

Virtual, Augmented and Mixed Reality Technology Based Simulations in Higher Education – Opportunities for Alternative Assessment Strategies

Matt Glowatz
College of Business
University College Dublin
Belfield, Dublin 4, Ireland
+353 1 7164736
matt.glowatz@ucd.ie

Eleni Mangina
School of Computer Science
University College Dublin
Belfield, Dublin 4, Ireland
+353 1 7162858
eleni.mangina@ucd.ie

Donal Holland
School of Mechanical Engineering
University College Dublin
Belfield, Dublin 4, Ireland
+353 1 7161910
donal.holland@ucd.ie

ABSTRACT

The purpose of this paper is to provide a concise overview of existing virtual, augmented and mixed reality technologies and simulations in the context of higher education. Particularly, the technologies' pedagogical implications and merits for assessment purposes will be investigated aiming to propose a theoretical learning and assessment framework.

CCS CONCEPTS

Applied computing → **Interactive learning environments**

KEYWORDS

Reality Technologies, VR, AR, MR, Gamification and Simulation-based Learning, Assessment Strategies, Higher Education, Student Learning

Permission to make digital or hard copies of all or part of this work for personal or classroom use is granted without fee provided that copies are not made or distributed for profit or commercial advantage and that copies bear this notice and the full citation on the first page. Copyrights for components of this work owned by others than ACM must be honored. Abstracting with credit is permitted. To copy otherwise, or republish, to post on servers or to redistribute to lists, requires prior specific permission and/or a fee. Request permissions from Permissions@acm.org.

SIMUTOOLS '17, September 11–13, 2017, Hong Kong, China ©
2017 Association for Computing Machinery. ACM ISBN 978-1-4503-6388-4/17/09...\$15.00
<https://doi.org/10.1145/3173519.3173529>

1. INTRODUCTION

Debate around emerging technologies, such as virtual reality (VR), augmented reality (AR) and mixed reality (MR) for education has gained pace in recent years [1] [2] [3]. However, much research focusses on implementation opportunities for either the primary or second level education sector or computer science and humanities studies in third level education. In contrast, very little attention has been drawn towards VR, AR and MR in third level business education and the suitability of those technologies to be used as alternative methods to assessing student learning.

This project addresses the existing gap in the literature with focus on investigating suitable assessment strategies for VR, AR and MR driven gamification and simulation applications to stimulate and maximize student learning and engagement in third level business education.

2. LITERATURE REVIEW

2.1 Technologies

Most primary, second level and higher level educational institutions have successfully integrated innovative Information and Communications Technologies (ICT), such as personal computers, tablets, web technologies and virtual learning environments (VLE) into their curriculum design aiming to improve both student engagement and student learning. In doing so, many teachers and academics have been following Koehler & Mishra's technology, pedagogy and content knowledge (TPACK) framework [4] to conceptualize the knowledge base required to teach effectively with technology and applications.

In recent years, the research community has been looking out for new innovative technologies and applications, such as VR, AR or MX to be utilized as part of introducing more effective pedagogical methods in education.

According to the U.K. virtual reality society [5], VR ‘entails presenting our senses with a computer generated virtual environment that we can explore in some fashion’.

AR – on the other hand – ‘is the integration of digital information with the user’s environment in real time. Unlike virtual reality, which creates a totally artificial environment, augmented reality uses the existing environment and overlaps new information on top of it’ [6].

Finally, MR ‘combines the best of both virtual reality and augmented reality. When used to classify the larger scope of reality technologies, it refers to the coverage of all possible variations and compositions of real and virtual’ [7].

Above technologies and associated applications have become very popular among educators providing suitable, effective and efficient pedagogical content delivery opportunities following Kolb’s experiential learning experience theory [8]. Hence, many schools and universities have started implementing VR, AR and MX to improve student engagement and learning [1].

2.2 Gamification and Simulation-based Learning

Debate around gamification in higher education (HR) has gained pace in recent years. Gamification is the concept of applying game mechanics and game design techniques in non-game contexts to achieve higher levels of engagement and to motivate individuals to achieve their set goals [9].

Gamification ‘is about discovering extrinsic and intrinsic motivators that can make learning more engaging’ [10]. Furthermore, it represents a means of recognizing tasks achieved by students and allows for quick feedback to be provided to students on progress made [11].

While Dicheva et al. [10] acknowledge that some research studies have been conducted on the implementation of gamification in an educational setting, such studies are limited and have not yet provided sufficient evidence to support gamification in this context.

Furthermore, simulation-based applications for learning which are primarily based on gamification principles, engage students in an active learning experience providing the learner with an invaluable hands-on opportunity to investigate and explore different business scenarios. While completing simulations, students are encouraged to test the usefulness of theoretical knowledge and reading materials covered during face-to-face classroom sessions. Online simulations utilizing the internet infrastructure help the learner to apply theoretical knowledge in a low risk and affordable environment.

Up to date, much research investigating the usefulness of gamification and simulation-based learning in higher education

has been concentrating on medical and science based subject areas overlooking business studies.

In the past, business simulations have predominantly focused on entertainment rather than learning which can be assessed. Therefore, the author focusses on the business subject area in higher education with an emphasis on assessment strategies for online simulation based learning utilizing augmented reality.

Permission to make digital or hard copies of part or all of this work for personal or classroom use is granted without fee provided that copies are not made or distributed for profit or commercial advantage and that copies bear this notice and the full citation on the first page. To copy otherwise, or republish, to post on servers or to redistribute to lists, required prior specific permission and/or a fee.
Conference’10, Month 1-2, 2010, City, State, Country.

Copyright 2010 ACM 1-58113-000-0/00/0010. . . \$15.00

2.3 Assessment

Much of research to date [1] [3] discusses and insinuates suitable teaching strategies and pedagogical approaches incorporating VR, AR and MR. Instead of focusing on teaching strategies, this research project, however, examines suitable approaches of assessing student learning using VR, AR and MR.

Other teaching and learning narrated research [12] [13] propose suitable assessment strategies to maximize student learning. Strategies incorporate formative (assessment for learning) and summative (assessment of learning) approaches working towards authentic assessment through the creation of realistic learning experiences.

Assessment provides valuable feedback to both educator and learner, however, Abbott argues that – unfortunately – it is also seen an evil associated with judgment and grades rather than an opportunity to improve learning [13].

Furthermore, Evans proposes an innovate assessment tool (EAT) allowing students to become more self-regulatory in managing their own learning [14]. The EAT methodology focusses on assessment literacy, facilitating improvements in learning and holistic assessment design approaches. It considers both the academic’s perspectives on assessment, such as asking “what constitutes good assessment?”, “how to provide meaningful and focused assessment?”, “how to provide accessible feedback to the learner?” as well as the learner’s views and concerns, such as “how can I learn and improve my learning based on formative and / or summative feedback?”, “what is meaningful dialogue?”, or “how can I get involved in the assessment process?” just to name a few [14]. In addition, EAT proposes an inclusive design process demanding academics to constantly explore whether any learner is excluded from assessment demands a universal design perspective to be implemented).

3. REFLECTION AND DISCUSSION

Many of today's student cohort entering HE have never known life without the Internet. Furthermore, students utilize mobile technologies, such as smartphones and tablets, primarily for entertainment purposes neglecting the educational value of those devices. Though, many institutions competing in the HE sector are not well equipped to meet today's and tomorrow's tech-savvy student's expectations resulting in many challenges to be addressed in this research project. For instance, one challenge to be dealt with is the so called "digital divide" existing between today's student and academic. Students envisage pedagogical approaches incorporating innovative technologies, such as online simulations, for better learning in HE. However, academics may not have the necessary knowledge base meeting those expectations inhibiting opportunities for teaching and assessing students innovatively. Moreover, Glowatz and O'Brien [15] suggest limited interest among many academics to integrate emerging technologies, such as educational technologies (EdTech) or mobile applications, into their teaching due to time pressure, lack of essential technology knowledge or inadequate technological and human resources-related support infrastructures.

First and foremost, it is a prerequisite for academics to appreciate the value of gamification-based simulations for teaching and learning. It is the author's opinion that adequate technology/application-related awareness initiatives and training for academics play a fundamental part in the process of creating a suitable environment allowing all stakeholders to collaborate in creating, implementing and administering an effective and efficient learning environment successfully. Next steps should only be taken if all stakeholders appreciate "technology for learning" equally.

The second challenge to be addressed explores student assessment and associated feedback. In the past, student learning was primarily measured as part of sitting an end-of-module / end-of-semester written examination carrying most a module's assessment weight (in many cases up to 80%). Not only, written examinations predominantly require students to engage in rote learning rather than critical thinking, exam grades also provide very little feedback leaving students in the dark in terms of their knowledge base and how they could improve their learning for future modules.

Consider the following: What happens when academics assign assessable readings or other activities to their student cohort? In many cases, students triage to let certain assessment components die to save others. Students think strategically rather than focusing on learning aiming to pass modules with minimum efforts resulting in no or very little engagement. Rather than being pro-active, many students don't prepare outside class, instead wait and hope to get the answers in class, find a fellow student to get the answer from or use other online applications, such as email or forums, to find the solution to an assessment

component. Certainly, this approach does not foster student learning.

It is the academic's challenge to encourage students engaging students with module content and assessments without investing substantial time. Moreover, many of the traditional assessment components require students to complete them independently, which again doesn't foster student learning. In other words, preparing assessments independently is a solitary experience, however, human kind values and appreciates collective experience.

How can technology help overcoming above challenge? How can VR, AR, and MR in form of interactive online simulations transform the student's assessment experience from being solitary to become collective helping students to become better learners. Above, how can above technologies and applications be implemented to streamline the overall assessment process (design – implementation – grading – feedback)?

The author argues that there is an opportunity for academics to utilize VR, AR, MR and online simulations not only for better student engagement and learning, however, also to automate assessment advice providing instant, meaningful and actionable feedback to reflect on student's work.

However, in order to proposing a best practice "VR, AR and MR simulation" based assessment implementation framework, the following key issues still need to be addressed:

- What are the shared understandings of what constitutes "good or bad" in the context of assessment feedback?
- How can we build a meaningful assessment and feedback practice with shared ownership?
- How can we empower the learning, aka students to become part of the assessment and feedback process? After all, feedback is not the sole responsibility of the academic; the student should become an active part in the overall feedback process.
- How can EdTech-based resources, such as VR, AR and MR be incorporated to implement and – more importantly – assess students to provide appropriate feedback on meaningful, deep learning.
- How can we move away from over assessing students by means of VR, AR and MR?

Considering above questions, a module's assessment design should, therefore, be aimed at supporting students to self-monitor/self-regulate their own learning.

Assessment should also be fit for purpose; with the purposes of assessment that is clear to all stakeholders and promoted through an active on-going dialogue as part of curriculum design and development. Access to suitable resources, and supporting students in developing their assessment literacy skills are fundamental elements of effective assessment feedback provision within higher education [14].

In terms of designing relevant and meaningful assessment strategies for the 21st century, Evans' EAT [14] must be regarded as a suitable approach in identifying meaningful learning and how it can be accessed to improve student learning. Thus, it has been identified as one of the key theoretical frameworks – from a module assessment point of view – for this research.

Particularly, the usage of VR, AR and MR and associated assessment strategies in business education need to be investigated in more detail due to the lack of research covering this particular subject area in the past.

The author insinuates that many of the above challenges open opportunities for the HE sector to maximize student learning. One prospect is the creation of a digital decision making process merging the module's assessment strategy with suitable technology-based applications. The digital decision making method combines the following implementation stages:

- What are the module's learning outcomes?
- What are the academic's and student's expectations?
- What are the module key content junks?
- What is the pedagogical approach?
- What are the academic's technological competences?
- What are the student's technological skills?
- Digital availability? Suitable tools, applications, technologies offering endless possibilities for alternative assessment and learning strategies.

4. CONCLUSION AND FURTHER RESEARCH

Utilizing innovative technologies and applications, such as VR, AR, and MR based simulations in HE linked with meaningful assessment and feedback strategies can be identified as a valuable method to further engage students and to attain an enriched learning experience. Creating a meaningful, relevant assessment structure will also enable students to reflect on actionable feedback they can relate to.

To conclude, creating an interactive online mobile-based learning environment students feel comfortable with will improve engagement and learning. For the academic, those applications will offer the opportunity to design and implement

assessment strategies which – without AR, VR, MR – would not have been possible.

Overcoming limitations in literature and for this research project, the author proposes to investigate the following in the context of business education:

- What are best practice assessment strategies for simulation based learning?
- How can VR, AR, and MR-based simulations in education help providing meaningful assessment feedback?
- Can simulation-based applications utilizing MR technologies be incorporated into a module's content and assessment strategy to both stimulate and maximize student learning and engagement?
- Do MR based simulations lead to increased student satisfaction and increased student performance, especially if assessment is context-related, immediate, and the users are provided with instant feedback?
- How can MR based simulations be implemented in modern business education?
- What are the factors motivating students for better learning?
- How can we use simulation based learning to move away from rote learning and assessment being a monologue towards becoming a dialogue between academics and students?

5. REFERENCES

- [1] Norlund, A.; Cucio, I.D.D. and Dipace, A., (2016). Virtual realities and education, REM - Research on Education and Media, Volume 8.
- [2] Wichrowski, M., (2013). Teaching Augmented Reality In Practice: Tools, Workshops and Students' Projects, In Proceedings of the International Conference on Multimedia, Interaction, Design and Innovation. (p.19), ACM.
- [3] Mateu, J.; Lasala, M. and Alamán, X. (2015). Developing Mixed Reality Educational Applications: The Virtual Touch Toolkit, *Sensors*, Vol 15, pp 21760 – 21784.
- [4] Koehler, M. J. and Mishra, P. (2009). What is technological pedagogical content knowledge?, *Contemporary Issues in Technology and Teacher Education*, 9(1), 60-70.
- [5] Virtual Reality Society (2017). *Virtual Reality*,

<https://www.vrs.org.uk/virtual-reality/what-is-virtual-reality.html>

- [6] WhatIs.com (2017). Augmented Reality (AR), <http://whatis.techtarget.com/definition/augmented-reality-AR>
- [7] Reality Technologies (2017). The Ultimate Guide to Mixed Reality Technology, <http://www.realitytechnologies.com>
- [8] Kolb, D. (2015). *Experiential Learning: Experience as the Source of Learning and Development*, Pearson Education.
- [9] Gartner (2011). Gartner Says by 2015, More Than 50 Percent of Organizations That Manage Innovation Processes Will Gamify Those Processes, <http://www.gartner.com/it/page.jsp?id=1629214>
- [10] Dicheva, D.; Irwin, K.; Dichev, C. and Talasila, S. (2014). A course gamification platform supporting student motivation and engagement., In *Web and Open Access to Learning (ICWOAL 2014)*, 1-4.
- [11] Kapp, K.M. (2012). *The gamification of learning and instruction: game-based methods and strategies for training and education*, John Wiley & Sons, San Francisco.
- [12] O'Neill, G. (2011). A practitioner's guide to choice of assessment methods within a module, UCD Teaching and Learning. <http://www.teachingandlearning.ie>
- [13] Abbott, L. (2012). Tired of Teaching to the Test? Alternative Approaches to Assessing Student Learning, *Rangelands*, 34(3), 34-38.
- [14] Evans, C. (2016). Enhancing assessment feedback practice in higher education: The EAT framework, <http://www.port.ac.uk/media/Media,194787,en.pdf>
- [15] Glowatz, M. and O'Brien, O. (2017). Academic Engagement and Technology: Revisiting the Technological, Pedagogical and Content Knowledge Framework (TPACK) in Higher Education (HE) – The Academics' Perspectives, *International Academic Forum (IAFOR) Journal of Education*, Special Issue on "Technology in the Classroom".