs, the importance of collaboration and improved cross-functional working are critical and key success factors.

9.1 The TFC business game is a real life simulation of the dynamics of doing business and therefore can be used to prepare IEs for the demanding world of corporate life, see the insert below in fig.2.
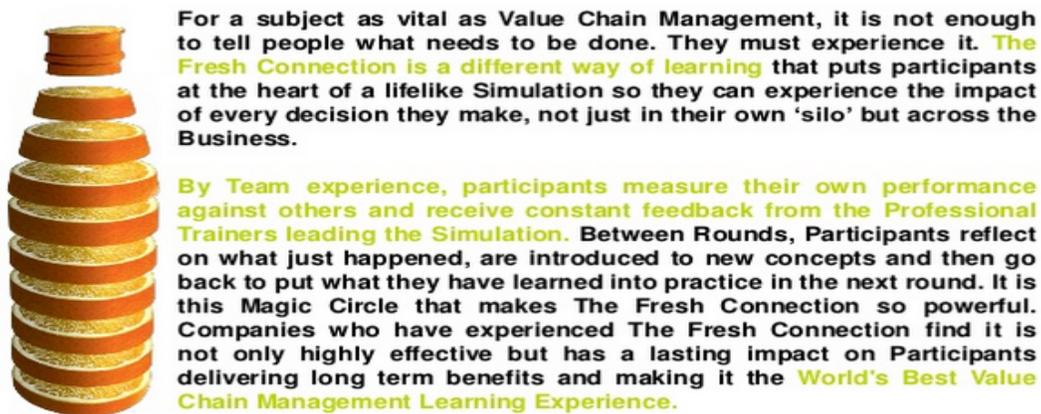

Fig.6: Value-add of TFC (source: www.slideshare.net/thefreshconnection)

10. Recommendations

Unisa being an ODeL institution finds itself in a challenging position in terms of introducing practical and laboratory work into the curriculum. The TFC is a perfect fit in terms of ensuring that students have adequate practical work suitable for training IEs. In an ODeL paradigm, where contact is non-existent, the TFC simulation closes the gap between the instructor and the student and the student and real-life industry situation (Orr & McGuinness, 2014). It is apparent that if Unisa applies the TFC properly and adequately, Unisa IE graduates will have competitive advantage in industry.

11. Conclusion

Result analysis and interpretation clearly highlights the benefits of adopting TFC in T&L, in an ODeL setting. The benefits gained by students participating in the TFC enable the IE department to meet the requirements of industry in terms of the ideal IE graduate envisaged. The benefits of implementing TFC in T&L are as follows: Although there are many reasons for this lag, the primary fault lies with the faculty's inability and unwillingness to

differentiate between the medium and the message, as described by McLuhan (2011), content of the medium is another medium. In an attempt to remedy this dilemma, faculty must comprehend the difference between the use and integration of the TFC into T&L, (De Grove et al. 2012). Using TFC requires only that the media be present during instruction and integrating TFC requires a careful analysis of the SWOT of TFC as well as its alignment to instructional strategies, methods and desired learning outcomes (Jisc, 2014), as stipulated by ECSA.

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Biography

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