Investigating how educational technologies can enhance learning experiences by assisting different learning activities

A thesis submitted to Middlesex University in partial fulfilment of the requirements for the degree of Master of Computing (by Research)

Cristiano Cardoso Maia
M00322036
c.cardosomaia@mdx.ac.uk

Middlesex University
School of Science and Technology
The Burroughs, Hendon, NW4 4BT
London, United Kingdom

June 2020

Abstract

Current educational technology implementations are done independently and not necessarily linked, neither with key elements of the pedagogic model, nor accommodating different learning styles. This work focuses on developing a framework that would standardise the use of assistive technologies in education. In particular, the focus of this work is on how social media, computer-assisted assessment, augmented and mixed reality can be used to improve the learning experience in certain educational contexts.

This research study is based on a combination of grounded theory that included a literature review on the following relevant areas, covering key topics that correspond to the dimensions of the proposed framework: i) communication in education; ii) assessment; iii) and feedback. This stage provided a review of the learning activity spectrum that can be affected by educational technologies. The deliverable of this stage was a detailed literature review with distinct links to the action research in the form of specific pilot studies. The following stage provides a discussion on the impact of educational technologies on learning activities. The main deliverable is a review of current technologies with emphasis on how they affect specific learning activities

The research also included an element of action research in the form of six pilot studies: i) Google Glass: Student Experience; ii) Google Glass: Presentation Feedback; iii) Google Glass: Feedback on Feedback; iv) Google Glass: Voting System; v) Social Media: Facebook/Twitter/LinkedIn; vi) Student Observable Behaviour. The pilots were conducted and analysed in order to provide sufficient evidence supporting the proposed framework guidelines.

The framework proposed consists of four dimensions: i) content; ii) communication; iii) assessment; iv) feedback. This framework is a framework of good practice. It can be used to support academics who wishes to deploy educational technologies in support of a range of learning activities. Furthermore, the framework has the flexibility of applying different educational technologies for different scenarios without missing a standardised evaluation criteria.

Table of Contents

Table of Figures

Table of Tables

1. Introduction

This work focuses on developing a framework that would standardise the use of assistive technologies in education. In particular, the focus of this work is on how social media, computer-assisted assessment, augmented and mixed reality can be used to improve the learning experience in certain educational contexts. The proposed solution enables the selective use of key pedagogic technologies in assisting learning pedagogies that are aligned to the specific requirements of certain learning scenarios. The learning needs are based on the identification of learners' requirements, the available infrastructure, the delivery approach and the discipline of the subject matter.

The problem is that current educational technology implementations are done independently and not necessarily linked to key elements of the pedagogic model. This means that training structure and expertise can be based on a single model and therefore, different learning styles and training needs cannot be accommodated. This is usually addressed by expanding/extending one technology implementation to cover various elements that correspond to various learning needs. What is lacking is the ability to provide a framework that will help in assisting different learning activities.

The more educational technology becomes advanced and ubiquitous, the more it is being implemented in learning scenarios. Unfortunately, it has mostly been done not in an organised manner but rather on individual implementations depending on their unique needs. Consequently, the criteria to measure its success are usually very different making it hard to analyse its real benefits. An ideal solution is to implement a framework in which would keep the flexibility of applying different educational technologies for different scenarios but having standardised evaluation criteria. The technical challenge is to provide effective ways of selecting technology elements to be used for each pedagogic model and offering sufficient evaluation criteria variations.

1.1 Aims

The aim of this research study is to develop a framework that would standardise the use of educational technologies in certain educational contexts. The objectives of the study include:

- Identifying suitable learning activities to be supported by the framework – this aspect of the work focuses on determining those activities that can benefit from the use of certain educational technologies such as the use of performance visualisation in the delivery of formative feedback.
- Providing suitable measuring mechanisms to ensure the impact of educational technology can be evaluated – this part of the research investigates the use of different measurable criteria for assessing the success of educational technology in enhancing student learning.

- Providing framework guidelines on how to adopt or adapt the use of technology – this aspect of the work is concerned with providing guidelines that can be used in academia for transforming learning activities, towards enhanced learning experiences.

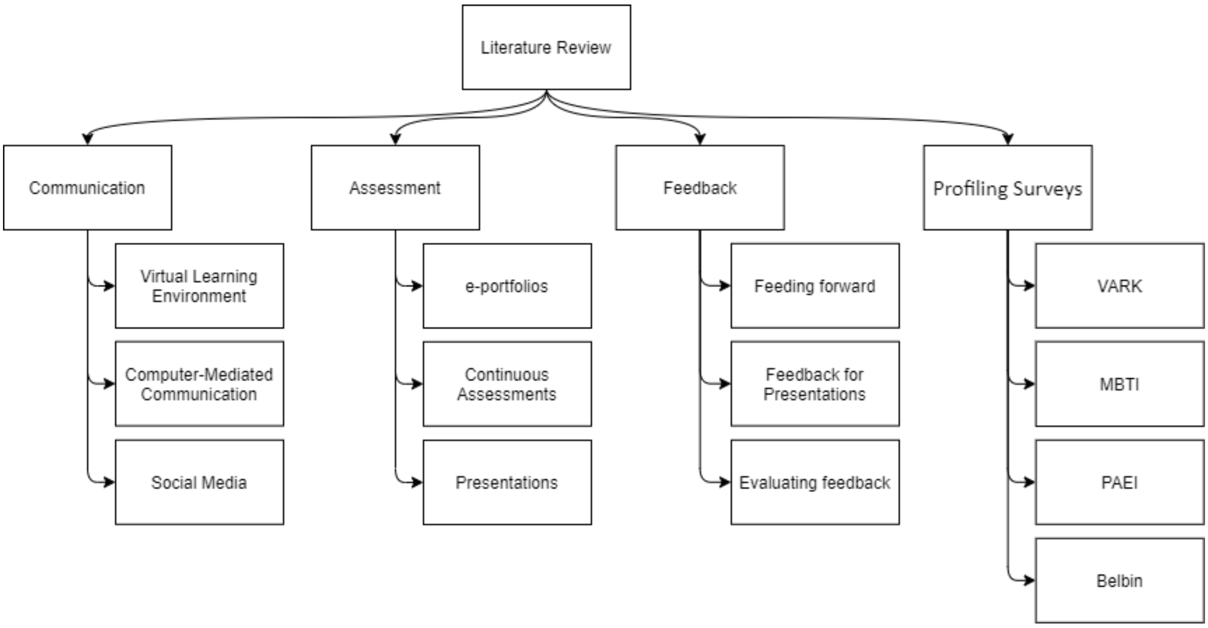
1.2 Method

This research study is based on a combination of grounded theory that included a literature review on the relevant areas, covering a number of key topics that correspond to the dimensions of the proposed framework. The research also included an element of action research in the form of a number of pilot studies that were conducted in order to provide sufficient evidence supporting the proposed framework guidelines.

The research process followed involved the following stages:

- Literature review – this stage provided a review of the learning activity spectrum that can be affected by educational technologies. The deliverable of this stage was a detailed literature review with distinct links to the action research in the form of specific pilot studies.
- State of the art review – this stage provided a discussion on the impact of educational technologies on learning activities. The main deliverable is a review of current technologies with emphasis on how they affect specific learning activities.
- Action research – this stage involved a number of pilot studies that were designed to examine the main dimensions of the proposed framework. The main deliverable is a set of guidelines on how to set up similar pilot studies and deploy educational technologies in learning scenarios.
- Reflection – this stage involved a detailed discussion that provided a summary of the findings from the work carried out to examine whether the proposed framework can be implemented in real learning scenarios. The deliverable of this stage was a detailed set of guidelines supported by the measurements carried out in the different pilot cases.

2. Literature Review



Considering the overall aim and the specific objectives of this research study, the first important step is to define those learning activities that will be supported by the deliverables of the study. This section not only provides the definition, but also in-depth literature review on the main four pillars of education: content, communication, assessment, and feedback.

Section *2.1 Communication* covers the different ways to communicate the knowledge to the student, and vice-versa. The first subsection (*2.1.1 Virtual Learning Environment*) considers the established implementation of Virtual Learning Environment to store the actual materials. Section *2.1.2 Computer-Mediated Communication* focuses on the advantages and disadvantages of synchronous and asynchronous and the best ways to use each one. Lastly, the benefits of using Social Media (*2.1.3 Social Media*) along with a goal-theory method is discussed, focusing mostly on how user/learner-generated content can be beneficial.

It is also important to be able to measure by using different assessment tools (2.2 Assessment). User/learner-generated content in the form of a portfolio is considered on the section *2.2.1 The Role of E-portfolios as Assessment Tools*. *Section 2.2.2* is responsible for providing contrasting and comparing continuous assessment, test, and quizzes. Finally, a discussion on best practices on how to assess a presentation is provided in section *2.2.3 Assessing presentations*.

After understanding the best approach when preparing the content based on the theory and the learner, section *2.3 Feedback* covers the different ways of providing feedback and its importance for the student learning process (*2.3.1 The Role of Feedback*). Chapter 2.3.2 Approaches for Feeding Forward discuss the best way to chapter focuses on how to encourage further learning and help students identify gaps between their actual and desired performance. Followed by well-researched feedback mechanisms for presentation (*2.3.3*

Feedback Mechanisms for Presentation), and lastly, how to measure if the feedback provided has been beneficial for the students (*2.3.4 Evaluating Feedback*).

To conclude the Learning Activities chapter, a very in-depth analysis on the different ways to analyse learner's preference for learning by making using different tools and methods is covered on the last section (*2.4 Understanding Learning Styles*). It covers the most popular and well researched profiling surveys: i) Visual, Auditory, Read/write, and Kinaesthetic (VARK); ii) Myers-Briggs Type Indicator (MBTI); Adizes Management Styles Indicator (PAEI); Belbin team role theory.

2.1 Communication

This section covers the most suitable platform to host learning content, provide suggestions on how to facilitate the communication between students and staff, and finally, discuss the use of social media in education. This section attempts to suggest the fundamental elements required for supporting communication that takes place as part of a learning process.

2.1.1 Virtual Learning Environment

The proliferation of Virtual Learning Environments (VLE) transformed the way education was delivered. The exploitation of Information and Communication Technologies (ICT) combined with the evolution of the World Wide Web (WWW) and the Internet boom of the 1990s, made it possible to provide an integrated learning experience through VLE functions. VLEs were originally introduced as a revolutionary way to support learning, before transforming into e-learning and at times blended learning solutions allowing individuals to learn remotely, at different paces and through flexible patterns of covering the curriculum. These days VLEs are regarded as the minimum requirement for an online supportive learning environment. VLE implementation in the education sector continues to grow. One of the benefits of such technology is to support online cross-cultural working and learning between students and educators (Jung-Ivannikova, 2016). White and colleagues (2010) have reported that, up to 2010, over 2600 higher education courses offered by, or on behalf of, UK HE and FE institutions were online and distance learning.

Since 2000, various academics (Dunn, et al., 2011) (Palloff & Pratt, 2005) (Salmon, 2000) (Salmon, 2011) have claimed that "the learner-centred constructivist foundation of VLEs entrusts online educators with responsibilities to facilitate and foster students' collaboration, cognitive presence and interaction".

More recent VLE developments have improved the interfaces and navigation for desktop and mobile devices. Furthermore, it also enables users to upload/download material in different formats such as documents, audio, and videos. Probably, the most important functionality, is being able to use synchronous (real-time) and asynchronous (time-delayed) computer-mediated communication (CMC). This research study assumes the presence of VLEs as a supporting mechanism for the learning process. Several of the study's suggestions are in the form of functionalities enhancing VLE use or approaches in using VLE features.

2.1.2 Computer-Mediated Communication

VLEs typically include functions that support communication between learners and their instructors, as well as exchanges between learners. Computer-Mediated Communication (CMC) is “communication that takes place between human beings via the instrumentality of computers” (Herring, 1996). In the 80s, CMC was being defined as a new type of communication genre that combines features of spoken and written modes (Jung-Ivannikova, 2016). The written communication in Virtual Learning Environments (VLEs) was implemented in two ways: synchronous and asynchronous. Synchronous communication is mostly applied using a VLE built-in chat tool or external software (such as Social Media or Second Life), consequently, is more closely associated with speech. Such a method requires students to convey thoughts and produce meaningful reactions faster. On the other hand, Asynchronous written communication is closer to conventional writing. It is static and can be produced and consumed at a self-determined speed and time. The VLEs tool generally used for Asynchronous is discussion board and private chat (Jung-Ivannikova, 2016).

In the 90s, it was mostly known for being a democratic media, where everyone was able to participate more easily regardless of social class, cultural background, gender, or physical appearance (McConnell, 1994). However, at the end of the same decade, some system’s weaknesses were identified. From a teacher point of view, evaluating the student in such an environment was only a partial solution. All the findings were based on online posts and questionnaires, without having a full understanding of the student perception for such activity or their learning preferences. Nevertheless, Taylor (2002) have used this information to divide the students into three categories: i) workers; ii) shirkers; and iii) lurkers. From a student point of view, the lack of non-verbal cues and face to face intimacy, made the use of CMC challenging and affected students’ participation and learning performance (Picciano, 2002) (Tu & McIssac, 2002).

Researches published before 1999 was commonly mentioning the lack of student confidence when using the newly developed technology as another major downside (Brosnan, 1998) (Hakkinen, 1994). As expected, the next generation, born in the earlier 2000s, did not experience such a problem. They were associated with terms such as “net generation” (Tapscott, 1998) or “digital natives” (Prensky, 2001) due to its early exposure to communication technology. Studies completed in 1986 (Horwitz, et al.) widely discussed language anxiety and second language communication issues. By using written computer-mediated communication (CMC) to integrate students across the world the issue has been aggravated (Horwitz, 2010).

Considering the positive and negative aspects of the CMC in a VLE, a diversity of tactics and strategies have been created to encourage and foster student communication in a Virtual Learning Environment (VLE) (Dunn, et al., 2011) (Salmon, 2000) (Salmon, 2011): i) Communication with a small presence of the tutor is directly correlated to an increase of student discussions, higher social presence, and reduced formality level; ii) Regardless of their age and experience, the students do not experience difficulties using CMC but do experience difficulties expressing themselves through written communication, therefore is important to provide guidelines and examples on the expected quality of the written work, rather than instructions on how to use the tool; iii) Miscommunication arises more commonly from participants' attitudes, educational background and professional culture rather than their national background or English language proficiency; iv) While existing frameworks can support the development of online communication and collaboration between students, they do not address intercultural issues adequately.

This research study is based on the presumption that learning, to some extent, is associated with information exchanges that can be in the form of instructor-learner or learner-learner communication. Therefore, the study focuses on providing guidelines on how to enhance and support CMC with the use of technology.

2.1.3 Social Media

The proliferation of social networks and associated social media changed the way individuals use the Internet, and to some extent, it has changed the way we socialise. Subsequently, these developments affected the education sector as over the years Social Learning Networks (SLNs) were used in experimenting how social environments can enhance the way people learn as part of a commune. As discussed in the previous section, Virtual Learning Environment (VLE) with Computer-Mediated Communication (CMC) plays an important part in the online communication between students themselves and students with educators. Another important piece of technology in this area is Social Media.

Around the year 2000, the Web 2.0 phenomenon started to emerge. This era is known for the advance in social effects rather than by technical innovation (O'Reilly, 2005) (Sester, et al., 2006) (McAfee, 2005). Its applications are based on different services, used for establishing networks and supporting the distribution of information within the network (e.g., e-mail, instant messaging, SMS, or blogs) (Allen, 2004) (Boyd, 2006).

Hippner & Wilde (2005) define five characteristics of social software: i) the focus of social software lies on individuals or groups; ii) social software relies on self-organization of the participants; iii) Each individual contributes voluntarily; iv) the role of actors changes from an information consumer to an information provider; v) it is the linkage of information that is of crucial importance, rather than the information of individuals. Internet forums, wikis, weblogs, instant messaging, RSS, podcasts, and social bookmarking are tools of social software.

By the end of 2009, there was no doubt that Web 2.0 technology could offer great potential for the design of innovative learning and teaching scenarios. In higher education, this trend could foster learning results as the active involvement of students helps facilitate a constructivist learning environment (vom Brocke, et al., 2009). Having emphasized the benefits of the technology, it is important to consider the human side of it as well.

Prominent examples such as Wikipedia and Facebook have inspired interest in the User-Generated Content (UGC) phenomenon not only in business, but also in higher education. While business objective is context-specific, the pedagogical side focus on achieving specific learning outcomes. One of the most striking of these differences relates to incentive setting: How to motivate students to share knowledge with others and spend time on doing so? In other words, the question is how to align pedagogical and individual interests (vom Brocke, et al., 2009).

Regardless of where the virtual community is being implemented, researches has shown that the user contribution is always driven by a complex portfolio of altruistic, intrinsic and extrinsic motivations. This includes motives such as the joy of creating content or following specific values (Shah, 2004), or extrinsic aspects such as gaining reputation in the community or signalling knowledge to companies to increase career chances (Lerner & Tirole, 2002).

Organizational psychology studies on incentive systems focus on either behaviouristic motivation theories (Weinert, 1998) (von Rosenstiel, 2003) or the equity theory by Adams (1963). LOCKE's theory analyses what influence goals has on individual's motivation. The core of theory affirms that clearly formulated and challenging objective targets have a stronger effect on motivation than vaguely formulated and easily reached one. Furthermore, a successfully reached goal might also cause objective, transparent, and quick feedback about the level of the goal reached (Locke, et al., 1981).

Vroom (1964) has also created a goal-based theory, called VIE. An important extension to such theory is the distinction between organizational goals and individual needs. Transferred to the field of higher education, this approach might help to study the relation between matching to the pedagogical learning outcomes and individual needs of the students driving their commitment to contribute. Vom Brocke and colleagues (2009) have adjusted VIE acronym definition to higher education as following:

- ***V**alence*: originally corresponds to the anticipated value of a result achieved by the individual's action. In terms of UGC Community this means: the higher the perceived value of being involved in the Community, the stronger is the incentive for students to contribute to it.
- ***I**nstrumentality*: originally specifies the relation between organizational and individual target objectives which can either be conflicting or identical. Hence, the challenge is to align individual needs of the students in a way they match the pedagogical objectives of the UGC. That is, the more the pedagogical objectives are aligned with the individual ones, the stronger is the incentive of students to contribute to the UGC.
- ***E**xpectation*: whereas the valence focuses on the potential value to be gained by an action, the expectation draws on the attainability of this potential as perceived by the individual through his or her own action. Hence, the stronger the belief in reaching the desired result, the stronger is the incentive of students to contribute to the UGC.

Four years after Vroom's VIE theory, Porter and Lawler (1968) has improved the original layout by adding further constructs and feed-back loops in their analysis. In Figure 1, both, valence (1) and expectation (2) correspond to the constructs depicted in the VIE-theory. There are several other relevant aspects which could be added with a view to extending the theory; these include: dedication (3), individual capacity (4), role perception (5), result of the goal realized (6), degree of justice (7), award (8), and satisfaction (9) of the agent.

Dedication corresponds to the energy an individual invests. This aspect is at the core of the approach, its effectiveness being relative to individual capacity and the role perception in the realized result. An agent brings in an exceptional out-put in those fields in which, based on his or her role perception, he or she expects the highest award. The result of the action determines the individually perceived degree of justice in relation to the award. These aspects are derived from both extrinsic as well as intrinsic sources. Both aspects, award and justice, influence the degree of the agent's satisfaction. As a result, they also influence the valence of future tasks (vom Brocke, et al., 2009).

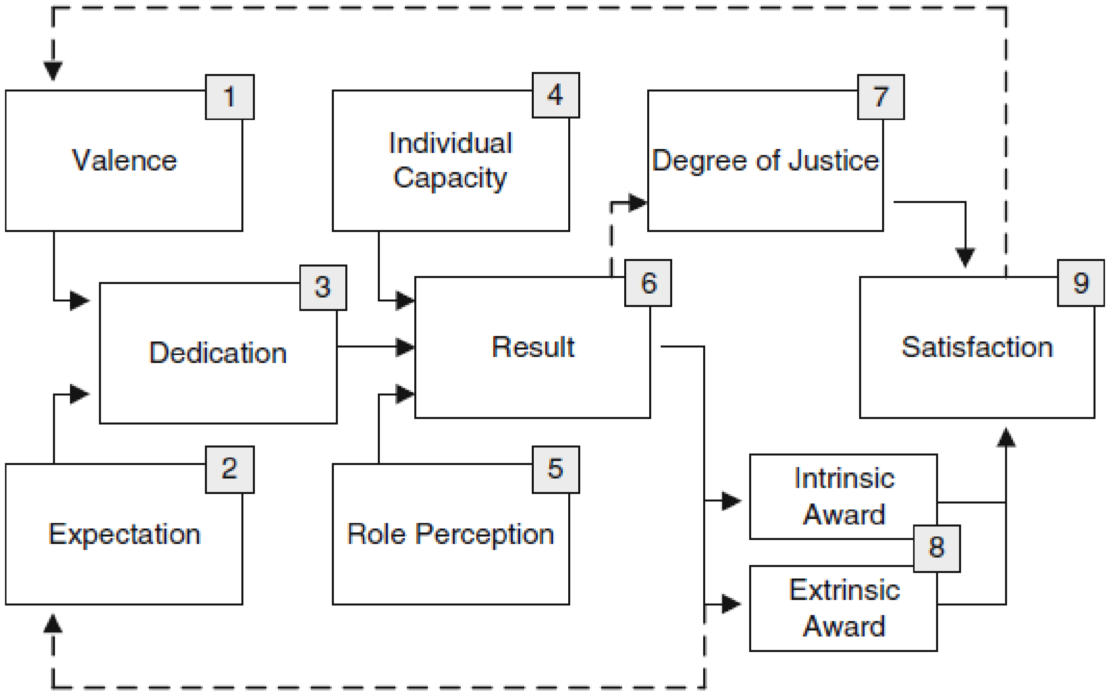


Figure 1 - Theoretical model about the impact of incentives (vom Brocke, et al., 2009)

This study is focused on providing educational support through technology in settings where learning communities exist. More specifically, the research study is concerned with online learning communities that on top of VLE use, exploit the use of social networks to bring learners together and engage them in group activity, communication, information exchange and other learning activities.

2.2 Assessment

At this point, the previous two sections have covered the concept of the pedagogical framework, the different learning style and its importance for the learner's experience, and how the communication between learners and educators can be taken place using different media.As well defined by Huitt and colleagues (2001), "Assessment is a process by which information is obtained relative to some known objective or goal". The assessment can be a test, but not all test are assessments. Assessments are usually included after a milestone on the teaching material. The objective of such an assessment is to verify if the learners have the necessary skill and knowledge to proceed to the next stage.

Assessment of skill attainment is rather straightforward. Either the skill exists at some acceptable level or it doesn't. Skills are readily demonstrable. Assessment of understanding is much more difficult and complex. Skills can be practised; understandings cannot. To assist with this complexity, assessments are given in different forms, through different media, and using different techniques. The following sub-sections will focus on explaining the benefits of e-portfolio with the use of Social Media (discussed in chapter 3.2.3). Moreover, it covers the use of continuous assessment, test and quizzes, followed by a discussion on the complexity of assessing presentations.

2.2.1 The Role of E-portfolios as Assessment Tools

With respect to content-related issues in educational technology, this study initially focuses on the role of electronic portfolios as the means to gather evidence of achieving learning outcomes, within the context of a set of learning activities. An electronic portfolio can be also in the form of a software tool not only because they organize content but also because they are designed to support a variety of pedagogical processes and assessment purposes (Gerbic, et al., 2009). The technology focuses on the learner experience and self-discovery by encouraging inquiry, problem-solving, and collaborative methods of learning, all characteristics of the constructivism methodology (Meeus, et al., 2006). Multiple researchers (Ramsden, 2003) (Marton & Säljö, 1984) (Kuh, et al., 2005) have concluded that students when faced with choices on how to learn course matter, students prefer gaining knowledge through a deeper understanding of the subject, rather than just information acquisition.

In the CoI framework of (Garrison, et al., 2001) shows how deep meaningful learning and reflection can be achieved with the use of technology. In the learning landscape framework (Tosh, et al., 2006) focus on three key elements: reflection, communication and sharing. **Figure 1** illustrates the learning landscape framework and the role played by electronic portfolios in the transfer and re-use of skills, knowledge and experiences through reflective thinking and self-assessment.

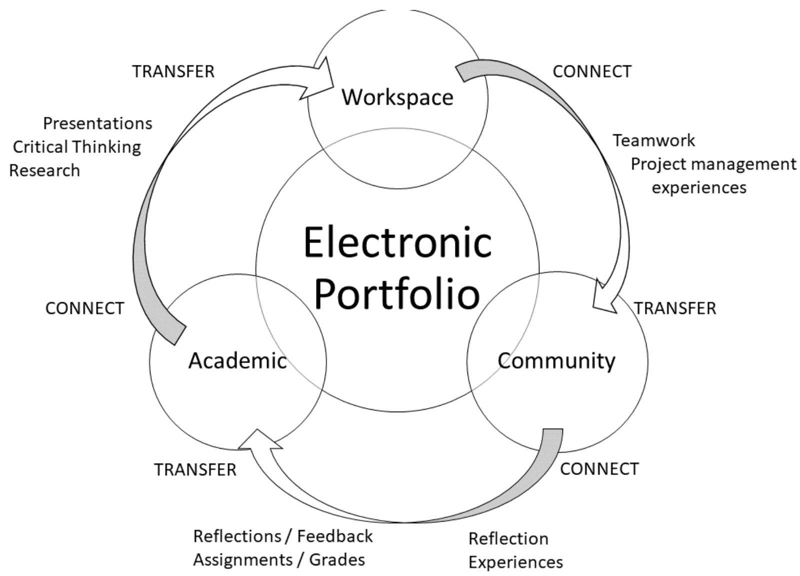


Figure 2 - Learning Landscape Framework

The electronic portfolio is an ideal mechanism for critical reflection, being one of its key characteristics (Bodle, et al., 2017). The platform allows the student's reflections to be recorded online where feedback, assignments, and grades are also provided. The social presence functionality provides the sense of a community, developing critical thinking, and interpersonal relationship through formal and informal interaction with peers. This study is based on the use of learning portfolios, as they form a suitable learning mechanism that offers itself in using educational technology for further enhancing the learners'' experience.

Assessment can be either formative or summative. This section will explain the importance and difference of each one and provide brief examples of how technology and gamification relates to it. The focus of this research is to integrate assessment activities with the way learning content is offered to learners, as well as the mechanisms that support communications necessary for the learning process.

The primary purpose of formative assessment is to promote learning. Both teachers and students are benefited from this type of assessment as it provides the chance to adapt the learning activities (Barrett & Carney, 2005). Black & Wiliam (1998) has completed a vast study reviewing more than 250 articles, with students age ranging from 5-years-old to university undergraduates, across several school subjects, and over several countries. It has been concluded that "innovations that include strengthening the practice of formative assessment produce significant and often substantial learning gains". Furthermore, "improvements in formative assessment raised student achievement more than any other educational initiative reviewed". Barret (2004) compares electronic portfolios used as assessment of learning with those that support assessment for learning.

Portfolios used for Summative Assessment of Learning	**Portfolios that support Formative Assessment for Learning**
Purpose of portfolio prescribed by institution	Purpose of portfolio agreed upon with learner
Artefacts mandated by institution to determine outcomes of instruction	Artifacts selected by learner to tell the story of their learning
Portfolio usually developed at the end of a class, term or program - time limited	Portfolio maintained on an ongoing basis throughout the class, term or program - time flexible
Portfolio and/or artifacts usually "scored" based on a rubric and quantitative data is collected for external audiences	Portfolio and artifacts reviewed with learner and used to provide feedback to improve learning
Portfolio is usually structured around a set of outcomes, goals or standards	Portfolio organization is determined by learner or negotiated with mentor/advisor/teacher
Sometimes used to make high stakes decisions	Rarely used for high stakes decisions
Summative - what has been learned to date? (Past to present)	Formative - what are the learning needs in the future? (Present to future)
Requires Extrinsic motivation	Fosters Intrinsic motivation - engages the learner
Audience: external - little choice	Audience: learner, family, friends - learner can choose

The concept of “portfolio” was originally defined in 1713 as a type of briefcase. No longer after, artists have adopted the same word to represent a collection of their best work. From the 1950s it has also been used in the financial field, representing a person's monetary worth. By contrast, an educational portfolio contains work that a learner has collected, reflected, selected, and presented to show growth and change over time (Barrett & Carney, 2005).

An electronic portfolio, as defined by Abrami and Barrett (Abrami & Barrett, 2005), is a digital container capable of storing visual and auditory content including text, images, video and sound. Having the portfolio stored electronically gives the ability to organise and reorder contents quickly and easily; to integrate student coursework; and to be used for collaboration, self-organisation, planning and presentation skills (Bhattacharya & Hartnett, 2007). Furthermore, (Abrami & Barrett, 2005) also suggest that e-portfolios can be designed as “process” portfolios meant to encourage improvement, growth and commitment to life-long learning; “showcase” portfolios which illustrate and demonstrate competencies and achievements; and “assessment” portfolios that focus on the formative or summative evaluation of learning.

Since 2009 researchers (Yancey, 2009) have argued that e-portfolios are re-shaping the landscape of higher education through changes in how students learn and how faculty teach. The success of such implementation is not only due to the e-portfolio characteristics described in the previous paragraph, but also the easiness in which the new learners’ generations have in using web-based technologies. The main evidence is the popularity of social media websites such as Twitter, Facebook, YouTube, and Instagram. In an age of multimedia self-authoring, student interest in creating rich digital self-portraits has grown exponentially (Clark & Eynon, 2009).

The research study focuses on identifying those mechanisms that can be used in providing rich feedback to learners during formative assessment. The study’s contribution is in the form of educational technology uses that not only enhance the learning experience during assessment but offering constructive feedback in forms that can be easy to understand so learners can easily build on the feedback provided and move forward.

2.2.2 Using Continuous Assessment, Tests, and Quizzes for Evaluating Learning

Different approaches to assessment were listed in the beginning of this section. One that is proving to be very beneficial is the use of continuous assessment instead of one final assessment. Such method is more appropriated when “student and/or instructor knowledge of progress or achievement is needed to determine the subsequent progression or sequence of activities” (Scanlan, 2010). The scope of this research study is to ensure that academics are provided with the means for identifying suitable assessment techniques that can be deployed with the use of educational technology in order to provide learners with continuous support.

Such observation is also similar to the one presented by Russell and colleagues (2006). They have emphasized on the importance of continuous assessment because it allows instructors to become familiar with students' work and to ensure student understanding. Gaytan and

McEwen (2007) is not against the tactic but insists that frequency of assessments does not automatically lead to learning effectiveness. It is crucial that the assessments are systematically and carefully planned to give the student an opportunity to demonstrate the learning occurred on specific subject as well as an opportunity for the teacher to provide meaningful feedback.

Obviously, the time to prepare and do the activities of the continuous assessment demands more effort. Koong and Wub (2009) have investigated ten templates (Table 5) that can be converted from traditional pen and paper approach to browsers in order to facilitate the process.

Item	Brief description
True and false	Using multimedia to demonstrate items needed to be described with lots of text. Answering is engaged through ratio button
Multiple choice	Using multimedia to demonstrate items, pull-down menu is provided for answering
Match	Using multimedia to demonstrate items. Answering is engaged through dragging
Completion item	Using multimedia to demonstrate items. Answers can be input in multiple-line
Short answer	Using multimedia to demonstrate item. Answers can be input in multiple-line
Operation	Interaction is engaged to simulate operation. Answering is engaged through dragging
Simulation	Interaction is engaged to simulate situation. Answering is engaged through dragging
Voice	Using verbal way to engage answering. Answers are recorded through microphone and be uploaded to database
Chain	Conducting chain test with items from the same category, and compare if there is inconsistency
Discussion	Using conversing features of the web to engage group discussion. User can express opinions to investigate various issues, and then to complete a report

Table 1 - Ten templates applicable to the world wide web (Koong & Wub, 2009)

Chen, Syn, and Lin (2005) pointed that the item categories that can be edited through the virtual learning environment Moodle item editor are: multiple choice, true and false, completion item, Multiple selection, calculation, match, explain, random assemble, random answer match, and link, among which ‘‘link” can be conducted in interactive test.

The use of online quizzes is a potentially powerful tool in today’s pursuit of understanding how to take advantage of technology to improve learning. (Gibbs, 2000)have reiterated on the importance of student assessment to increase understanding. If applied outside classes, online quizzes is a way to motivate students to spend more time working on the subject, this is valuable especially to procrastinators (Tuckman, 1998). Since online quizzes provide immediate feedback it allows students to be aware of their understanding for each topic and their general level of understanding (Martins, 2017).

Moreover, there are different strategies to be considered when implementing a quiz: mandatory or optional; contributing to the final grades or not; generating slightly different question for each student, or not; the best periodicity for quizzes; penalty for submitting late, or not; only multiple-choice questions or more sophisticated ones (Lawson, 1999).

Many studies around the use of quizzes to support teaching in Higher Education has been published in the last couple of decades. The results vary and more work still needs to be done for evidence of effectiveness.

Blanco and colleagues (2009)created a large set of Moodle quizzes for Mathematics 1 and 2 of Catalunya Politécnica Universitat, Spain. The quizzes were used in many different ways. For example, when used in computer lab sessions, students' results were not predictive of students' grade in the course: there was no correlation between quizzes and course grades. However, in a questionnaire about the quizzes, more than 80% of students rated quizzes as a positive activity; more than 70% of students stated that the quizzes helped them to understand some topics covered in lectures; and around 45% felt that undertaking quizzes made them more interested in the subject (Martins, 2017).

Siew (2003)administered six quizzes to 21 students on a Linear Algebra course that counted 20% to the final grade. Quizzes used Maple in background, giving questions with different values each time the question is launched. A penalty was assigned when a student resubmits an answer and the solution is only available after the due date. According to 86% of the students, the quizzes contributed to their understanding of the subject; and for 95% of the students the feedback on quizzes was useful to their learning. Students' scores on the course were higher in this year than in the previous years.

Broughton and colleagues (2013) have used Computer Assisted Assessment at Loughborough University, UK, for more than 10 years. Lecturers find it efficient and time-saving but have concerns that some students developed tendencies to depend on the feedback to complete assessments and to develop procedural strategies for solving problems.

Shorter & Young (2011) made a comparison of three assessment methods: (1) daily in-class quizzes, (2) online homework and (3) project-based learning. They found 'daily in-class quizzes' were the best predictors of students' learning (dependent upon post-test grades) for 117 undergraduate students on a Calculus course.

Myers (2007) assessed a statistics course with around 65 students in two semesters with two different strategies. First strategy: during a semester, students get two exams, one in midterm and the other at the end of the semester. Second strategy: in the other semester students had a test every 2 weeks. Their results reported that the second strategy produced better results. The much higher success rate cannot be assigned only to the quizzes since it was not the only different variable in the semester. (1) The responsible teacher changed: in the data available, there were three different responsible teachers and the results of this semester were much higher than the results with the two other responsible teachers. (2) Contents were the same in all semesters but the responsible teacher in that semester gave more emphasis to concepts applications and it could have increased student's motivation. (3) This was the second time that the teacher was responsible for a course and the first time that they applied the quizzes, and it may lead to exceptional enthusiasm. (4) Exam exercise difficulty was not smaller, on the contrary (exercises like in Fig. 3 would be considered as too difficult for the others responsible teachers and never would take place in an assessment, as often happened in that semester).

An objective result was, despite of the optional policy, the students strongly participated in the quizzes. One of the quizzes was answered by 94 of the 104 of subscribed students. All the quizzes had high rate of attendance. Among the students that went to any 'regular' assessment, almost all took a quiz and a large percentage got high average grades on the quizzes. The pass rate in that semester increased significantly, it was roughly the double of the remaining eight semesters studied. Average grade of passed students was also higher. This cannot be directly attributed to quizzes, there were other changing variables in that semester, however, it is a positive indicator suggesting the effectiveness of the quizzes. Students' vision (shown in questionnaire) was that quizzes made students study more; learn new things to answer the quizzes; get a better perception of their level of understanding; and are a fair assessment tool. Nearly all students perceived the quizzes as useful. This study shows that these weekly online quizzes, applied with this set of strategies, have some evidence of effectiveness. Larger and deeper studies are needed to generalize and ensure evidence of effectiveness (Martins, 2017).

Following the discussion on assessment techniques, it is important to understand that the aim of this research study is to provide the mechanism for identifying suitable educational technologies that can support formative and summative assessment. Although the focus of this research is not to examine whether assessment results are significantly improved with the use of technology, its aim is to assist academics in selecting suitable uses of technology to further support learners through assessment.

2.2.3 Assessing presentations

On the previous two sections, the assessments discussed are likely to be used to evaluate a skill, something practical that the learners can either replicate or not. Generally, it is something easy to judge. This final section on assessment covers presentations as an assessment option. Presentations are considered to be a critical aspect of assessment in this research study. Increasingly most industries require presentation skills as part of graduates' profile. This requirement applies further pressure in the education sector to train learners on how to become effective presenters. Educational technologies and in particular implementations of augmented reality can be excellent tools to support learners into practising presentations skills.

Assessing a presentation is not as straightforward. There are different factors to be considered. One of them is the presenting skills, involving the presenter posture, hand movements, eye contact, and voice projection, for example. These are factors that can be improved with practice and training.

On the other hand, when a presentation is not up to the minimum standards it may be unclear for the assessor what the issue was. It could be poor presentation skills as mentioned above, or pure lack of understanding of the subject. These chapters will review the literature on the topic, covering different ways to use empirical evidence to support the examiner decision (Dobson, 2006).

Messick (1989) has explained the issue above by stating that "Validity is an integrated evaluative judgment of the degree to which empirical evidence and theoretical rationales support the adequacy and appropriateness of inferences and actions based upon test scores and other modes of assessment". Rubric for grading presentations is Messick's suggestion to make sure empirical evidence is implemented. The rubric would clearly state the criteria being analysed as well as the weight for each one, such as the content of the slides, quality of the content, presentation time, presenter body posture, voice projection, and others.

Such practice is also supported on Sadler (1989) publication. For any kind of assessment, the use of a marking scheme must be defined. Such decision must be taken in agreement with other lectures, in a collective fashion, to provide verbal descriptors and exemplars of the components skills they wished to weight.

Another important factor to be discussed is if the presentation assessment should be considered formative (non-graded, only use for practice and feedback) or summative (part of the marking criteria). Such discussion should not only be limited to the academics but also including the student's opinion. If such method is taken, it would be an instance of what Askew and Lodge (2000) have called co-constructivist, where participants were engaged in a looping dialogue about its validity.

This research study focuses on the use of augmented reality as a mechanism for providing feedback on learner presentations. Emphasis is given on identifying the most appropriate ways for providing such feedback, as well as the learners' perception of how useful current technologies are in supporting their presentation delivery.

2.3 Feedback

The previous section has discussed the use of assessment in education. The different types of assessment, the different ways to implement it, and finally its advantages and disadvantages. In conclusion, assessments are a crucial part of education. Without such a stage, it is not possible to have empirical evidence of the knowledge and skill of the student. Educational technologies can play a critical role in supporting the way feedback is provided in various learning settings. Provision of rich feedback is one of the key areas for this research study, as emphasis is given on deploying educational technologies in order to support feedback provision, as well as modernise the way feedback is delivered.

Naturally, the next step is in academia is to provide constructive feedback. Only providing the grade to the student is not enough. They must also receive criticism. Such information will allow them the opportunity of analysing it and discuss their point of views provided by the academic. Only after this reflecting on it the learners will be able to work to improve it further.

Similarly, to the 2.2. Assessment section, there are different ways to provide meaningful feedback. This chapter goes more in-depth on why the feedback is important, followed by the different use of rubric feedback, how technology such as video-recording can assist in the process, and finally, explaining how to evaluate if the feedback being provided is efficient.

2.3.1 The Role of Feedback

Across the nation, several instruments have been used to evaluate learning provision. Typically, the provision of feedback is one of the top criteria used for assessing whether institutions provide sufficient support to their students. Since 2015, the National Student Survey (NSS) reveals that assessment and feedback, although improving, are still the lowest in terms of satisfaction of all the six groups of questions. This, coupled with increasing pressure upon lecturers to provide a 'quality learning experience', as well as respond to the effects of market forces (Brown & Carasso, 2013), means that understanding the relationship between the feedback that is offered and its subsequent use by students becomes even more important.

Feedbacks are primarily created for the students and is clear that they want more of it (quality and quantity). Other feedback-related researches have shown that lectures consider the action of providing feedback a useful learning tool (Maclellan, 2001) (Carless, 2006). Although both sides understand the benefit of it, several studies have suggested that the feedback students are receiving is doing little to improve their learning (Bailey & Garner, 2010) (Sadler, 2010).

The understanding of what the purpose of the feedback is, how students are engaging with feedback, and how they are using it to improve their future work has been changing in recent years. From the student's point of view, the most widely accepted definition is that feedback should be used to help them close the gap between their actual performance and the desired performance (Nicol & Macfarlane-Dick, 2006). However, a growing number of students in the past decade believes that the feedback comments appear detached from a supportive tutorial system, which once existed, and thus students have become dissatisfied with the feedback process. It is not only about providing relevant academic content feedback. It is about being more sympathetic to the students feeling about it.

These are some of the reasons why this research study is focused on using educational technologies as supportive mechanisms for providing feedback. Such technologies can help academics to provide better feedback, as they can offer a mechanism to enhance the detail of feedback, as well as consider a variety of feedback forms that are better suited for different learners.

2.3.2 Approaches for Feeding Forward

Feedback is essential, and it is essential that it feeds forward. It must encourage further learning and help students identify gaps between their actual and desired performance (Brown & Glover, 2006) (De Nisi & Kluger, 2000) (Higher Education Academy, 2013). The literature has emphasised two main points that deter this to achieve: feedback focusing on addressing past work (rather than future work) or is too context-specific (rather than more generally applicable) (Gibbs & Simpson, 2004). This section will cover the use of assessment rubric to facilitate the implementation of feeding-forward feedback.

Assessment rubric technique adoption has grown considerably for the past 20 years. It has been reported that only 83 publications with such terms were published by 1997. The 1000th publication on the topic was published 8 years later, and the 5000th paper mentioning rubrics was published in 2013. Figure 5 below shows the number of publications with the "assessment rubric" from 2010 until 2018.

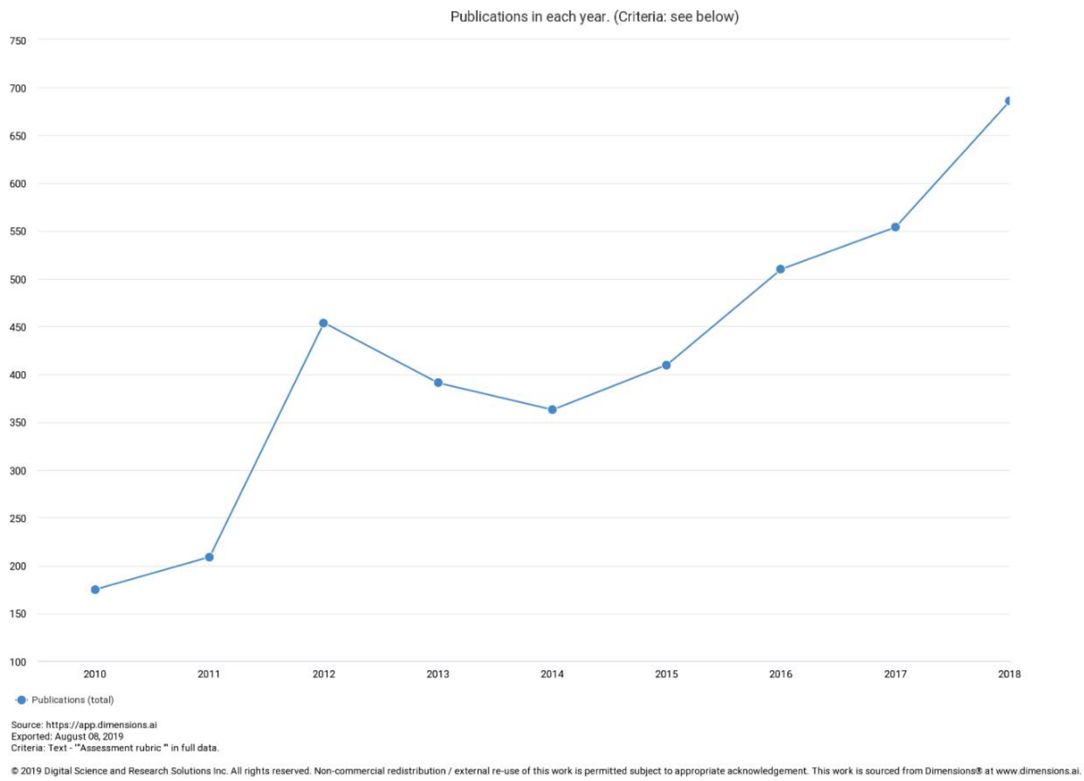


Figure 3 - Total number of publications with the term "assessment rubric" (Digital Science and Research Solutions Inc., 2018)

Although its implementation has increased in educational settings, there is no clear definition of what a rubric consists of: "*A couple of decades ago, rubric began to take on a new meaning among educators. Measurement specialists who scored students' written compositions began to use the term to describe the rules that guided their scoring. They could have easily employed a more readily comprehensible descriptor, such as scoring guide, but scoring guide lacked adequate opacity. The rubric was a decisively more opaque, hence technically attractive, descriptor.*" (Popham, 1997). There is a consensus that rubric should be used as a tool to set a scoring strategy, define the standard, and evaluate the student performance. After investigating the diversity of rubrics, Philip Dawson (2017) have created a framework consisting of the following fourteen design elements:

- Specificity: the particular object of assessment
- Secrecy: whom the rubric is shared with, and when it is shared
- Exemplars: work samples provided to illustrate the quality
- Scoring strategy: procedures used to arrive at marks and grades
- Evaluative criteria: overall attributes required of the student
- Quality levels: the number and type of levels of quality
- Quality definitions: explanations of attributes of different levels of quality
- Judgement complexity: the evaluative expertise required of users of the rubric
- Users and uses: who makes use of the rubric, and to what end
- Creators: the designers of the rubric
- Quality processes: approaches to ensure the reliability and validity of the rubric
- Accompanying feedback information: comments, annotation, or other notes on student performance
- Presentation: how the information in the rubric is displayed
- Explanation: instructions or other additional information provided to users

Philip Dawson (2017) article discussion on the potential benefits and limitations of the framework has the potential do assist a different range of professionals. Researchers will gain a better understanding of what a rubric may consist of when analysing other academic publications in the same area. Practitioners designing a rubric will have potential assumptions clarified, therefore being easier to reach consensus when developing a rubric for a wide range of courses. By understanding the different types of rubrics and the different scenarios where it would be more beneficial, the policy-makers will be able to provide a more appropriate policy, instead of a one-fits-all approach. Lastly, computer software manufacturers can benefit from such framework during the software design conception, by considering what potential elements the user may want to use.

2.3.3 Feedback Mechanisms for Presentations

Presentation is not the most loved form of assessment, according to students. Some researchers have even started that is the least liked of all. The main justifications for it are: lack of an ideal form of feeding-forward feedback, stress, and anxiety (Sander, et al., 2002). However, the list of benefits is long: i) promotes deep learning (Biggs, 1999) (Rees & Harris, 1992); ii) encourage information sharing; iii) enhance independent learning; iv) increase expertise in knowledge and presentation skills (Curtis, 1999); v) improve self-esteem; vi) prepare graduates for the real world therefore increasing their employability (Curtis, 1999). The benefits outweigh the concerns. The academic objective would be to be able to provide meaningful feedback, so the students improve their performance, therefore reducing the stress and anxiety for the next oral assessment. Due to its flexibility in design, rubrics can be adapted for a variety of learning activities, including the challenging oral presentation but it may not be the most efficient method (Quigley & Nyquist, 1992).

After submitting a written assignment, students are likely to have an electronic copy of it themselves. If this is not the case, the academic can always correlate the feeding-forward feedback from a rubric on the submitted version. It is not as straight-forward for presentations. Once students have finalised their presentation, it is no longer available to review in conjunction with the assessor's feedback (Murphy & Barry, 2016). This is, unless you have a video recording of it.

Collins and colleagues (1994) confirm that the use of video-recordings from presentations can be used to provide similar feedback to the ones used in written assessment. Not only is used as a valid tool for feedback, but it also facilitates knowledge of performance and improve students' understanding of their learning (Hattie & Timperley., 2007) (Issenberg, et al., 2005). Moreover, video feedback combined with other feedback has resulted in expedited learning (Stefanidis, et al., 2007).

In regards their presentation skills (content aside), people tend to inaccurately report on their own communication behaviour (Bernard, et al., 1982) and consequently see their behaviour different to the others (Quigley & Nyquist, 1992). The main objectives of having a presentation recorded are: i) inform the speaker about the audience's reaction to their work; ii) suggest improvements for future presentations; iii) and motivate the person to present again (Book, 1985).

The success of using video recording has been presented in different publications. Yamkate and Intratat (2012) recorded students' presentation and students completed a questionnaire reflecting on the strengths and weaknesses of their presentations. Students noted that the video has helped them identifying their non-verbal characteristics and summarised it as a positive experience. On following up assessment, the quality of the students' presentation has improved, and their ability to use evaluation to progress their performances was evident. Tugrul (2012) have done a similar implementation, but students and lectured reviewed the video together. After the review, students rated the effectiveness of this learning exercise for oral presentation skills, communication skills, career-related skills, learning motivation and overall course evaluation. For all categories, students' ratings were well above neutral, which indicated that students viewed the assessment task very positively as it developed many critical presentation skills.

The studies above clearly indicate that video recording is a helpful feed-forward feedback tool for students' presentation, regardless of its native language. Given that students learn from Assessment & Evaluation in Higher Education 215 engaging with and reflecting on feedback for written work (Quinton & Smallbone, 2010), it is critical that video review studies embed these elements within oral presentation assessment tasks.

This research study considers the use of augmented reality as a support mechanisms for presentation feedback in the form of vignettes that demonstrate to individual learners how their body posture and presentation content can be improved.

2.3.4 Evaluating Feedback

Feedback in academia is essential and desired by the students. The previous sections suggested a few ways to do it. There are many more. Some students favour written comments only (Yang & Carless, 2013) and others appreciating a combination of written comments alongside one-to-one meetings with their lecturers (Blair & McGinty, 2012). One of the barriers to effective feedback in one-to-one meetings is explained by Poulos and Mahony (2008), who suggested that some students do not feel that they can interact with their lecturer due to their own confidence level and a lack of established relationship. Brockbank and McGill (1998) found that what many students want from the feedback process is to engage personally with the marker to discuss feedback, rather than receive written comments alone.

Students' preferences will differ (Hepplestone & Chikawa, 2014) and it appears to be a gap in knowledge and expectations as to what constitutes high quality and efficient feedback between academics and students, resulting in student dissatisfaction and staff frustration (O'Brien & Sparshatt., 2008). To reduce this gap and improve satisfaction on both sides, it is important to implement a mechanism that allows the teachers to receive feedback on the feedback being provided.

Pitt & Norton (2017) have chosen to hear it directly from the ones being affected the most, the students themselves. During an in-depth interview with fourteen final year undergraduate students, they have expressed their perception of the written feedback received on different assignments, selecting examples of what they consider "good" and "bad. Following a more quantitative approach, Mulliner and Tucker (2017) has sent a questionnaire survey to students and academic staff at the School of the Built Environment, Liverpool John Moores University (LJMU). From the approximate 1300 students, 15% have responded to the questionnaire (194). A much higher percentage of staff (43%, 26) have done the same. The students' responses were almost evenly spread according to the three academic years (31% 1st year, 35% 2nd year, 34% 3rd year). The questionnaire consists of 6 sections, but the first three are relevant to the discussion. The first part asked how effective different types of feedback are (Figure 5), followed by what their personal preference for feedback would be (Figure 6), and finally, the third part is regarding the timeless of feedback (Figure 7).

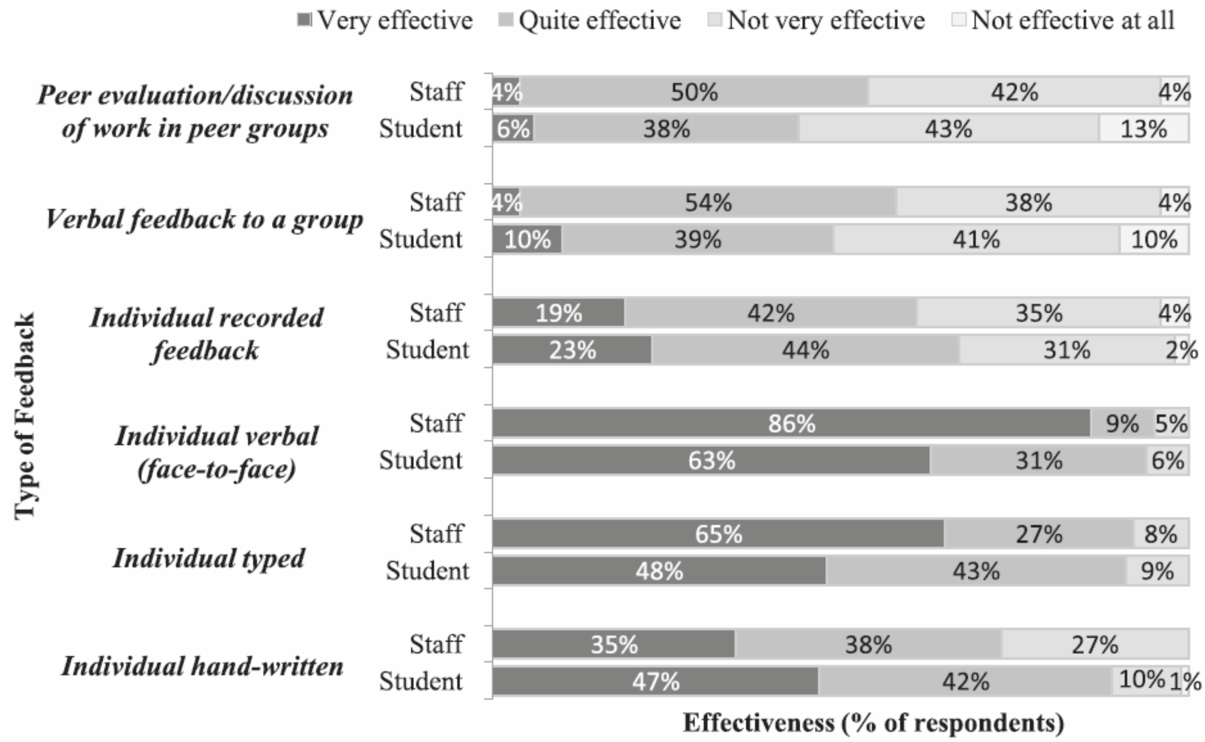


Figure 4 - Effectiveness of different forms of feedback (Mulliner & Tucker, 2017)

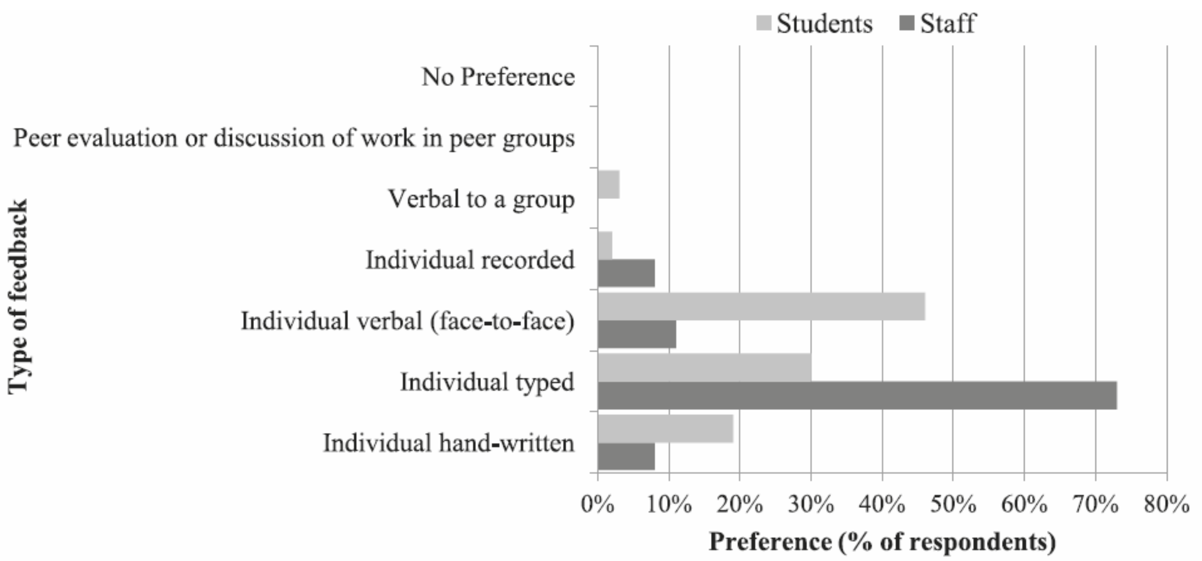


Figure 5 - Feedback preference (Mulliner & Tucker, 2017)

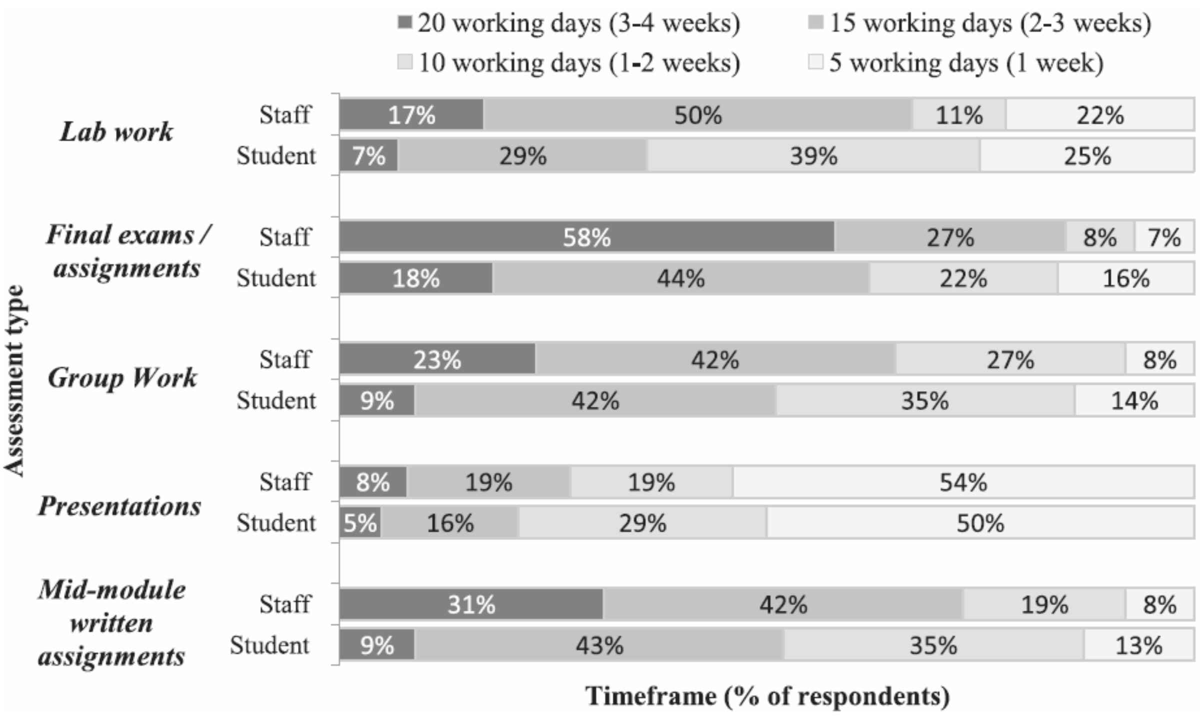


Figure 6 - Ideal time frame for feedback (Mulliner & Tucker, 2017)

The results for the examples above are discussed in detail on the original publication and it is outside the scope of the report go more in-depth. The main point was to exemplify the common discrepancy between what the teacher believes is the best implementation of feedback and what the student appreciates. There is no magic formula. Different factors such as the subject being taught, the type of assessment, culture, previous academic experiences, and others will affect the judgement of staff and students regards the feedback involved. The best solution is indeed to have a clear understanding of the opinions form each side and work to find the best middle term solution, considering the HEA definition of effective feedback "effective feedback should not be produced for this purpose, but should be produced 'for the student, with the student's learning needs as the central concern" (Higher Education Academy, 2013).

This research study also focuses on offering an appropriate mechanism for learners to evaluate the feedback provided to them with the support of educational technologies. Emphasis is given on identifying whether the use of certain technologies improved the value of feedback provided, as well as the ability of each learner to use the feedback mechanisms effectively in meeting the learning outcomes.

2.4 Understanding Learning Styles

After investigating the role of learning portfolios in education, this study is concerned with the way different learners interact with learning content. It is essential to understand that learners experience their learning journey differently according to their learning style, as it allows to cater to individuals with customised, or even personalised content and learning management environments.

According to (Sternberg, 1994), a learning style is a preferred way of using the learner's abilities rather than an ability in itself. Learning styles usually represent two extremes of a wide continuum (for example reflective versus impulsive; random versus sequential; visual versus auditory; global versus analytic; inductive versus deductive) however, each end of the spectrum has advantages and disadvantages (Dornyei, 2005). Although individuals will have their preferred methods, it is more likely that the behaviour will be extended and modified depending on the situation and the task at hand (Oxford, 2011) (Reid, 1987). The extent to which individuals can adapt or shift their styles to suit a particular situation varies (Ehrman, 1996).

By proposing the "theory of psychological types" in the 1920s, Carl Jung has officialised the interested in learning styles in general psychology (Sternberg & Grigorenko, 1997). In the field of education, the learning style concept has been recognized since at least the mid-1970s (Griffiths, 2012). Considering the continuum spectrum mentioned in the previous paragraph, researchers started classifying learning styles in distinct groups. The groups were defined based on conceptually and empirically investigation, multiple taxonomies attempt, and numerous theories. Influential models and instruments (for example, written surveys and questionnaires) have been created for both research and pedagogical purposes (Coffield, et al., 2004).

The research on learning styles is powered by three main motivations: i) providing a link between cognition and personality; ii) understanding, predicting and improving education achievement; iii) and improving vocational selection, guidance, and possibly, placement (Sternberg & Grigorenko, 1997). Furthermore, advocates of learning styles believe that it can be measured and used as a valuable teaching tool inside the classroom. According to these scholars, by understanding the students' learning styles and matching them to teaching methods (for example for a 'visual learner', being taught with information through illustrations), learning can be greatly enhanced (Sternberg, et al., 2008).

Between 1974 and 2004 the volume of research on the field was extremely vast. Two examples illustrate this point. First, in 2000, David Kolb and his wife Alice produced a bibliography of research conducted since 1971 on his experiential learning theory and Learning Style Inventory (LSI): it contains 1004 entries. Second, the website for the Dunn and Dunn Learning Styles Questionnaire (LSQ) has a bibliography with 1140 entries (Coffield, et al., 2004).

As the number of learning theories grows, the need to classify them into different groupings becomes more pressing. One of the models (Vermunt, 1998) aimed to integrate different learning processes in two main categories: i) some of which are thought to be relatively stable (mental learning models and learning orientations); ii) and some of which are contextually determined (choice between regulating and processing strategies).

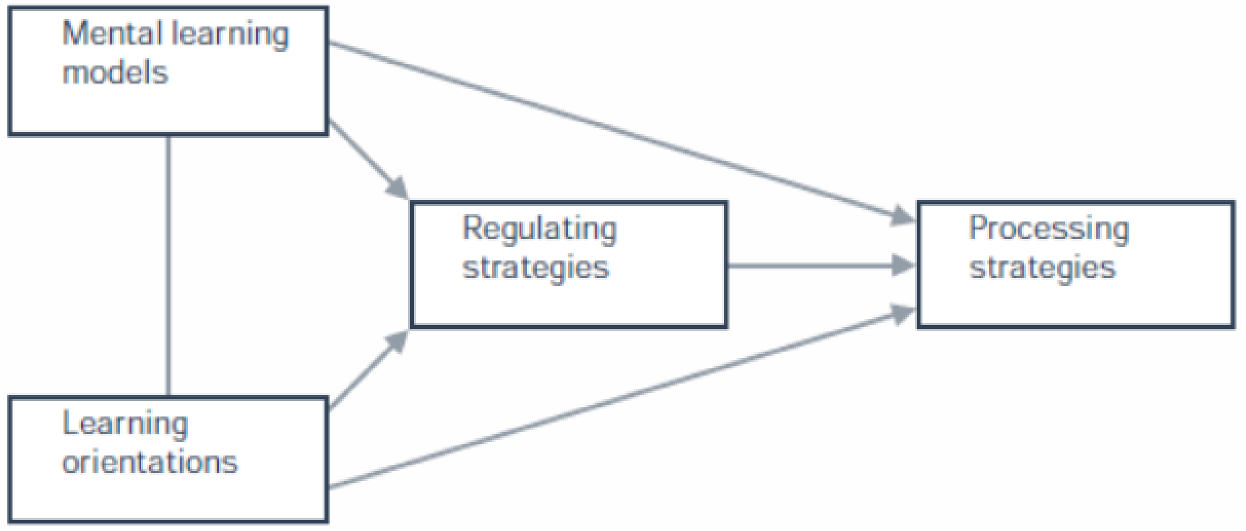


Figure 7 - Vermunt's model of learning styles (Price & Richardson, 2003)

A review supported by The Learning and Skills Research Centre (Coffield, et al., 2004) has identified 71 learning styles models, of which 13 were considered major ones. The remaining were only briefly mentioned as they are mostly minor adaptations of one of the leading models and therefore lack influence on the field. Furthermore, in the same document, the researchers' aim was to organise, in a simple way, the different models according to some predominant ideas behind them. A total of four conceptual models are considered in this research study. They are used as the foundation for identifying learner profiles and understanding their learning needs. The four models that can assist in the mapping of individual learning styles are presented in detail next.

2.4.1 Visual, Auditory, Read/write, and Kinaesthetic (VARK)

"Learning styles and preferences are largely constitutionally based including the four modalities VAKT (visual, auditory, kinaesthetic, tactile)" (Coffield, et al., 2004). The VARK Learning Style Questionnaire was developed by Fleming and Mills in 1992 to help students understand and adapt their individual learning preferences (Sinclaire, 2012). The work is an expansion upon earlier notions of sensory modalities such as the VAK model (Barbe, et al., 1979), the earlier neuro-linguistic model (Eicher, 1987), and the representational systems (VAKOG) in neuro-linguistic programming (Fleming, 1995).

Each VARK question presents a situation likely to be within the respondent's experience and asks him to select from among alternative actions. Each answer represents a modal preference. Respondents may select multiple answers and all answers are counted. After finishing the questionnaire, a score is assigned to each of the four sensory modality dimensions of learning, that is, the way the information is taken in and processed by a learner (Sinclaire, 2012). The four modalities are visual, aural/auditory, read/write, and kinaesthetic.

Visual learners prefer the use of symbolic devices such as diagrams, graphs, flowcharts and models that represent printed information. Auditory learners prefer to hear information and, thus, learn better through discussions, lectures, tutorials and talking through the material with themselves or others. Read-write learners prefer printed words and texts as a means of acquiring new information; they thus prefer textbooks, lecture notes, handouts, lists and glossaries. Kinaesthetic learning employs a combination of sensory functions; such learners have to feel or live the experience to learn; they prefer simulations of real practices and experiences, lessons that emphasize on performing an activity, field trips, exhibits, samples, photographs, case studies, real-life examples, role-plays, and applications to help them understand principles and advanced concepts. Some learners prefer any one of these learning modalities (uni-modal learners), whereas multimodal learners do not have a strong preference for any single method. They rather learn via two or more of the modalities. Multimodal learners thus are sub-classified as bi-, tri-, and quad-modal learners, who prefer to use two, three, or four styles, respectively (Fleming & Mills, 1992).

Table 2 - Activities that accommodate VARK learning styles (Fleming, 2001)

Visual	**Aural**	**Read/Write**	**Kinaesthetic**
Diagrams	Debates, Arguments	Books, Texts	Real-Life Examples
Graphs	Discussions	Handouts	Examples
Colours	Conversations	Reading	Guest Lecturers
Charts	Audio Tapes	Written Feedback	Demonstrations
Written Texts	Video + Audio	Note Taking	Physical Activity
Different Fonts	Seminars	Essays	Constructing
Spatial Arrangement	Music	Multiple Choice	Role Play
Designs	Drama	Bibliographies	Working Models

According to Fleming’s 2006 article, the VARK questionnaire has two main objectives: i) be a catalyst for staff development - thinking about strategies for teaching different groups of learners can lead to more, and appropriate, variety of learning and teaching; and ii) to start a conversation among teachers and learners.

VARK has been used in various ways to explore student preferences for course delivery mode, assessment method, and course effectiveness. Zapalska and Brozik (2006) have used to develop an online environment that would fit each type of learner. Becker and colleagues (2007) survey results have shown that VARK styles do not impact student preference for course delivery methods (face-to-face or online delivery) or preferences for assessment approaches. On the following year, VARK was used to classify students and evaluate performance measured as pre-test/post-test score differences. Being a heavily economic graph-based course is not surprising that students with higher Visual scores had better grades (Boatman, et al., 2008). Lastly, Rogers (2009) used the VARK instrument to survey traditional undergraduate students to increase student awareness of individual learning preferences and guide the adaptation of teaching methods to accommodate all learning styles. The VARK instrument popularity is due to two main factors: it is deliberately kept short and simple (Leite, 2010) and is based on real-life situations that users easily relate to

(Rogers, 2009). VARK is critical for this research study as it allows the classification of individual learners according to the way they experience a learning process. Therefore, this study attempts to reflect on how to support each learner type best through the use of educational technologies.

2.4.2 Myers-Briggs Type Indicator (MBTI)

"Learning styles are one component of a relatively stable personality type" (Coffield, et al., 2004). By utilising the necessary instruments in this category, theorists aim to understand the personality traits and learning style that shape all aspects of an individual's interaction with the world.

Myers-Briggs Type Indicator (MBTI) was designed by Katherine Cook Briggs and her daughter Isabel in the early 1940s and is now one of the most popular instrument, with an estimative that 2000 articles have been written about it between 1985 and 1995 (Coffield, et al., 2004). Furthermore, MBTI has been defined by Furnham (1996, p. 307) as 'the most popularly used measure in the consultancy and training world' as well as being widely used as career development and managerial tool in business, management, and religious communities. Reports show that over 2m copies of the MBTI are sold annually (Pittenger, 1993).

The instrument has a set of closed questions that are related to four bipolar discontinuous scales: i) Extraversion (E) VS Introversion (I); ii) Sensing (S) VS Intuition (N); iii) Thinking (T) VS Feeling (F); iv) Judging (J) VS Perceiving (P). Based on the selected answers, the scores generated would be assigned to one of 16 personality types, which are regarded as distinct from one another in terms of cognitive, behavioural, affective and perceptual style:

ISTJ	ISFJ	ISTP	INTP
INTJ	INFJ	ISFP	INFP
ESTJ	ESFJ	ESTP	ENTP
ENTJ	ENFJ	ESFP	ENFP

The complexity behind the MBTI's theory is usually underestimated by casual users who have problems understanding its real implications. According to Myers and Briggs, each four-letter type represents a complex set of relationships among the functions (S, N, T and F), attitudes (E and I) and attitudes toward the outer world (J and P). These various interactions are known as type dynamics (Fleenor, 2001). Thorne & Gough (1999)'s table below summarises the 10 most common MBTI types:

Table 3 - Summary of the 10 most common MBTI types (Thorne & Gough, 1999)

Type	Positive traits	Negative traits
INFP	Artistic, reflective, sensitive	Careless, lazy
INFJ	Sincere, sympathetic, unassuming	Submissive, weak
INTP	Candid, ingenious, shrewd	Complicated, rebellious
INTJ	Discreet, industrious, logical	Deliberate, methodical
ISTJ	Calm, stable, steady	Cautious, conventional

ENFP	Enthusiastic, outgoing, spontaneous	Changeable, impulsive
ENFJ	Active, pleasant, sociable	Demanding, impatient
ENTP	Enterprising, friendly, resourceful	Headstrong, self-centred
ENTJ	Ambitious, forceful, optimistic	Aggressive, egotistical
ESTJ	Contented, energetic, practical	Prejudiced, self-satisfied

This research study is based on the notion that personality profiles and learning styles are strongly interrelated. This is based on the belief that learning is one of the processes that are affected by an individual's personality and is likely to be affected by the way a person's characteristics manifest and affect his/her learning experience.

2.4.3 Adizes Management Styles Indicator (PAEI)

"Learning styles are flexibly stable learning preferences" (Coffield, et al., 2004). Ichak Adizes started working on an earlier version of the Adizes Methodology as part of his doctoral dissertation in 1966. The focus of his research was finding a more democratic approach to management in the United States, where the top-down management approach was the most popular. During the next 13 years, Dr Adizes has published a book (*Industrial Democracy: Yugoslav Style*) on the topic, as well as established an organizational research group where he worked as a consultant. In 1979 he resigned his tenure at UCLA Graduate School of Management to dedicate more of his time to developing and documenting the Adizes Methodology (Adizes, 2015).

According to Shiva & Hassan (2016), the Adizes Methodology emphasizes that there is not a type that is of all for an organisation. Instead, the theories emphasize the importance of fit (Aldrich, 1979), which means that the employee with certain traits must align better with the organisational resources, opportunities, and threats that he/she will be involved with (Chandler, 1962). Management style and work personality have been studied by scores of researchers over the last hundred years. Like many others, the Adizes model is based on the pioneering work of Dr Carl Jung (Adizes, 2012). As most of the other work that is based on Jung's work, Adizes describe his four basic management styles as follow:

Produce: The first and foremost role of an organization is to produce results. The result to be produced -- the basic reason for the existence of the organization -- is to satisfy customer needs. This role is developed in an organization through all those activities that focus on producing the product or service that is being offered to the marketplace.

Administer: While the Producing role focuses on what to do, the Administering role focuses on how to do things. The Administering role is developed by those activities and functions that are directed at getting things organized, planned, scheduled, systematized, and generally under control by capturing the learning curve about how to do things right in processes, procedures, and systems.

Entrepreneur: Entrepreneuring is the third role of any organization, which drives the organization to successfully adapt to change. It is developed in a company through all those activities that are focused on creating new opportunities or responding to threats. To Entrepreneur requires that organizations have "sight" and the ability to see things that others cannot see, plus the willingness to believe in those visions and undertake significant risks.

Integrate: To succeed over a long period of time, organizations need to establish a “life” that is independent of the life provided by its founder(s). The Integrating role focuses on the development of a cohesive team that makes the organization efficient over the long term. Organizations that are well integrated have a pervasive and persistent culture of mutual trust and mutual respect.

Furthermore, the table below shows how different styles relate to different dimensions:

Table 4 - Dimension per different style (Paych, 2018)

DIMENSION	P	A	E	I
Time Focus	Immediate	Past	Future	Present
Task Focus	Result	Process	Result	Process
Coordination Of	Goals	Systems	Ideas	People
Scope	Individual	Systemic	Global	Local
Thinking	Concrete	Abstract	Possibilities	Relationships
Restraint	Unrestrained	Restrained	Unrestrained	Restrained
Regulation	Controlled	Controlled	Free	Free
Reasoning	Literal	Literal	Metaphorical	Metaphorical
Reference	Specific	Specific	Approximate	Approximate
Concerns	External	Interval	External	Internal
Positioning	Central	Peripheral	Central	Peripheral

To simplify, when considering a problem-solving situation, each role would have a different focus:

(P): what?
(A): how?
(E): when?
(I): who?
Lastly, by analysing the PAEI relationship on a 2x2 matrix (below) it is clear to see that the greatest inter-type conflict is between types that are on diagonal of each other. The Administrator is structured, slow, local process orientation has nothing in common with the Entrepreneur is unstructured, fast, global results orientation. A similar conflict exists between the Integrator and Producer (Shiva & Hassan, 2016).

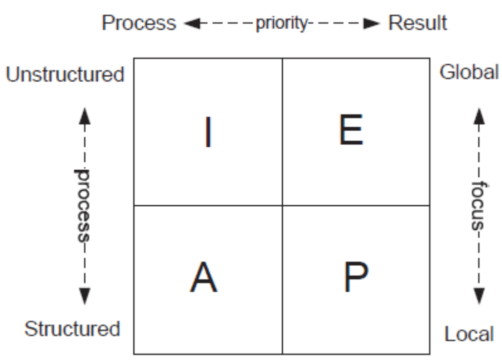


Figure 8 - PAEI 2x2 matrix (Shiva & Hassan, 2016)

In conclusion, Adizes (2012) believes that the success of its model is due to three main points:

1) It is easy to understand it: Although the lack of sophistication of the model may be a downside from the psychologist and other professionals' point of view, the creator sees it as an asset. Being able to have employees across the board not only understanding it but most importantly, applying it, it is crucial for the business.
2) It is accurate: according to Adizes, his model has been implemented on business all over the world in the last 47 years. Companies size ranging from start-ups to the Global 100. Clients have found it to be a highly accurate and useful representation of how people really work.
3) It is versatile: PAEI is a powerful management tool that can be used to gain helpful insights into people, a company, a project, a product, and a wide range of another phenomenon that are important to management.

The outcomes and contributions of the research study are not confined in the application of educational technology only on traditional educational settings, such as University courses. Since Work-Based learning (WBL) and Life-Long Learning (LLL) scenarios are quite common these days, individuals are expected to learn at the workplace or even independently at home through life experiences. Understanding individuals' stances towards management is important for the learning process, as it helps to understand how they approach the overall learning process or handle specific learning activities.

2.4.4 Belbin team role theory

"Move on from learning styles to learning approaches, strategies, orientations" (Coffield, et al., 2004). Quite often, individuals learn in teams. Teamwork and team learning is quite often part of modern curricula as it is a skill set required by most industry sectors., According to Smith and his colleagues (2012), work activities implementation are driven by a wide range of needs such as i) addressing the employability agenda (Gedye, 2009); ii) encouraging enterprise skills (Healey & Matthews, 1996); iii) implementing a problem-based learning exercise (Spronken-Smith, 2005) (Pawson, et al., 2006); iv) or efficiently deploying teaching resources (Gibbs, 2010);

The market and the shareholders' pressure under organisations have been increasing considerably in the last 20 years. Recent evidence suggests that companies seeking to react and adapt must focus on the team working to achieve high-performance results (Partington & Harris, 1999). Furthermore, Wheatley (1992) reports that, in the UK, the managers' dependence on team-working skills is also increasing. Consequently, the education system must not only focus on teaching the theory behind the subject but also the necessary soft skill related to team activities. Livingstone & Lynch (2002) states that group project "can be a method of increasing complexity in the learning experience, which thus strengthens students' preparedness for the complex environments into which they move after completing their degrees".

On the other hand, when implemented at the undergraduate level, the challenges faced during group projects may reduce individual student's motivation (Gold, et al., 1991) (Kerr &

Bruun, 1983). Students at such level are more likely to have poor group work skill, which may manifest itself as anxiety and disorientation upon encountering a group work situation for the first time (Gibbs & Dunbat-Goddet, 2007). Two other common problems listed during work projects are the unproductive time in group meetings (Healey & Matthews, 1996) and hardworking student reducing their effort due to unfairness caused by freeloaders (Houldsworth & Mathews, 2000). The practice is essential to develop the understanding of personality clashes and therefore improving in group management and facilitation skills (Gibbs, 2010).

Regardless of how difficult it may be to implement successful group projects in undergraduate level, the competitiveness in graduate market demands that the skills are properly developed by the time the students graduate (Henderson & Robertson, 1999). Team role classification has been proposed as a way of making the most of group work in higher education and developing the interpersonal and team skills appreciated by employers (Bradshaw, 1989). Moreover, a well-balanced team, which works well together, should experience an enhanced learning opportunity as the focus is on the task at hand and not on personalities (Smith, et al., 2012).

Since the beginning of the 1950s, it is known that the mix of individual personalities in a group is considered the main performance measure. Benne & Sheats (1948) and Bales (1950) are one of the first documented attempt to design the ideal team categorisation based on the individual's team role. The management development professional in the 1990s (Partington & Harris, 1999) has built up a considerable momentum for the Belbin scheme (Belbin, 1981) (Belbin, 1993).

As with most role theories, Belbin's model focus in the ways in which the roles develop, change and interact with other patterns of behaviour over time, rather than with the collective team behaviour (Smith, et al., 2012). Belbin hypothesis was proposed after nine years of observations of the behaviour of managers during training courses (Lawrence, 1974) and stated that team balance was more important for success than combined intellect, focusing on the emergence of informal, functional roles during training exercises. Belbin's eight role model was introduced in 1981 (Belbin, 1981) but some roles were renamed and a new one added 1993 (Belbin, 1993).

Table 5 - Belbin's role (Belbin, 1993)

Team role	Descriptors	Strengths	Allowed weaknesses
Completer-Finisher (CF)	Anxious, conscientious, introvert, self-controlled, self-disciplined, submissive and worrisome.	Painstaking, conscientious, searches out errors and omissions, delivers on time.	Inclined to worry unduly. Reluctant to delegate.
Implementer (IMP)	Conservative, controlled, disciplined, efficient, inflexible, methodical, sincere, stable and systematic.	Disciplined, reliable, conservative and efficient, turns ideas into practical actions.	Somewhat inflexible. Slow to respond to new possibilities.

Team Worker (TW)	Extrovert, likeable, loyal, stable, submissive, supportive, unassertive, and uncompetitive.	Co-operative, mild, perceptive and diplomatic, listens, builds, averts friction, calms the waters.	Indecisive in crunch situations.
Specialist (SP)	Expert, defendant, not interested in others, serious, self-disciplined, efficient.	Single-minded, self-starting, dedicated; provides knowledge and skills in rare supply.	Contributes on a narrow front only. Dwells on technicalities.
Monitor Evaluator (ME)	Dependable, fair-minded, introvert, low drive, open to change, serious, stable and unambitious.	Sober, strategic and discerning, sees all options, judges accurately.	Lacks drive and ability to inspire others.
Co-ordinator (CO)	Dominant, trusting, extrovert, mature, positive, self-controlled, self-disciplined and stable.	Mature, confident, a good chairperson, clarifies goals, promotes decision making, delegates well.	Can be seen as manipulative. Offloads personal work.
Plant (PL)	Dominant, imaginative, introvert, original, radical-minded, trustful and uninhibited.	Creative, unorthodox, solves difficult problems.	Too preoccupied to communicate effectively.
Shaper (SH)	Abrasive, anxious, arrogant, competitive, dominant, edgy, emotional, extrovert, impatient, impulsive, outgoing and self-confident.	Challenging, dynamic, thrives on pressure, has drive and courage to overcome obstacles.	Prone to provocation. Offends people's feelings.
Resource Investigator (RI)	Diplomatic, dominant, enthusiastic, extrovert, flexible, inquisitive, optimistic, persuasive, positive, relaxed, social and stable.	Extrovert, communicative, explores opportunities, develops contacts.	Over-optimistic. Loses interest after initial enthusiasm.

Belbin team role analysis was introduced with the aim of encouraging greater reflection on general group work skills and to promote a greater understanding of individual strengths and weaknesses (Smith, et al., 2012). By using the latest version of the Belbin self-perception index an individual is able to rapidly determine its own natural team role preference. The user must distribute 10 points between 10 10 statements according to the strength in which they felt the statement reflected their own behaviour. This was repeated for seven categories of statements. For each student, this generated a score between 0 and 100 for each team role presented in Table 5.

With the objective of validating the Belbin efficacy, Aritzeta and colleagues (2007) have examined along with 43 empirical studies that have tested theoretical associations between team roles and other cognitive or behavioural traits. Their conclusion states that "definitions of team roles are valid and that independently of the instrument used to measure team roles, results are consistent with other theoretical models". In addition, researchers, since 1995 have agreed that Belbin's scheme is widespread in organisations including government bodies, FTSE-100 companies and multinational agencies, render it a useful tool for managers (Parkinson, 1995) (Aritzeta, et al., 2007).

This research study also focuses on understanding how individuals' team roles may affect their strategy towards tackling learning activities. Team roles are likely to affect the planning of learning journeys as well as affect the way individuals follow a learning process, from covering content and using learning management systems, to communicating their learning needs and presenting their reflections.

3. The Impact of Educational Technology on Learning

The previous chapter (*2. Literature Review*) has covered four main topics: i) the various options students and academics have to communicate between themselves on a modern scenario; ii) the advantages and disadvantages of different assessment; iii) how to measure the quality of feedback being provided on different activities; iv) how different learners will have different preferences on the type of educational material they are more comfortable using.

There is no doubt that Information Technology offers great potential to assist with each of these four topics mentioned, especially in Higher Education. Having said that, there will be constraints depending on how the environment is framed, for example: i) learners may be unfamiliar with learning in unstructured, nonlinear ways; ii) students and staff may not feel comfortable developing their understanding through co-constructed knowledge within the social reality that they are part of (Felix, 2002); iii) they may also struggle to participate in shared practice through interaction and collaboration; iv) lastly, they may not want to participate in the kind of adaptive learning required to make use of technology and tools (vom Brocke, et al., 2009). All these factors justify why collaboration tasks aided by technology does not necessarily produce results (Kreijns, et al., 2003).

Previous sections of the report have mentioned examples of how different technologies assist different learning activities, as well as its benefits and drawbacks. This section will be providing more in-depth analysis of three supportive tools: i) Optical Head-Mounted displays, ii) Social Learning Networks, iii) and Student Monitoring Tools.

3.1 Using Wearable Computing to Enhance Learning

Students and teachers are not at the stage of being cyborgs, but wearable computing market is growing, the number and types of devices are also increasing, so it's its use on education scenarios. Wearable devices allow students to be always connected allowing quicker interaction with the tutors. Furthermore, virtual and augment reality has proven to be excellent facilitator for students to learn in new ways. In order to understand the benefits of such technology better, this chapter takes a few steps back on the wearable computing history, current devices available in the market and the technology behind it.

It is within the scope of this research study to consider how certain wearable devices can be used for enhancing learners' experience. A significant portion of the work presented in the following chapters is associated with the use of augmented reality in education that requires the use of wearable computing devices such as Google Glass.

Glaros and Fotiadis (Glaros & I. Fotiadis, 2005) have defined wearable as a device that can either be supported on the human body directly or via a piece of clothing. Either way, the device must be comfortable, have minimal size and weight, and have appropriated functional and power autonomy to the task that is going to be allocated for. All these characteristics will make the devices suitable for being used during a prolonged period as a wearable accessory. The author also states that the main objective of wearable input/output devices is to: “facilitate human-computer interaction with minimal hindering of other activities”.

There are records of the use of Wearable Computer Systems, as we know today, since early 1990s. There has been a range of form factors examined for wearable computers (Gemperle, et al., 1998). Wearable Learning and Supporting systems have already been implemented in industry and it does a good job supporting learning, training and operation of maintenance activity. The point that needs to be improved in such devices is the context information service, being able to have access to service, resource information process, and adaptive strategies that are directly related to the task or training being performed at that point in time (Xiahou, et al., 2006).

Contemporary workplaces training programs has been widely investigated and researched in order to improve it for today’s requirements. “A more complete performance technology that not only supports training but other variables as well that affect the improvement of works, their work, and their workplace” (Xiahou, et al., 2006). Najjar and colleagues (Najjar, et al., 1999) also shares a similar view on the problem: the manufacturing systems are becoming more and more sophisticated while the company investing less on training and/or support for the engineers to keep it running. The effect of these trends is to reduce workers specialization and to produce a growing need for workers who can adapt quickly to a variety of situations that use a wide range of skills.

Pilots projects using the wearable computer and handheld devices with the more advanced approach to documentation has been running in different sectors. In 2001, NASA has published a paper detailing the process they have completed developing a wearable, wireless, voice-activated computer using many off-the-shelf components (Pfarr, et al., 2001). The final device was used in a “wide range of crosscutting space application that has benefited from having instant internet, network and computer access with complete mobility and hands-free operations”. These applications are not limited to ground-based research such as spacecraft application, integration, and testing, but also to astronauts in orbit so they can control and monitor different a range of experiments. Astronauts’ performance is considerably increased by being able to have the hands free to perform a specific task at the same time they are wearing a small and light computer to reference procedures and manuals (Pfarr, et al., 2001).

A typical wearable device is basically built around a Central Processing Unit (CPU), some quantity of Random-Access Memory (RAM), and usually some data storage. The new market standard is also requiring some degree of physiological monitoring, which may be combined with the use of microelectronics, and a degree of intelligence and telemedicine functions through sensors. In summary, like any computer, a typical device will have a data input mechanism, a processing unit and an output mechanism (Glaros & I. Fotiadis, 2005). Standard output devices are very similar, structure wise, to the ones used in bigger devices: liquid crystal display (LCD), projectors, monitors embedded in glass frames, and speakers.

The Head Mounted Display (HMD) was the predominant option in 1997, including the Eye Glass, which was made commercially available 10 years ago, in 2005 (Glaros & I. Fotiadis, 2005). Thomas (Thomas, 2012) analysed the technology available in 2012 and compared to the original researches from the *IEEE International Symposium on Wearable Computers in 1997*. Its researches' goals were to analyse if the goals set in the 1997 symposium has been achieved, and how the direction of research has changed in the past fifteen years.

In later sections the use of Optical Head Mounted Displays (OHMD) is discussed as an optimum solution for supporting learning activities in the least intrusive and obstructive way. This research study has extensively examined the use of such devices in learning and in particular the provision of feedback.

3.1.1 Considering Selection Criteria for Best Educational Support

Wearable devices research continues stronger than ever. This chapter investigates the most popular wearable devices on the following categories: Augmented reality (AR), Optical head-mounted display (OHMD), Wearable technology, and Wearable computer. Furthermore, it compares its functionalities, analysing the advantages and disadvantages of each one, and conclude by deciding which device would be more suitable for an educational scenario.

Oculus Rift

Founded by Palmer Luckey, Brendan Iribe, Michael Antonov, Nate Mitchell, and Jack McCauley in 2012, the American start-up Oculus VR has demonstrated its optical head-mounted display (OHMD) Oculus Rift on 1st August in the same year. It was bought by Facebook in 2014 and the first device released in March 2016 (Gleasure & Feller, 2016). Although it was primarily developed for games (Oculus, 2014), the device has been used inf a few other applications: i) **media**: by making deals with film companies 360° 3D videos movies was produced for Rift (Clark, 2015); ii) **social**: in 2013 Second Life founder left the business to create a new virtual world designed for Rift called Hight Fidelity (Robertson, 2014). Two years later, the company behind Second Life company (Linden Lab) itself started investing in a different virtual world for reality headsets (Bernadette, 2015). iii) **casinos**: some users are able to play slots and experience a virtual casino lobby through a computer using VR headset (Daily, 2016). iv) **education**: The Oculus rift is increasingly used in universities and schools as an educational tool (Moro, et al., 2017). The main fields covered are marketing, architecture, computer science, paramedics and health science in general (Kuehn, 2018).

Samsung Gear VR

Samsung Eletronics, in partnership with Oculus, has officially launched the Gear VR in 3rd September 2014 (Samsung, 2014). Opposite to the competitors, the Gear VR does not come with its own screen. The user must have one of the compatible smartphones to attach the front of the device (Samsung, 2014). By not having the screen and processor power limited to the head device the Samsung managed to get the highest resolution and frames per second without losing too much on the viewing optics angle.

VR for G3

VR for G3 has been released to consumers in Korea in April 2015 (LG, 2015). The headset will be free for every customer that buys the LG smartphone G3. The availability to sell separately or not has not been fixed yet. Similar to the Samsung Gear above, the design of

VR for G3 is based on the blueprint for Google Cardboard. The neodymium ring magnet on the side of the VR for G3 works with the magnetic gyroscope sensor in the G3 to select applications and scroll through menus without touching the display. VR for G3 requires no assembly other than inserting the phone in the viewer.

Sony SmartEyeGlass

Sony has released the essential tools to allow developers to start coding applications for its Google Glass rival, the SmartEyeGlass. The software for creating apps was released in September 2014, and the Japanese company hopes to have hardware available by March 2015. SmartEyeGlass includes an array of features, including a gyroscope, accelerometer, ambient light sensor and built in camera. However, the monochrome screen is likely to put off consumers, if Sony chooses to release it beyond the business world (Sony, 2018).

Microsoft HoloLens

Part Google Glass, part Oculus Rift, part helmet from RoboCop, Microsoft HoloLens is "the future of computing", according to Microsoft. The HoloLens headset is a computer itself, with its own CPU and GPU on board. Microsoft has demoed its vision of a Holographic future, with videos depicting a range of experiences; from work-based tasks to gaming (LAMKIN, 2015). Not a lot of technical information has been released yet. The product is expected to be launched at the end of 2015, at same time as the new Windows Operating System. “Holographic experiences with Microsoft HoloLens are different from existing experiences, such as virtual reality (VR). With VR, the user is completely immersed in a computer-generated reality, or virtual world” (Microsoft, 2018).

Meta Pro

With a view its makers claim is 15x the screen area of Google Glass, Meta Pro is built with cutting-edge technology. There is the dual 820p ZEISS displays and 3D surround sound audio, supported by an Intel Core i5-based computer with 128GB SSD. It is clear how much more powerful this device is compared to its competitor, though its price tag is likely to limit appeal to all but the most determined clients. Each pair of glass is being sold for $3,650, since its release in June 2014 (Meta, 2018).

ODG R-7 Smart Glasses

Focusing more on enterprises and Governments, ODG's self-contained, Android running, smart glasses includes 3D stereoscopic see-through HD display and stereo sound. Included on the same prince range of the Meta Pro, R-7 is available for £2,100 (ODG Store, 2018).

Google Glass

Being the lightest wearable device on the list (43 grams / 1.5 ounces), Google Glass also displays the second smallest resolutions, although is the equivalent of a 25-inch-high definition screen from eight feet away. Other technical details of the Google Glass includes a 5 MP camera, 16GB storage and 2GB RAM (Google, 2018). One of the main benefits of it is that it can be used as a Bluetooth headset with any Bluetooth compatible phone.

	Cost US$	Dimension W x L x H	Weight	Resolution	Viewing Optics	Sensors	Camera	Interfaces
Oculus Rift DK2	350	33 x 373 x 178 mm	440 g	1920 x 1080	100°	Accelerometer, Gyroscope, Magnetometer	-	HDMI, USB
Samsung Gear VR	899	198 x 116 x 90 mm	555 g	2560×1440	96°	Accelerometer, Gyroscope, Magnetometer, Proximity	-	USB
Sony SmartEyeGlass	-	-	-	419 x 138	20°	Accelerometer, Gyroscope, Electric Compass	3 MP	Proprietary
Google Glass	1500	133 x 203 mm	43 g	640×360	-	Accelerometer, Gyroscope, Magnetometer, Proximity	5 MP	USB
Microsoft HoloLens	450-900	-	-	1920 x 1080	-	Accelerometer, Gyroscope, 3D Scanner	-	-
LG VR for G3	490	133 x 90 x 80 mm	-	1440 x 2560	-	Accelerometer, Gyroscope, Proximity, Compass	13 MP	USB
Meta Pro	3650	-	179 g	1280x720	40°	Accelerometer, Gyroscope, Proximity, Compass, 3D Scanner	-	HDMI, USB
ODG R-7 Smart Glasses	2700	152 x 183 mm	127 g	1280x720	50°	Accelerometer, Gyroscope, Magnetometer, Altitude sensor, Humidity sensor	720p	USB

Table 6 - Technology Comparison Table

3.1.2 Choosing the Ideal Device

This research study aims to create a solution that can be widely implemented and replicated. For this reason, it is important to choose a device that is both technologically feasible as well as being easily accessible. To analyse popularity, the author has compared the amount of interest over time from the three most secure technology (Google Trends, 2015):

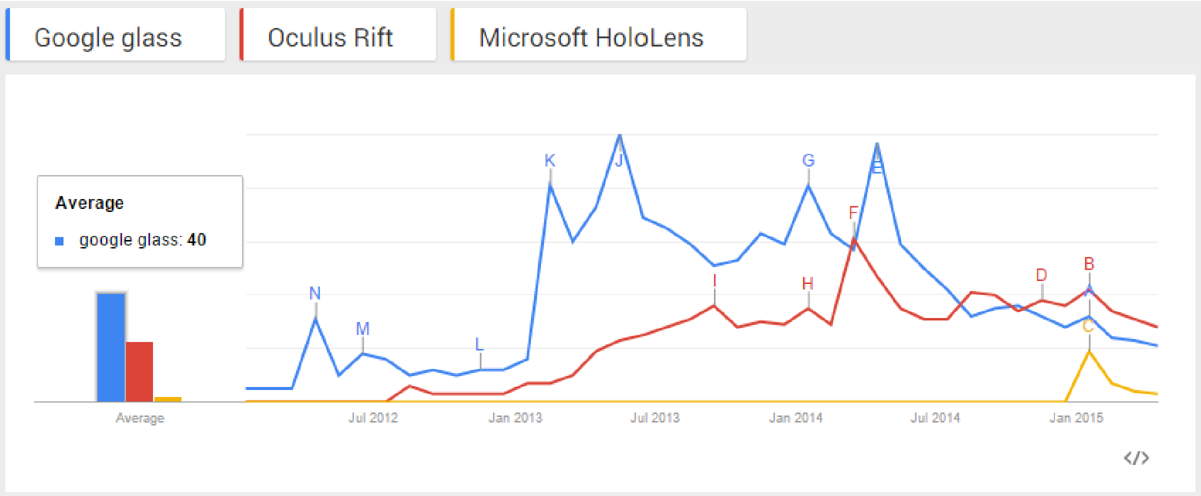


Table 7 - Google Trends

Microsoft technology was announced in January, in the same month as Mozilla's enhanced Oculus Rift support in its browser (O'Connor, 2015). The steep disinterest in Google Glass in the first month of 2015 was due to a miscommunication among the media. A considerable amount of media was announcing that the Google Glass project has been discontinued (Yahoo!-ABC News Network, 2015). In 2015 Google publicised that the device was officially "graduating" from Google[x] to be an official Google product and it would be re-launched (Wray, 2015). Two years later the Google Glass Enterprise Edition was officially deployed in business partners such as Boeing, GE, and DHL (Savov, 2017).

Although Oculus Rift was more popular than Google Glass (42 against 32), its peak was evaluated at 61 points, 39 points behind Google's device peak. In additional, Oculus Rift is originally designed to be attached to a computer to be able to perform its task. The scenario evaluated on this report demands a device that is more flexible and portable.

Lastly, there has been plenty of well-funded projects involving Google Glass technology. Augmedix raises $16 million to make Google Glass a must-have for doctors (Abbruzzese, 2015). Yves Saint Laurent has been using the technology to help make-up artist during their daily jobs (March, 2014). One of Europe's busiest airports, Amsterdam's Schiphol hub in the Netherlands, is trialling Google Glass for use by airport authority officers as a hands-free way to lookup gate and airplane information (Lomas, 2014).

3.1.3 Identifying OHMD Features with Significant Impact on Education/Learning

This section lists and discusses what features are the most implemented on wearable devices for different scenarios. The main objective of wearable input/output devices is to facilitate human-computer interaction with minimal hindering of other activities (Glaros & I. Fotiadis, 2005).

There are few different ways on how the device can be worn. One option would be to attach or embed electronic systems into conventional clothing and clothing accessories. Another option includes merging textile and electronic technologies during fabric production (e-broidery) to produce electronic textiles (e-textiles). Finally, it is noticeable that devices with sensors have been also embedded and integrated into fashion accessories, such as jewellery, gloves, belts, eyeglasses and wristwatches in a number of applications (Orth, et al., 2000).

E-textiles has been mostly used for medical monitoring as it allows the patient to wear multiple sensors at once and still keep the portability (Van Laerhoven, et al., 2002). There is another prototype application with internet capability that is plugged directly on a runner's shoes, with the objective to connect different runners that are poles apart. Devices that track the body responses are being used even during the sleep. A smart house can automatically monitor the user's body heating and adjust the room temperature accordingly (Mann, 1997).

Based on all the scenarios explained above is possible to collect a list of the most useful features as well as what type of content the wearable should be able to display. Najjar (Najjar, et al., 1999) has created the following requirements for its project:

- Explanations, examples with consequences
- Definitions, illustrations, descriptions
- Cross-reference, similar activity description
- Demonstration, checklist, procedure description, flowchart
- Explanation of events, log of activity
- Demonstration
- Interactive training/tutoring, practice activities, assessment
- Interactive advisor, job aids
- Monitoring systems, feedback on success
- Assessment, encouragement
- Descriptions of what you have done, summary of assessment
- Explanations, diagrams, demonstrations
- Comparative explanations, similar examples, case histories
- Predict outcomes, simulation
- Boolean search, index
- Logbook, notes

The same source took a similar approach to this report and has also discussed the type of data to be transmitted. This includes textual information, such as online operating procedures, product information, specifications, reference manuals, up-to-the-minute-changes, glossaries, policies, messages/notifications, and a list of where to go for additional help. Furthermore, allowing the user to collaborate with another person wherever the user goes, enter data or retrieve information were mentioned. The software created by them supports integrated multimedia information, tools, databases and methodologies. Pfarr (Pfarr, et al., 2001) has mentioned a significant requirement to be implemented: the ability to live stream the problem from the expert point of view for whoever is relevant.

Although Xiahou (Xiahou, et al., 2006) has focused more on the hardware point of view, it is interesting to state that the University of Electronic and Science Technology of China have also worked on a hardware and software to support a wearable computing environment. Another project with a similar approach was the device created for WLSS to support the workers who are responsible to test devices and communication networks in complex and costly systems.

Some of the points are not relevant for the scenarios where the wearable devices will be tested. Other features, although relevant and useful, will not be incorporated due to the short period to have the application developed, implemented and tested.

The devices success cannot be measured based only on its features. It is also important to make sure that the device is comfort, small, and highly adjustable so it can provide functionality in a natural and unobtrusive manner, allowing the user to dedicate all of his or her attention to the task at hand (Xiahou, et al., 2006). Two lessons learned by Najjar (Najjar, et al., 1999) that will be taken into consideration on this project is: first, make sure that the background noise will not reduce the speech recognition accuracy. Secondly, Measure how long all the setup time takes for each new user. Having the process as less hassle-free as possible is interesting from the user experience point of view.

Some of the wearable devices’ advantages compared to the traditional computer has already been mentioned in the chapter above. In additional is important to discuss the interaction between the user and the system. Keyboard, mouse, joystick and monitor requires some physical relationship, which can considerably reduce the efficiency of a support system.

3.2 Social Learning Network

Section 2.2.3 Social Media already highlighted the importance of using such technologies to allow students to generate its own content in a familiar scenario, as well as being able to reach and collaborate with communities worldwide. This section goes more in-depth on the different types of social media available, what their role are in education scenarios, and its impact.

3.2.1 Discussing different social media

The work completed by Attwell (2007) for a European Project investigating the use of "Information and Communication Technology in Small and Medium Enterprises in Europe" found little practice of formal e-Learning but extensive use of technology for informal learning through social networks.

Although many platforms fit under the social media category, they are very diverse. For example, Twitter and Tumblr are more focused on rapid communication and part of the sub-category named microblogs. Other are focused on community and has most of its content generated by users. Facebook is highly focused on exchanges between friends and family and are constantly pushing interaction through features like photo or status sharing and social games (Statista, 2019).

Common characteristics can be found in the leading social networks, such as being available in multiple languages and enabling users to connect with friends or people across geographical, political or economic borders. It is estimated that 2 billion internet users worldwide are using social networks. Numbers on developing countries are still likely to increase as mobile device usage and mobile social networks increasingly gain traction. Figure 9 below, provides information on the most popular networks worldwide as of January 2019, ranked by number of active accounts (Statista, 2019).

This research study provides guidelines on how to support learning activities that use social media as a communication and collaboration platform. It is critical to have a list of criteria assisting academics to select the most appropriate platform for deploying certain learning activities.

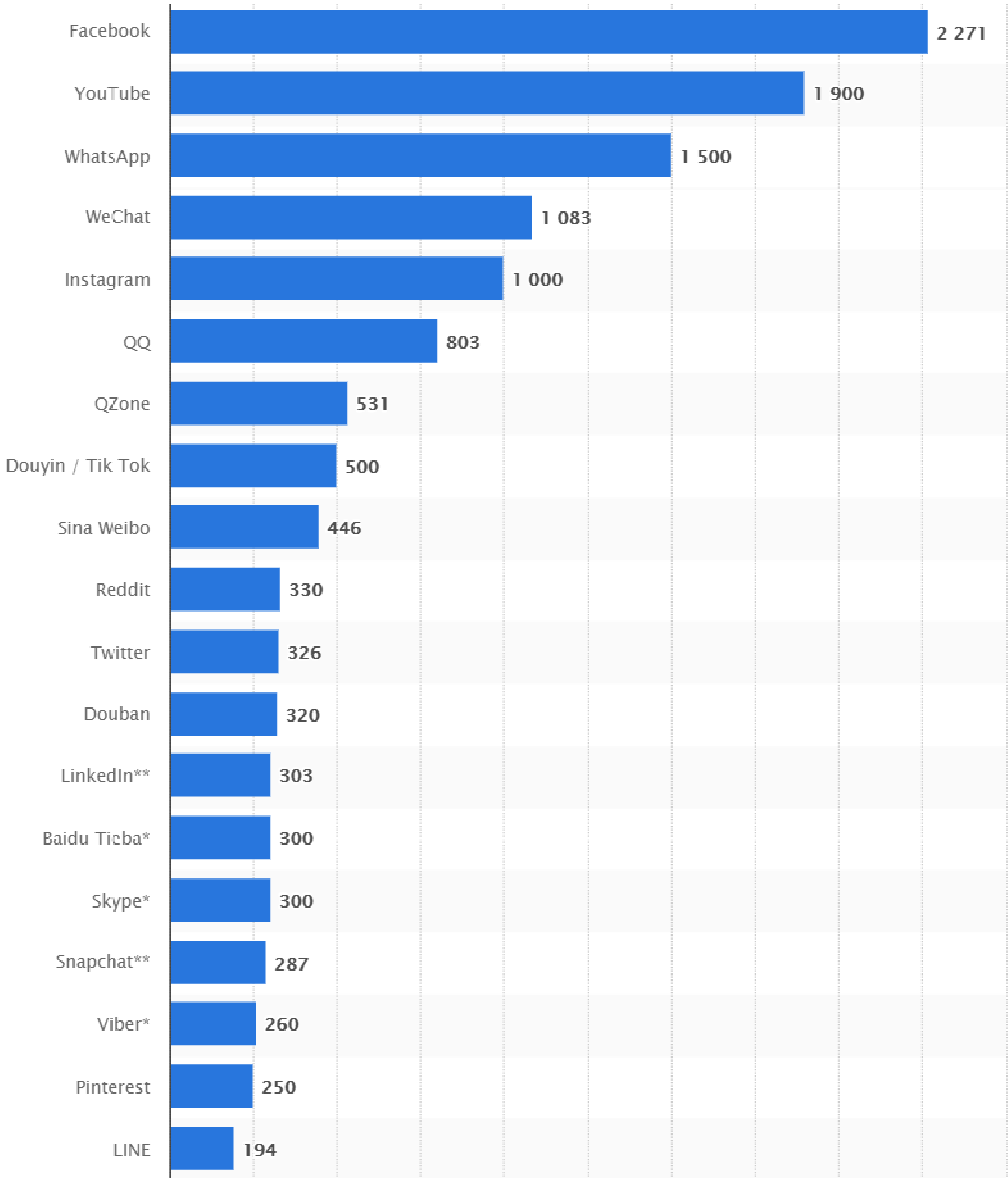


Figure 9 Number of active users in millions worldwide (Statista, 2019)

**Platforms have not published updated user figures in the past 12 months, figures may be out of date and less reliable*
***These platforms do not publish MAU data, user figures from third-party reports*

Market leader Facebook was the first social network to surpass 1 billion registered accounts (Statista, 2019) and currently sits at 2.27 billion monthly active users. Sixth-ranked photo-sharing app Instagram had 1 billion monthly active accounts.

Most social networks with more than 100 million users originated in the United States, but European services like VK or Chinese social networks Qzone and Renren have also garnered mainstream appeal in their areas due to local context and content (Statista, 2019).

Within countries, too, digital divides persist. Age, education, income and in some cases gender still differentiate who uses the internet and who does not, who is active on social media and who is inactive (POUSHTER, et al., 2018).

3.2.1.1 Regions

As countries with advanced economies reaches to internet reaches its upper limits the digital divide continues to narrow between wealthy and developing countries. Social media is popular among many internet users. Usage rates are high in many of the advanced economies surveyed. This includes two-thirds or more of *all* adults in the U.S., Australia, South Korea, Canada, Israel and Sweden (POUSHTER, et al., 2018).

According to Pushter and colleagues (2018) Emerging and developing countries rates of social media access is not far behind either. For example, eight in ten of Jordanian adults are internet users, and 94% of them are active on social media platforms. Similar patterns appear in Philippines, Indonesia, Lebanon and Tunisia. In contrast, in some countries with high rates of internet use, relatively small shares of adults report using social media. In Germany, for instance, where 87% of people use the internet, less than half say they use social media.

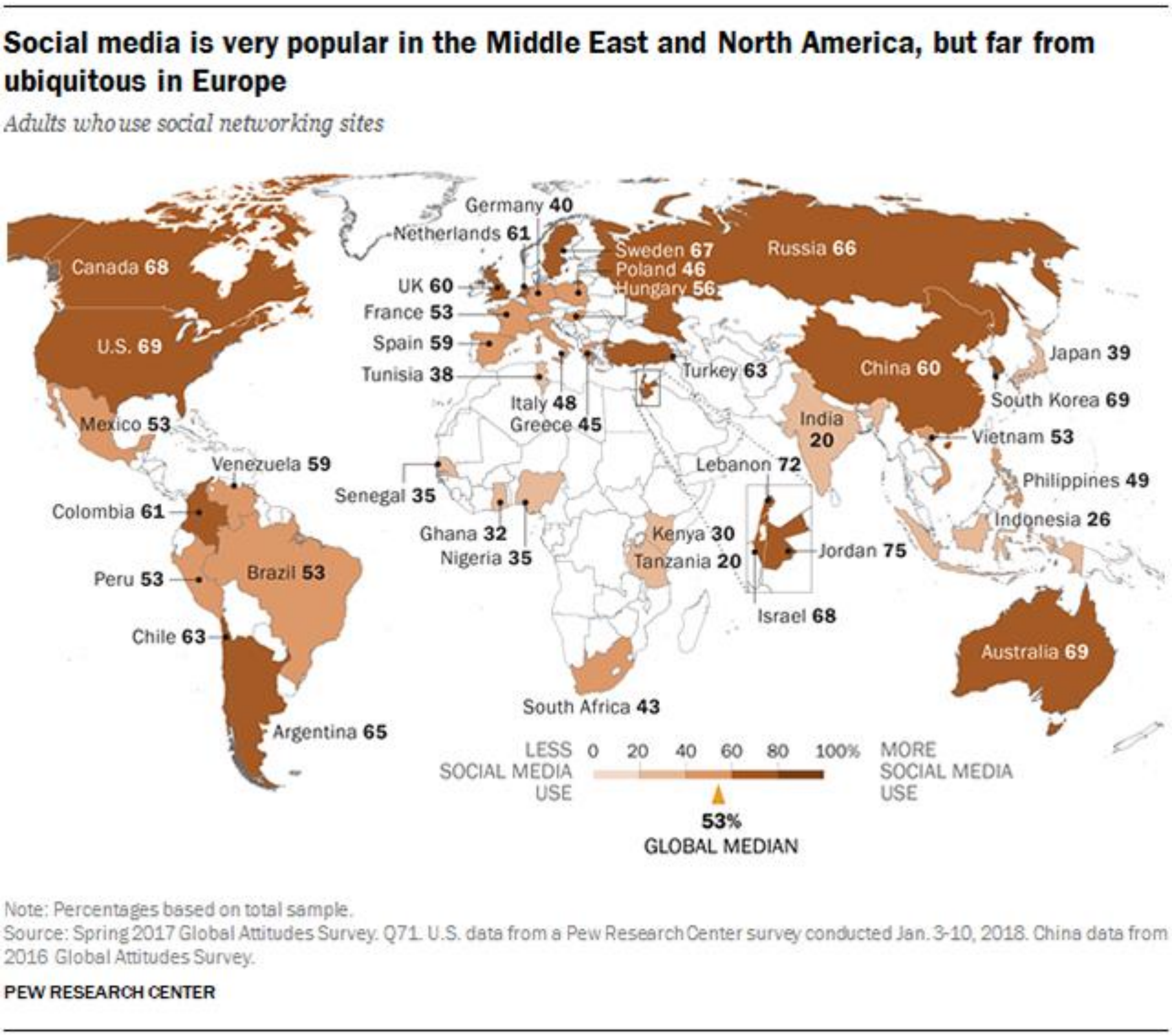


Figure 10 Use of social media per country (POUSHTER, et al., 2018)

3.2.1.2 Age

A Pew Research study from 14 years ago (Lenhart and Madden 2005) was already reporting that over half of the young population in America were using computers for "creative activities, writing and posting of the internet, mixing and constructing multimedia, and developing their own content." Twelve to 17-year olds look to web tools to share what they think and do online. One in five who use the Net said they used other people's images, audio, or text to help make their own creations.

A more recent study conducted in 2018 (Martin, et al.) with 593 students in United States middle school has shown that almost one in every five have started using social media at age nine or younger. At their age group, they indicated that Instagram (27%), SnapChat (25%) and YouTube (25%) were their most used social media sites. Similar pattern is found when comparing between people younger than 36 years old and older than 36. In Philippines, 76% of the younger group are on social media, compared with just only 18% of the population older than 37. This generational divide is prominent in every country surveyed (POUSHTER, et al., 2018).

Divergent ageing patterns might also help explain variations in social media use across certain countries. For example, in Japan and Germany, social networking sites are quite popular among young adults; 82% and 74% of those ages 18 to 36 are on social media, respectively. However, the median age is 47 in both Japan and Germany. There simply aren't many young adults in these countries.

By contrast, like many Arab countries, Lebanon and Jordan are experiencing a "youth bulge": The median age is 31 in Lebanon and 23 in Jordan. The age differences in these countries aren't as drastic as in Germany and Japan – a 34-point gap in Lebanon and 8 points in Jordan – but the large youth population contributes to high social media use.

3.2.1.3 Gender

In some emerging and developing countries, men are much more likely to use social media – in Tunisia, for example, 49% of men use social networking sites, compared with just 28% of women. However, in advanced countries, social networking is often more popular among women. In the U.S., Spain, Sweden and Israel, women are more likely to use social networking sites, even when accounting for internet use. In Sweden, more women are on social media than men (72% to 63%), even though men are more likely to use the internet than women (94% to 90%). There are significant differences in social media use across other demographic groups. Those with higher levels of education and those with higher incomes are more likely to use social network sites (POUSHTER, et al., 2018).

Gender divide on social media use tilts toward men in developing economies, women in advanced economies

Adults who use social networking sites

	Men %	Women %	Diff
Tunisia	49	28	**+21**
Ghana	42	22	**+20**
India	28	11	**+17**
Kenya	38	22	**+16**
Senegal	43	28	**+15**
Nigeria	41	28	**+13**
Tanzania	27	14	**+13**
Turkey	68	57	**+11**
Japan	44	35	**+9**
Australia	66	72	**-6**
Poland	42	50	**-8**
U.S.	65	73	**-8**
Spain	54	63	**-9**
Sweden	63	72	**-9**
Israel	64	73	**-9**
Lebanon	67	76	**-9**

Note: Based on total sample. All differences statistically significant.
Source: Spring 2017 Global Attitudes Survey. Q71. U.S. data from a Pew Research Center survey conducted Jan. 3-10, 2018.

PEW RESEARCH CENTER

Figure 11 Percentage of men and women who uses social media (POUSHTER, et al., 2018)

Due to a constant presence in the lives of their users, social networks have a decidedly strong social impact. The blurring between offline and virtual life as well as the concept of digital identity and online social interactions are some of the aspects that have emerged in recent discussions (Statista, 2019).

Cormier (2008) states that the present speed of information based on new technologies has undermined such processes. The explosion of freely available sources of information has helped drive rapid expansion in the accessibility of the canon and in the range of knowledge available to learners. We are being forced to re-examine what constitutes knowledge and are moving from expert developed and sanctioned knowledge to collaborative forms of knowledge construction. Social networking tools, blogs, and wikis are facilitating such processes. Social learning practices are leading to new forms of knowledge discovery.

3.2.2 Determining the role of social media in education

Learning communities are one important way by which students in universities can learn together with experts and lecturers rather than from themselves. Knowledge construction and competence development through active participation is in the foreground rather than knowledge acquisition and reproduction. Complementing this is the potential of web 2.0 technologies for learning communities. Emerging practices show more and more that online networks supported by social media can sustain powerful learning communities (Wenger, et al., 2010).

For the last few years, many of the tools, applications, systems, and websites developed are somehow oriented towards building and visualizing relationships, particularly social networking for finding and explicitly stating relationships with other people (Wenger, et al., 2010).

Certain Social Media features used in academic (both staff and students) in order to investigate a topic further are: (i) hashtag - where a content is tagged with specific keyword(s) so they are easily found; (ii) following - option to follow certain profiles so its content is displayed in a timeline manner (iii) joining groups on specific subjects where different discussions and content is shared. By using one or more of these options, the user can collect different point of views on the same topic in a centralised manner. Furthermore, many of the contributors are available for one to one interaction, allowing the research to have a more in-depth discussion, have questions answered, or even work on a potential academic partnership.

3.2.3 Explaining the impact of a Social Learning Network

Porter and Lawler (1968), as discussed in the 2.1.3 Social Media chapter, improved the original goal-based theory called VIE by adding further constructs and feed-back loops in their analysis. The previous section of this current chapter has covered the different social media available and its role in education. In order to correlate the theory to the practice Middlesex University students were requested to provide answers to their assignment by using Facebook, LinkedIn, and Twitter.

The result of relating such tasks with the updated VIE theory is as following: first, the students need to understand the importance of such knowledge for their careers (1). Furthermore, they need to have an expectation that such activity will increase their practical skills (2). A dedication of at least one hour a week should be completed by the student (3). The result (6) of their work depends on the individual capacities (4) and the clear understanding of its own contribution to the group (5). Depending on the students view of their own work, the grades received (8) he/she would then make a self-reflection to define how fair the results were (7) to then define the satisfaction degree in the end (9).

The adoption of Web 2.0 and social software and the development of personal learning environments facilitate new pedagogic approaches to teaching and learning and, through formative assessment based on authentic learning tasks, the embedding of assessment within the teaching, learning, and research process. This, in turn, provides a new approach to quality for universities (Attwell, 2010).

This research study focuses on investigating how certain social networks can be used as social learning networks and can offer academics an opportunity to use them for learning delivery, as well as assessment. The study does not attempt to provide a definitive answer about the platform that is most effective but facilitate academics in reflecting on those learning activities that can be better supported by social networks. The research study also considers how each platform can be an effective learning support tool for academics.

3.3 Assessing student behaviour

Different pedagogical frameworks and the importance of e-portfolios was covered on section 2 of this report. Furthermore, the section 2.1 Communication explained in detail the theory behind different online systems structure available to support Computer-mediated communication in education using Virtual Learning Environment systems. Based on the literature review, this section explains how Middlesex University uses the technology to better support the continuous assessment learning and teaching practice in the Computer Science Department of the Faculty of Science and Technology.

3.3.1 Continuous Assessment

Continuous Assessment, also known as Frequent Assessment, refers to the use of one or several assessments during the course period, instead of a single final exam in the last weeks of the semester (Rezaei, 2015). Different authors have observed different benefits of such approach. Rezaei (2015) has reported that it is beneficial for student learning. Holmes (2015) stated that it improves the student engagement. Continuous Assessment can also be used to improve feedback to students (de Kleijn, et al., 2013) and teachers (Domenech, et al., 2015). The cognitive principle of reinforcement learning is related to Continuous Assessment (Daw & Frank, 2009) as it can be used as a reward system for desired studying behaviour (Admiraal, et al., 1999).

Two main cognitive benefits were also observed. Firstly, the testing effect (Roediger & Karpicke, 2006), as the name suggests, it means that the more the student repeatedly test the information the more likely they are to retain it. The testing effect also extends to final assessments with new information, denoting a transfer of knowledge (Butler, 2010). The second benefit (spacing effect) states that by studying across the study period students are more likely to retain information rather than last-minute cramming (Kornell, 2009).

Day and colleagues (2018) have examined the relationship of different types of continuous assessment and student characteristics with academic achieves in a group of 94 undergraduate students. The results show that male students performed worse than their female peers in courses without continuous assessment, but in courses using any type of continuous assessment, this gender difference disappeared. Furthermore, intrinsic motivation was a negative predictor of achievement in courses using writing assignments and mandatory homework assignments.

The current assessment framework that exists in the Computer Science Department includes a continuous assessment process that is mostly a way to provide formative feedback to students rather than yet another assessment tool.

3.3.2 Student Observable Behaviours (SOBs)

Student Observable Behaviours (SOBs) is a bespoke tool developed at Middlesex University to support the inverted curriculum approach, where students learn theory whilst they are doing practical exercises (Androutsopoulos, et al., 2018). In addition, the tool "aims of addressing the known limitations of self-paced learning and constructivist approaches" (Benjamin & Tullis, 2011) (Kirschner, et al., 2006).

Although different modules have the flexibility to measure it differently, the assessment of SOBs are more commonly performed every lab section, on a weekly basis. The tasks added to the system can be thought of as fine-grained learning outcomes, or capabilities, such as "Discussion of how the secondary data will be used" or "Pair to post how they will be using the Kubler-Ross model to manage changes introduced with the deployment of social media". Other than being used as an activity tracker, the SOBs system also keeps track of students' attendance, for each lab and lecture section.

The SOB tool provides not only a platform for managing students' portfolios, but it also has the benefit of generating several reports for both the students and the staff. Students can use these reports to measure their performance to date against what is expected and against the rest of the cohort. According to the Middlesex University staff members, the experience so far is that this real-time reporting is an excellent motivational tool, maximising performance through competition within the cohort (Clark, n.d.).

This research study also focuses on how continuous assessment can be supported by educational technologies and offer effective tools for academics to monitor student performance and progress. The study focuses both on individual and group learning scenarios, and how observing student behaviours can improve overall progression, as well as offer further support to learners. The next chapter describes the core of this research study that includes a number of pilot studies examining the areas that were presented in the above sections.

4. Pilot Studies

This research study was based on investigating different learning aspects that were discussed in previous sections. The driver of the study was to provide a better understanding of how educational technologies could support different learning activities.

The studies involved two undergraduate modules (i) a first-year module covering foundation topics of business information systems and (ii) a third-year module covering strategic management in information systems. The data being analysed by this project was collected in a variety of ways. It can be divided in four different categories: (i) survey results; (ii) media material – pictures/videos; (iii) social media content; (iv) log of activity tracker.

Based on the literature review, five suitable activities have been identified. These are listed as follows: (i) content, (ii) communication, (iii) assessment and (iv) feedback. This classification helps us to understand that most of the learning activities can be classified into these four groupings.

Below you can find:

i) The activities being supported
ii) Detailed description about each experiment
iii) The period and the data collected
iv) A reflection (benefits/drawbacks/impact) on how the aims of this research study have been achieved, based on the associated category associated with each one, the literature review, as well as the feedback volunteered provided by the user (student or academic).
v) And, lastly, guidelines on how to implement each pilot as well as its relationship with the four dimensions of the proposed framework.

4.1 Google Glass: Student Experience

Supporting: (i) content, (iii) assessment, and (iv) feedback.

Description: The first pilot discussed in this chapter focuses on the use of Optical Head Mounted Display (OHMD) in developing a learning portfolio. Emphasis was given on assessing whether the technology used helped learners to gather content needed for their portfolio, with minimum difficulty, while following clear guidelines. The approach can benefit learners in receiving clear steps of what is required to achieve, while facilitates academics in guiding several learners at the same time with reduced effort.

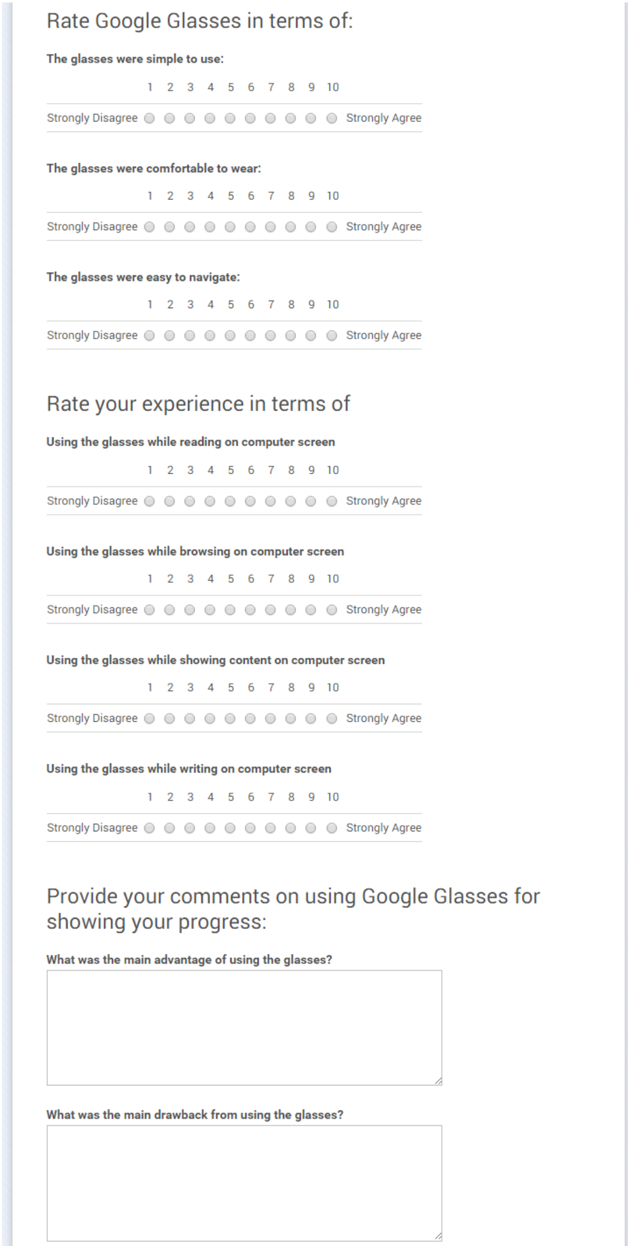
In this experiment, we consider how Google Glass is used by students to describe a range of activities that they have undertaken. The scenario requires a student to use the OHMD Google Glass and perform the following tasks in his/her computer:

1. Use the swiping on the device touchpad to go from one instruction to the next.
2. Go to a specific page and read the content on it.
3. Take a picture of the content read by pressing the camera button.
4. Slide down to go back to the instructions.
5. Go to a specific data entry field and type some content on it.

6. Take a picture of the written content.
7. Slide down to go back to the instructions.
8. Go to one of the sections in the report and take a picture of it.

The entire process is recorded on video and photographs of the participants' facial expressions are taken. The objective of this work was to reflect on users' perceptions of how suitable the technology is for the specific learning purpose.

Once the participants completed the task, they were requested to provide their views regarding their experience. The evaluation was concerned with the simplicity of the technology during the multi-tasking process, the comfort of using the specific OHMD (Google Glass), and the navigability of the software application that was created for the purpose of this study. The participants were also required to rate their experience with respect to the four learning activities as well as provide the main benefits and drawbacks from using the technology:



Rate Google Glasses in terms of:

The glasses were simple to use:

1 2 3 4 5 6 7 8 9 10

Strongly Disagree ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ Strongly Agree

The glasses were comfortable to wear:

1 2 3 4 5 6 7 8 9 10

Strongly Disagree ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ Strongly Agree

The glasses were easy to navigate:

1 2 3 4 5 6 7 8 9 10

Strongly Disagree ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ Strongly Agree

Rate your experience in terms of

Using the glasses while reading on computer screen

1 2 3 4 5 6 7 8 9 10

Strongly Disagree ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ Strongly Agree

Using the glasses while browsing on computer screen

1 2 3 4 5 6 7 8 9 10

Strongly Disagree ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ Strongly Agree

Using the glasses while showing content on computer screen

1 2 3 4 5 6 7 8 9 10

Strongly Disagree ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ Strongly Agree

Using the glasses while writing on computer screen

1 2 3 4 5 6 7 8 9 10

Strongly Disagree ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ Strongly Agree

Provide your comments on using Google Glasses for showing your progress:

What was the main advantage of using the glasses?

What was the main drawback from using the glasses?

Period and data: This experiment has been performed between 2014 and 2019 and includes: (i) Pictures taken with Google Glass; (ii) Pictures from the students; (iii) Video recorded (iv) Feedback survey.

Benefits: By using the Google Glass an extra screen, students can receive instructions in different types of media, such as text, video, or audio. The device also facilitates multitasking as the task details are easily accessible in a glance. Based on the survey results, students have reported that the Google Glass is easy to use and easy to navigate. Lastly, the majority has positively rated their experience of reading, browsing, showing, and writing while wearing the device.

Drawbacks: Although the technology was positively received, it is not being public mass produced anymore. Similar Optical Head Mounted Display (OHMD) are available but without major adoption. One of the reasons is the prohibitive cost in large scale. The other reason, according to the student's feedback, is not being very comfortable as well as being difficult to focus on the screen if the user has any vision difficulties.

Impact of measurement: The student can easily access the instructions provided as it is displayed on the Google Glass device. The experiment also provides a chance for the students to get more familiar with Optical Head Mounted Display technology and how it can be used in different scenarios.

Constraints: A number of constraints were identified as follows. i) although this application is used to assist the student in specific tasks, it may have the opposite effect if the user is not comfortable using the device; ii) pictures taken from the screen to show progress may not be clear enough for the staff to evaluate it.

Application: To run this experiment the following requirements are necessary: i) a Google Glass device; ii) the specific software with the instructions installed; iii) short training to teach the user how to run the application; iv) a power bank if the device will be used for more than thirty minutes; v) a USB cable to transfer the pictures taken from the Google Glass to the computer.

4.2 Google Glass: Presentation Feedback

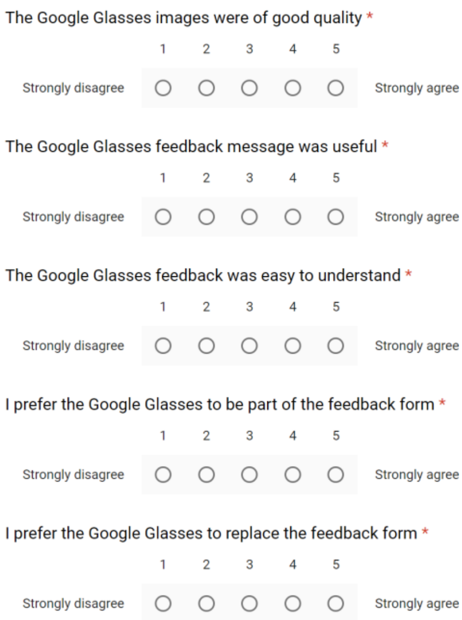
Supporting: (iii) assessment and (iv) feedback.

Description: Quite often presentation feedback is provided in rubrics that are not necessarily effective in explaining what students have done wrong. Furthermore, the use of feedback forms can lead to vague feedback, feedback that is provided with significant delay and difficulty in associating feedback comments with what went wrong. As wearable devices continue to become more ubiquitous and touch some aspect of the learning process, students and teachers are faced with new means to improve the presentation experience.

One of the main capabilities of OHMD is to be able to provide users with a readable, effective interface that can be an information source whilst not distracting their attention from reality. The literature has analysed that OHMD can provide educators, trainers and professionals with the ability to train, assist and support workplace or classroom learning.

With the intention of improving the presentation feedback process, an application was developed for Google Glass. The application allows the user to take a photo and added an specific semi-transparent tag on the top right of the picture. In this scenario, the user was one of the staff members, and he/she was responsible for taking pictures of when a student has a good or bad body language as well as if the presentation slide is good or not. The collected pictures, the video recording of the presentation and the feedback sheet are provided to the students.

Lastly, students were asked to provide feedback on the feedback they have received.



The Google Glasses images were of good quality *

	1	2	3	4	5	
Strongly disagree	○	○	○	○	○	Strongly agree

The Google Glasses feedback message was useful *

	1	2	3	4	5	
Strongly disagree	○	○	○	○	○	Strongly agree

The Google Glasses feedback was easy to understand *

	1	2	3	4	5	
Strongly disagree	○	○	○	○	○	Strongly agree

I prefer the Google Glasses to be part of the feedback form *

	1	2	3	4	5	
Strongly disagree	○	○	○	○	○	Strongly agree

I prefer the Google Glasses to replace the feedback form *

	1	2	3	4	5	
Strongly disagree	○	○	○	○	○	Strongly agree

In order explore the possibilities of this approach in a real-life scenario, the experiment was conducted for five years, involving more than two hundred final year students. The results are encouraging and suggest that as this technology matures and more unobtrusive OHMD models become available, it could provide effective support to improve presentation feedback on a variety of scenarios.

Period and data: This experiment has been performed between 2014 and 2019 and includes: (i) Glass pictures + vignette; (ii) Video recorded from the presentation (iii) Pictures taken from the presentation/students; (iv) Survey answered by students

Benefits: When presented with the images taken by the academic, most of the students have stated that they are of good quality, easy to understand, and useful. They have also agreed that it should be part of the feedback form provided. From the staff point of view, they have found the application easy to use and agree that it provides meaningful feedback to the students.

Drawbacks: Few students have mentioned that they have initially felt intimidated by the academic wearing the Google Glass but were comfortable in the presentation after few minutes. Academics were not as pleased when using it for a long period of time. It was a common complain that the device gets very hot near the head temple. This is regarding the battery overheating with the prolonged and intensive use. Furthermore, users who wore it for longer than a couple of time have also reported light headache related to the light screen just above the eyesight. Lastly, the teachers who were not familiar with the technology were not able to efficiently use it for the early presentations, therefore some initial training is required.

Impact of measurement: Students satisfaction have increased due to the improved feedback method. Student shows great improvement on presentation technique after receiving the Google Glass feedback photos.

Constraints: A number of constraints were identified as follows. i) it is a time-consuming task from the staff. It sometimes distracts the students presenting; ii) Staff needs to be positioned no more than 2 meters away from the presenters otherwise the picture will not be clear; iii) Google Glass battery will not last for more than one hour; iv) if the picture is taken against a bright background (either from a projected screen or external light) the students may not be clearly visible.

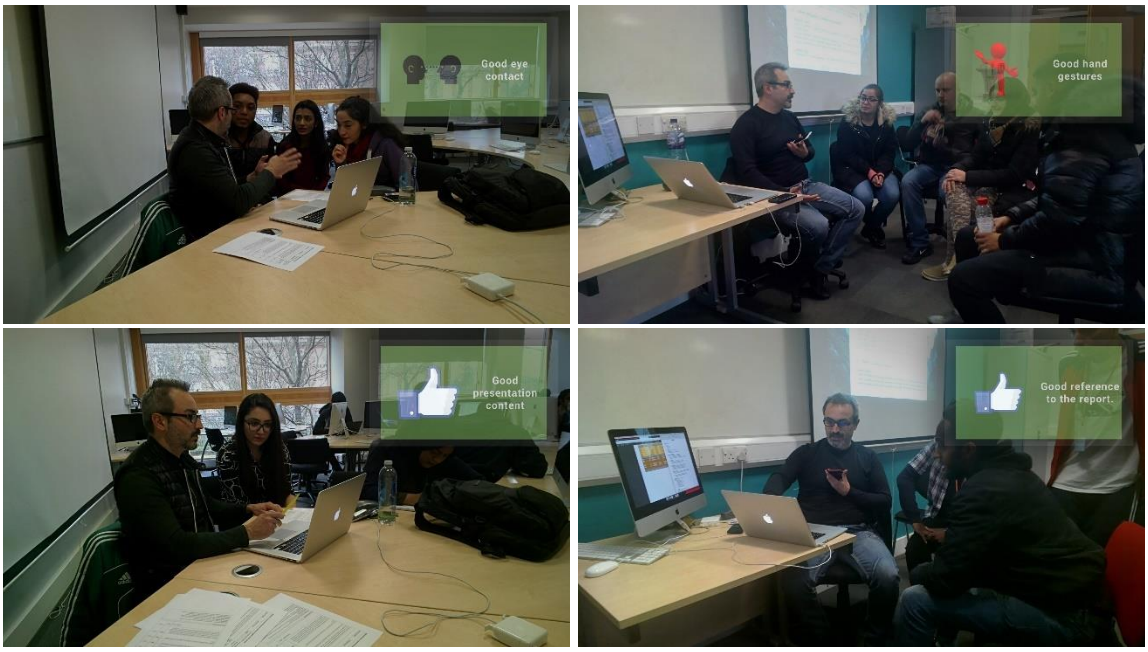
Application: To run this experiment the following requirements are necessary: i) a Google Glass device; ii) the specific feedback software with the feedback images; iii) short training to teach the user how to run the application; iv) a power bank if the device will be used for more than thirty minutes; v) a USB cable to transfer the pictures taken from the Google Glass to the computer.

4.3 Google Glass: Feedback on Feedback

Supporting: (iv) feedback.

Description: Academics tend to be concerned mostly with how to support students when providing feedback, which is a very demanding process that requires the academic to be completely focused on the student(s) receiving feedback. This is a process that may be difficult to reflect upon. The use of augmented reality as a mentoring and peer observation tool can help improving the way feedback is provided in a few ways.

In this experiment, we have analysed the benefits of using Google Glass technology to enhance peer assessment feedback between academics. The scenario consisted of the main academic providing feedback to a group of students based on the formative assignment submitted. Furthermore, another academic is observing the process while documenting key points by taking pictures of it with the Google Glass. The pictures are instantly tagged based in one of the four options available (i) good feedback form; (ii) good eye contact; (iii) good hand gestures; (iv) good presentation content;



The collected material is then handed out to the colleague in order to support the default written feedback form. In conclusion, students are asked to answer a survey saying if they agree with the tagged pictures and the experience they had.

Period and data: This experiment has been performed between 2015 and 2019 and includes: (i) Glass pictures + vignette; (ii) Survey from students about the feedback they've received;

Benefits: Similarly, to the student's opinion on the pilot 4.2 above, the staff being observed agreed that the Google Glass pictures in addition to the form and verbal feedback was a very positive. It facilitates the understanding of the positive and negative aspects during the practice. The staff providing the feedback found the tool not intrusive and easy to use.

Drawbacks: The Google Glass device was reported slow by some of the users. The short delay in between the teacher pressing the camera button and the camera being taken is too long. The user being observed may have already changed its body postures therefore not reflecting the image the trainer tried to capture.

Impact of measurement: staff being observed have reported being clearer of exactly what actions were good and which ones needs to be improved.

Constraints: A number of constraints were identified as follows. i) The delay between the time the observer press the camera button and the picture being taken may negatively affect the experience; ii) if the picture is taken against a bright background (either from a projected screen or external light) the students may not be clearly visible.

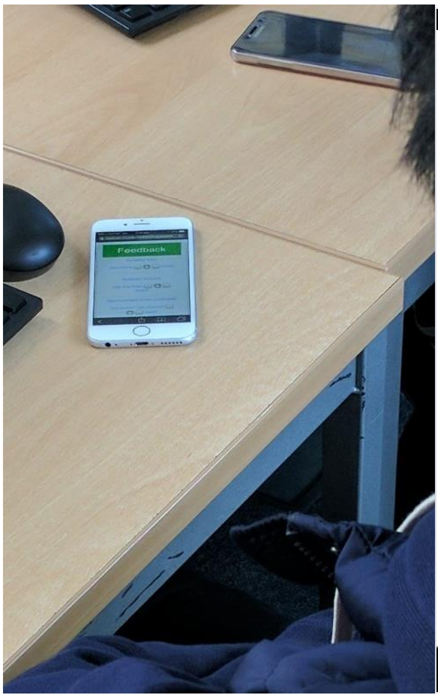
Application: To run this experiment the following requirements are necessary: i) a Google Glass device; ii) the specific feedback software with the feedback images; iii) short training to teach the user how to run the application; iv) a power bank if the device will be used for more than thirty minutes; v) a USB cable to transfer the pictures taken from the Google Glass to the computer.

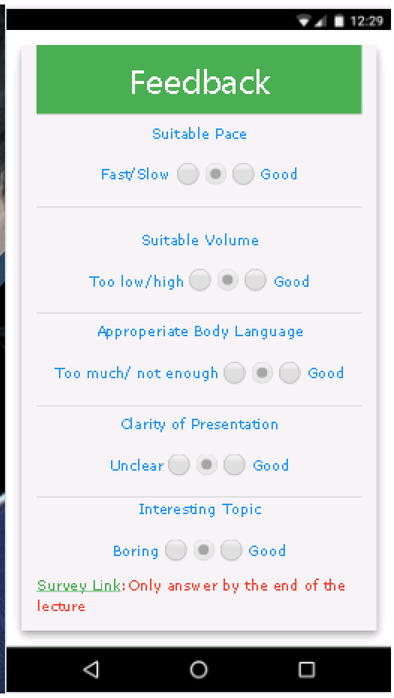
4.4 Google Glass: Voting System

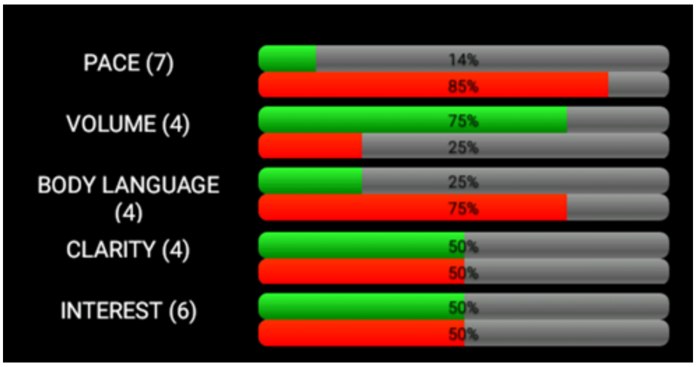
Supporting: (ii) communication.

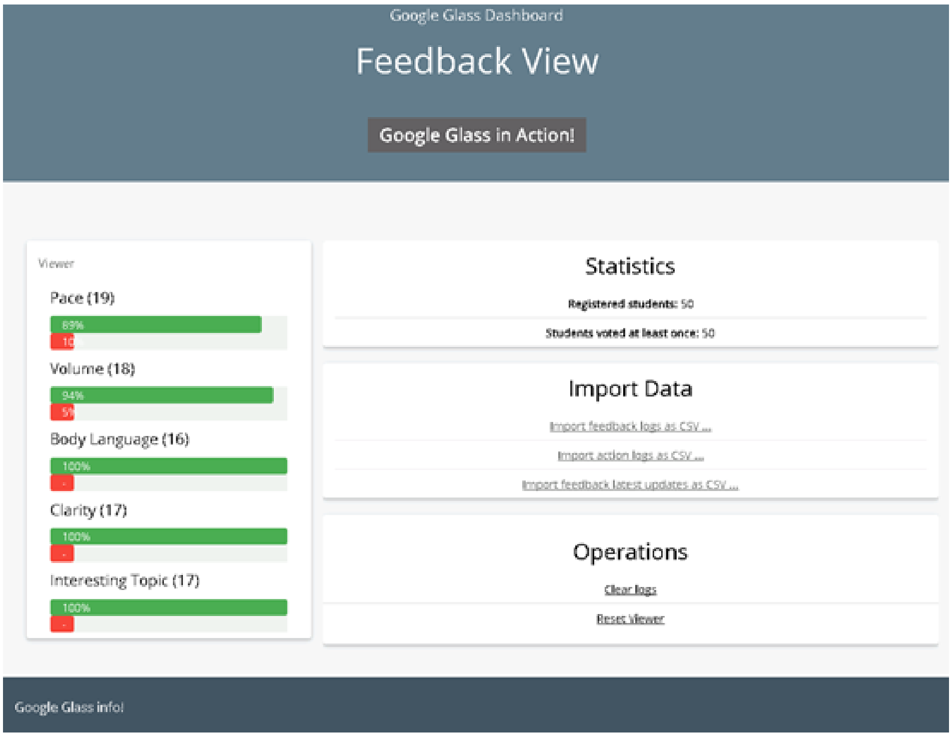
Description Another learning process that can be enhanced with the use of educational technologies is the delivery of lectures and other forms of talks. As with student presentation feedback, evaluations of such sessions are difficult to contextualise, while comments that are informative and seem helpful may be difficult to associate to specific sessions. Providing real-time feedback in the form of an instant survey is an approach that has been used in the past in different scenarios (e.g. using clicker technology for in-class quizzes) and could help academics to get direct feedback on their delivery skills. Considering the formal way, when students have any concern regards the way the lecturer is teaching, they provide their views to the voice leader of the module. Every student's feedback is then summarised and taken to the board of studies meeting. Some of the weak points of this process are: (i) summarised version may not reflect the reality; (ii) some feedbacks collected may not be relevant anymore; (iii) some students may not feel comfortable expressing their view to a colleague.

In order to avoid some of the issues, a Google Glass application was developed so students can vote on four criteria: (i) lecturer body language; (ii) clarity of the lecturer voice; (iii) interest on the topic; (iv) the pace of the lecturer. The average of each criteria is calculated live and displayed on the Google Glass that the lecturer is wearing, being then able to act on any low score. The data of each vote computed by each student is stored as well as their feedback on the tool. The experiment was also implemented on first and final year modules lectures.




12:29
Feedback
Suitable Pace
Fast/Slow Good
Suitable Volume
Too low/high Good
Approperiate Body Language
Too much/ not enough Good
Clarity of Presentation
Unclear Good
Interesting Topic
Boring Good
Survey Link: Only answer by the end of the lecture


PACE (7)
14%
85%
VOLUME (4)
75%
25%
BODY LANGUAGE (4)
25%
75%
CLARITY (4)
50%
50%
INTEREST (6)
50%
50%


Google Glass Dashboard
Feedback View
Google Glass in Action!
Viewer
Pace (19)
89%
Volume (18)
94%
5%
Body Language (16)
100%
Clarity (17)
100%
Interesting Topic (17)
100%
Statistics
Registered students: 50
Students voted at least once: 50
Import Data
Import feedback logs as CSV ...
Import action logs as CSV ...
Import feedback latest updates as CSV ...
Operations
Clear logs
Reset Viewer
Google Glass info!

Period and data: This experiment has been performed between 2016 and 2019 and includes: (i) Survey results; (ii) feedback results, which is the opinion from the voters/students about the experiment.

Benefits: There is a consensus from the student point of view regards the benefit of such tool. The instant feedback provided on a click of a button allows the most experienced lectures to adjust their delivery in an instant, instead of waiting to hear the feedback (if any) after the session has finished. The flexibility of such system allows the academic to set it up as it suits depending on the environment and content being taught. Furthermore, the timestamp collected from the voting allows the academics to correlate it to the specific slide being taught at that specific moment. Lastly, by collecting the short quiz result available at the end of the lecture, academics may be able to find patterns correlating the topic being taught and its performance delivering it.

Drawbacks: The adoption of the tool by the student has been low. The instant feedback idea is appreciated by the students (as shown on the feedback survey) but they have reported that the focus is on the teacher and on the content and having to get the phone to provide a feedback is too distracting and rarely done. Some lecturers who had the opportunity to use this technology in class did not feel comfortable in doing so. It was reported that they feared the students live feedback being too low and instead of being able to positively react to it they would feel nervous and demotivated.

Impact of measurement: Students can provide real feedback to the academic. Academic can, based on the live feedback results, improve its own delivery.

Constraints: A number of constraints were identified as follows. i) students have reported that the application was sometimes a distraction from the actual lecturer; ii) academic have reported being uncomfortable with the live feedback results constantly changing on the Google Glass screen.

Application: To run this experiment the following requirements are necessary: i) a raspberry pi configured as a local server to display the website to the users as well as collect the results; ii) a router connected to the raspberry pi server and providing a Wi-Fi network for the users to connect to; iii) a device for each student so they are able to login into the system and vote; iv) a Google Glass device for the academic to be able to see the voting results.

4.5 Social Media: Facebook/Twitter/LinkedIn

Supporting: (i) content, (ii) communication, and (iii) assessment.

Description: As discussed in previous chapters, social media have been used extensively for supporting learning. There are numerous case studies discussing the use of social media as a teaching mechanism. A significant amount of work has been published in the role of social media in education. It appears that the most common approach is for instructors to consider the use of social media as an enhancing set of tools and functions for transforming traditional virtual learning environments. The scope of using social media in educational contexts usually includes the participation of students in active learning, the engagement of students with a range of interactive features, the creation of an online community and the use of a familiar environment for sharing content and engaging students with their instructors and their peers.

The primary investigation involves the assessment of how students communicate during learning activities that are supported using Facebook. The studies involve self-evaluation and reflective portfolios in the way the social network affects the learning process. Participants provide their views on how they used the medium and their perception of their learning experience through the platform. As learners and instructors use the medium to communicate and interact, it is evident that the available functions are more suitable for certain learning activities. Instructors have used the platform primarily for (i) quizzes, (ii) polls, (iii) monitoring learners' activities, (iv) providing comments, (v) asking questions, and (vi) providing feedback.

The focus of this study is to provide suggestions on how the specific social media platforms can be used in conjunction to an existing VLE in order to further support student exchanges and enhance the learning experience.

Projects

Introduction - Team Role

According to Belbin role, I have contributed that i am a Team worker and co-ordinator. This tells me that I am able to work as a team and as a team we can work together to get work done sufficiently and co-ordinately. Also as a co-ordinator, I want to make sure everything within a project is running smoothly and we are working towards the deadline and goals.

4 team members


Dhiran Vekaria
Student Ambassador at Middlesex Univ...


Visar Quqalla
Final Year Student in BSc Business Info...


Mohammed Zia
Student at Middlesex University


Daniel Cecil
IT Infrastructure & System Analyst

Information Strategy & Strategic Management

I have worked on a topic which is Customer Relationship Management (CRM). My client was a Recruitment Agency and my plan was to ask questions which will help me out and to gather as much information as possible for my final project.This helped me to adapt more and also helped me adapt my skills.
The management point of side, I managed to plan everything smoothly and went to the interview and asked the organisations the questions. With the answers, I planned and used the answers to help me construct my final report.
less

4 team members


Dhiran Vekaria
Student Ambassador at Middlesex Univ...


Visar Quqalla
Final Year Student in BSc Business Info...


Mohammed Zia
Student at Middlesex University


Daniel Cecil
IT Infrastructure & System Analyst

Strategic Managers & Strategic Management

My PAEI Score is:
Producers (Paei) (15):
Administrators (pAei) (15)
Entrepreneur (paEi) (16)
Integrator (paeI) (9)

This tells me that i am Entrepreneur, like to focus on future opportunities and threats, what changes to make, longer term and the big picture and can generate new ideas to improve methods, products and business easily. I am creative, flexible, courageous and comfortable with risk and ambiguity. I have the ability to see things that others cannot see plus the willingness to believe in my insight and undertake significant risks.

This reflects on the decisions are made because at university i was managing most of the groups i was in and making sure everything was done to plan and in before the deadline. **less**

4 team members


Dhiran Vekaria
Student Ambassador at Middlesex Univ...


Visar Quqalla
Final Year Student in BSc Business Info...


Mohammed Zia
Student at Middlesex University


Daniel Cecil
IT Infrastructure & System Analyst

The Strategic Environment

By looking at the Porters five forces, i have identified that the porters five forces are:
- Barriers to entry
- Rivalry Determinants
- Determinants of supplier power
- Determinants of customer power
- Industry Competitors.

This model has been developed as a response to a SWOT analysis.

The terms upstream and downstream is part of the supply chain and also in the porters five forces.
Upstream is the power of customers where the ability of customers put the firm under pressure and affects the customer's sensitivity to price changes.
Downstream is the power of suppliers, this means that the suppliers of raw materials, components, labour, and other services to the firm that can be a source of power over the firm. Suppliers may refuse to work with the firm.
These two types of information are lead from two different points of view. If you look at the porters five forces, you can see that two of the five forces are upstream and downstream which are Determinants of supplier power and Determinants of customer power. **less**

BIS3300_1617_13
@BIS3300_1617_13

Hendon, England Joined February 2017

26 Following **28** Followers

Not followed by anyone you're following

Tweets | Tweets & replies | Media | Likes

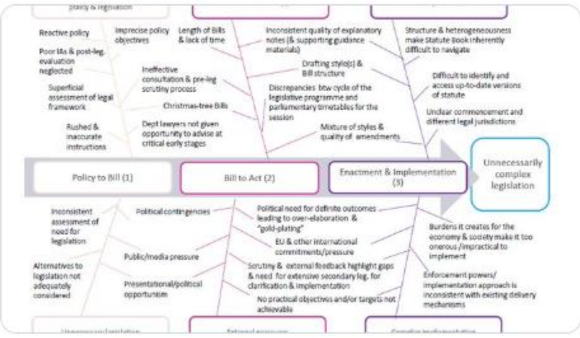
BIS3300_1617_13 @BIS3300_1617_13 · Mar 8, 2017
#BISwk16 SM have transformed corporate communication. In doing so, however, they can become aware of personal details.

BIS3300_1617_13 @BIS3300_1617_13 · Mar 8, 2017
Replying to @BIS3300_1617_13
increase understanding of the customer experience, and set the tone for the personality of your business

BIS3300_1617_13 @BIS3300_1617_13 · Mar 8, 2017
Replying to @BIS3300_1617_13
The data businesses can glean from social networking can help to monitor SEO metrics
1

BIS3300_1617_13 @BIS3300_1617_13 · Mar 8, 2017
#BISwk16
one of the most useful, and often under-utilized, aspects of social media is the ability to gather data.
1

BIS3300_1617_13 @BIS3300_1617_13 · Mar 1, 2017
this is how the constraints due to regulations/legislation affecting social media use in business #BISWK15



BIS3300_1617_13 @BIS3300_1617_13 · Mar 1, 2017
this is customizing /product/service strategy using social media #BISWK15

Period and data: This experiment has been performed between 2015 and 2019 and includes the social media content.

Benefits: Most of the student have reported that the familiarity with the technology allows them to easily use its different features to complete the given task. In addition, being able to showcase their work online was also appreciated. Students are aware of the importance of having a visible and high-quality work online.

Drawbacks: Although a minority, some students were not familiar with the social media aspects and said they had spent unnecessary time learning how to make the most of it, time that could have being used to do the activity. Furthermore, few students have shown privacy concern regards their data being unsafely store. Such mistrust is based on well-known data leaks published on the last few years. From the academic point of view, there was unhappiness regards the time taken to set up the environment. The fact that the Social Media automated security was blocking the registration from some of the student added even more complexity to the task.

Impact of measurement: Student gain great knowledge on the different types of social media and how it should be used from the business point of view. For the social media used for personal tasks (such as LinkedIn), the student had the opportunity to create a high-quality portfolio, therefore increasing their online presence and also increasing their chance of being contacted for a job position.

Constraints: A number of constraints were identified as follows. i) the time spent setting up individual accounts on the correct way is very long; ii) students have reported having trouble with signing up to some social media networks due to automatic security checks; iii) academics checking individual work on a weekly based has reported the activity being extremely time-consuming, especially considering that the task becomes accumulative as they had to check past weeks as well.

Application: To run this experiment the following requirements are necessary: i) an online account created on each social media (depending on the requirements).

4.6 Student Observable Behaviour (SOBs)

Supporting: (iii) assessment and (iv) feedback.

Description: The next pilot study focused on observing student behaviours as discussed in an earlier section. The Student Observable Behaviour (SOB) system has been successfully implemented two years in some of the modules in Computer Science and Engineering before starting our pilot with the two undergraduate modules. The system allows the academic to list every task the students should complete and tick the completed ones, while the students are able to keep track of what is overdue as well as their position on the module ranking.

Dashboard | Staff | Students | Topics | SOBs | Observe | Attendance | Reports | Logout

Attendance Overview

Week From 1 To 24 Recalulate

CRN	Details	Expected	W1	W2	W3	W4	W5	W6	W7	W8	W9	W10	W11	W12	W13	W14	W15	W16	W17	W18	W19	W20	W21	W22	W23	W24
14843	C01 - CG41 - Wednesday (1300 - 1359)	77	55	51	48	49	45	42	38	48	41	38	40	28	27	69	30	46	38	31	30	35	33	25	26	0
14844	L01 - HG07 - Wednesday (900 - 1059)	20	16	16	18	16	18	13	13	16	16	16	17	15	20	19	13	13	15	12	9	16	10	14	17	19
14845	L02 - HG07 - Wednesday (1100 - 1359)	19	10	17	14	13	16	14	18	15	16	14	15	13	18	19	16	12	17	16	9	17	9	12	17	19
14846	L03 - HG07 - Wednesday (1400 - 1559)	19	15	13	15	14	13	12	15	15	15	13	13	13	18	17	15	12	13	10	12	10	13	12	13	16
14847	L04 - HG07 - Wednesday (1600 - 1759)	20	9	12	13	13	12	15	7	13	11	10	4	5	10	14	12	13	10	5	9	8	11	7	5	18

Table 8 - SOBs Attendance Report

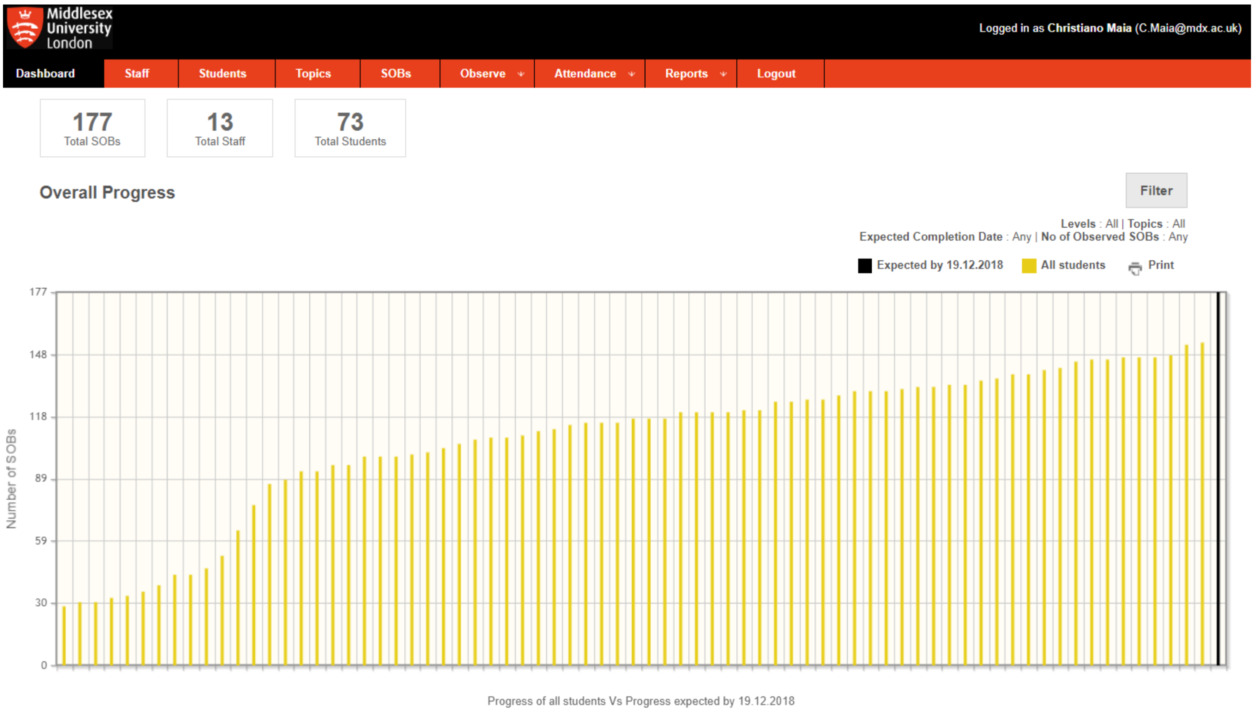


Table 9 - SOBs Dashboard

SOB ID	Level	Topic	SOB	Start Date	Expected before	Observed
1	Threshold	Element 1 - Group Report	Join a group	03.10.2016	23.10.2016	70
2	Threshold	Element 5 - Facebook	W1) Create a Facebook Account	03.10.2016	23.10.2016	71
3	Threshold	Element 5 - LinkedIn	W1) Create a Linkedin Account	03.10.2016	23.10.2016	67
4	Threshold	Element 1 - Group Report	Send 10 emails to the companies	24.10.2016	29.10.2016	64
5	Threshold	Element 1 - Group Report	Have an interview confirmation	31.10.2016	06.11.2016	64
6	Threshold	Element 1 - Group Report	Do the interview	07.11.2016	13.11.2016	60
7	Threshold	Element 1 - Group Report	Produce interview notes in writing	21.11.2016	27.11.2016	56
8	Threshold	Element 5 - Facebook	W1) Group to identify an organisation to be used as a case study	10.10.2016	16.10.2016	69
9	Threshold	Element 5 - Facebook	W1) Group to discuss plans for interview with manager / strategis	10.10.2016	16.10.2016	67
10	Threshold	Element 5 - Facebook	W1) Group to discuss plans for research in published works	10.10.2016	16.10.2016	67
11	Threshold	Element 5 - LinkedIn	W1) Individuals to specify how they are contributing to the organisation's strategy	10.10.2016	16.10.2016	64
12	Threshold	Element 5 - LinkedIn	W1) Individuals to specify how they are contributing to the organisation's strategic management	10.10.2016	16.10.2016	66
13	Threshold	Element 1 - Group Report	Create questions for interview	17.10.2016	06.11.2016	64
14	Threshold	Element 1 - Group Report	First draft shown in lab	07.11.2016	13.11.2016	61
15	Threshold	Element 1 - Group Report	Second draft shown in lab	28.11.2016	04.12.2016	61

Period and data: This experiment has been performed between 2017 and 2019 and includes: (i) List of activities to be completed; (ii) When each student completed it; (iii) Attendance;

Benefits: Staff and students have appreciated the well-organised system, where most of the tasks for the whole academic year is listed, dated and categorised. The gamification available on the tool has motivated some of the students to either go from the lower part of the ranking to one of the top or having the top 10 students competing for the first place. Being able to see its own attendance was noted as innovative and an important feature by students.

Drawbacks: In the current pilot, a big percentage of the activities on the system were group related. This mean that if the group is not able to complete it, none of them have the task as observed. Consequently, the student who put most effort on it feel demotivated as they are unlikely to reach the top of the ranking due to the lack of group contribution. Although this is more of a teaching plan issue, the tool emphasises the downside of it. Staff have mentioned that the initial set up of each module is time consuming. They have also complained about the difficulty in managing groups and group activities in the system as it was not originally designed for this.

Impact of measurement: the use of such tool gives the opportunity for students and academic to have a clearer view of their progress compared to the whole cohort. Furthermore, students have a clearer view of the tasks required and its deadlines. Lastly, the Student Observable Behaviour system has the functionality of taken the class attendance. The data collected is reported back to individual students, or to the academic responsible.

Constraints: A number of constraints were identified as follows. i) The SOB system needs to be set-up each academic year; ii) the system is not currently designed to support group activities in a easy manner; iii) the activities completed by the students must be manually updated on the system. This may be very time-consuming from the academic point of view. It also may have incorrect data collected regards the day the student has completed the task and the date the activity was marked as completed in the SOB.

Application: To run this experiment the following requirements are necessary: i) the webserver with the Student Observable Behaviour system installed; ii) set up of the environment for each module; iii) the system must be populated with the tasks to be completed, the student details, as well as the staff details and permissions.

5. Proposed Framework - TSED

The previous chapters provided the foundation of the research study, investigating the different areas that can be supported by educational technologies. A number of learning activities have been investigated as part of the preliminary stages of the research. Next, the discussion focused on a few pilot studies that assessed the impact of educational technologies on certain types of learning activities. The main contribution of this research study is the summary of these findings that are in the form of the proposed framework illustrated below. Named **Technology Supporting Educational Dimensions (TSED)**, this is a framework that can be used by academics who wish to deploy educational technologies in support of a range of learning activities. The way this framework can be used is described below.

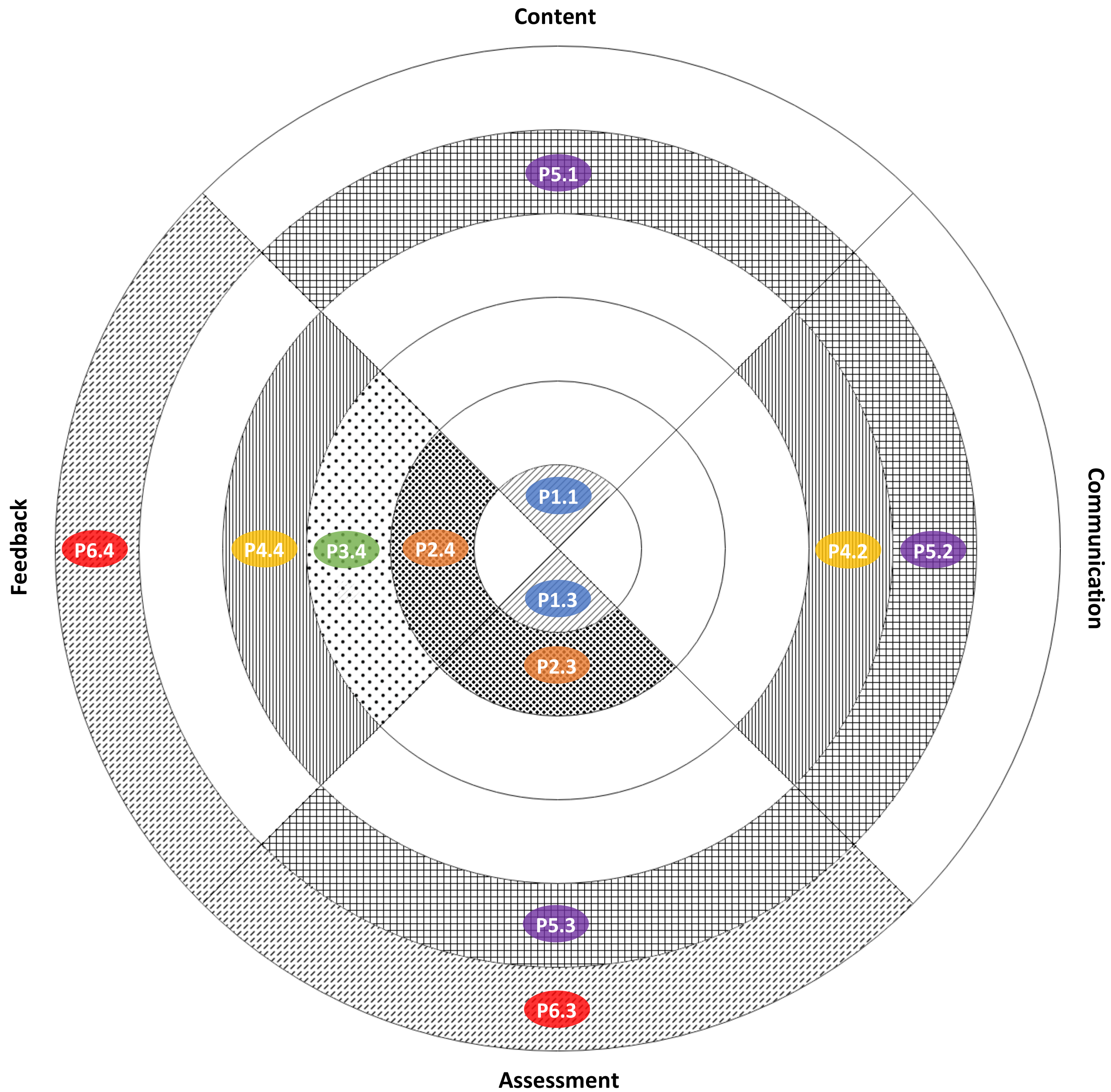


Figure 12 - Technology Supporting Educational Dimensions (TSED) Framework

The TSED consists of four dimensions. The dimensions were chosen based on extensive literature review discussed in detail on the previous sections of this report:

i) **Content**: responsible for providing the necessary material to the end-user. pedagogical frameworks, electronic portfolio, and the different learning styles should be taken in consideration when creating the pilot relevant to this section.

ii) **Communication**: pilots that will assist with the communication (synchronous and asynchronous) between academics-students, academics-academics, or students-students would fit in this dimension. Virtual learning environments and social media are currently the two most common options deployed.

iii) **Assessment**: the assessment dimension applies to technology which will verify if the information obtained is relative to some known objective or goal. E-portfolio technology can be helpful when analysing both summative and formative assessments. Continuous assessment, tests and quizzes are also popularly efficient choices. Lastly, and the most complex, is finding the necessary technology to support presentation assessments.

iv) **Feedback**: extremely popular by the students, the feedback dimension includes technology which allows the academic to provide a comment, criticism, or advice on a submitted assessment. The old fashion but still widely implementation rubric is a excellent example. Furthermore, technology to assist with presentation assessment must also be considered.

The framework has been successfully applied to six different pilots:

P1 = Google Glass: Student Experience
P2 = Google Glass: Presentation Feedback
P3 = Google Glass: Feedback on Feedback
P4 = Google Glass: Voting System
P5 = Social Media: Facebook/Twitter/LinkedIn
P6 = Student Observable Behaviour

This framework is a framework of good practice. It can be used to identify the necessary steps to enhance each of the four dimensions, for example, the pilot 5 “Social Media: Facebook/Twitter/LinkedIn” covers three of the dimensions: i) content; ii) communication; and iii) assessment. On the other hand, pilot 3 “Google Glass: Feedback on Feedback” covers only one dimension: feedback. By plotting the pilots to the framework, the user can easily perceive what technology is complementary to each other, meaning that more dimensions can be covered without much redundancy.

The framework also has the capability of having new pilots added to it. The new pilot would be added as layer around the main circle. This can be extremely relevant when applying the four dimensions to new technologies such as biometric sensors, augmented reality, virtual reality and others. Furthermore, the framework also allows new dimensions to be included. If future literature or/and pilots shows the need to have a fifth (or more) dimension, a new slice of the circle can be inserted at any stage without affecting the previous work. The scope of this framework is not to provide an exhaustive solution for the use of educational technologies but to act as a guide for academics who develop similar pilots to the ones discussed in the previous chapter. The intention is for this framework to be extended further with additional pilot studies that fall under the four dimensions of content, communication, assessment and feedback. One of the future directions for this framework is also to consider whether there are additional dimensions that might be included in subsequent versions.

6. Conclusion

6.1 Major findings

This work was carried out in five main sections. First section covers the different learning activities and the academic theories around it. It provides a brief overview of the pedagogical framework structure, followed by a detailed analysis of most common learning styles. Furthermore, it covers the different forms of: i) communication in education; ii) assessment; iii) and feedback.

The next section is about how technology impacts the different areas of an educational environment. Wearable computing is discussed in-depth, considering what the main criteria are, how to choose the ideal device and how to apply it to education. Social learning network has become a hot popular in the recent years, therefore there is a sub-section exclusively for it. It discusses the different types available, the role, and the impact in education. Lastly, continuous assessment has been chosen as the ideal methodology/technology to assess different activities.

Following up, the next section covers the six pilot studies implemented. The first four pilots use the Google Glass technology.

Firstly, to improve the student learning experience: this pilot has run the longest (six consecutive years) and collected the most variety of material, including pictures, videos, and feedback surveys. Although the students appreciate the benefits of such technology, the device itself has not been well received by a big percentage of users. Mostly due to not being very comfortable and having unfamiliar control methods.

Secondly to improve the feedback given on presentation: this pilot ran for five consecutive years, involving more than two hundred final year students. The results are encouraging and suggest that as this technology matures and more unobtrusive OHMD models become available, it could provide effective support to improve presentation feedback on a variety of scenarios.

Thirdly to improve the staff peer-feedback: in order to analyse different points of views, two different feedbacks were collected. One informal discussion between the staff providing feedback and the tutor receiving it. And another from the students, asking if they agree that the feedback provided to the tutor reflects the same opinion they have received. Fortunately, both results were extremely positive.

Fourthly to improve the feedback provided by the students to the lecturer: being able to receive live feedback from the students during a lecture has both benefits and downsides. From the students' point of view, they are happy to provide feedback when the academic is doing something that needs to be improved, but on the other hand they rather not get distracted when by the voting system when the lecturer is doing a good job. From the academic point of view: the lecturers that are experienced presenter and is constantly receiving positive feedback from the students appreciates the tool. In the meantime, other lecturers were reluctant to use it, affirming that the live feedback will fireback, making them lower their performance due to the live result pressure instead of being able to work on it.

The fifth pilot is about the use of social media: during this pilot, students were asked to use three different social media (Facebook/Twitter/LinkedIn) for different academic tasks throughout their 24-week academic year. Although no formal feedback was gathered from students, some points were observed. By using LinkedIn, students were constructing layouts professional profiles with high quality content, making them standout, and even having students being contacted by headhunters. Facebook has provided them the opportunity to understand the business point of view from the network, what functionalities are available to advertise specific products or services, as well as what statistics can be accessed from the Facebook users' profiles. The benefit of Twitter was not as obvious, but some students were able to understand how such a worldwide connected network can assist on collecting different point of views to have a better picture of certain topics.

Lastly, it covers an internally developed software called Student Observable Behaviour (SOB) used as a continuous assessment tool: The SOB tool provides not only a platform for managing students' portfolios, but it also has the benefit of generating several reports for both the students and the staff. Students can use these reports to measure their performance to date against what is expected and against the rest of the cohort. According to the Middlesex University staff members, the experience so far is that this real-time reporting is an excellent motivational tool, maximising performance through competition within the cohort (Clark, n.d.).

Naturally, after discussing the implementation of the pilot studies, the next section reflects and discuss the result for each one. It is divided in 3 sub-sections: i) activities: where it discusses what learning activity each pilot covers, its benefits, and drawbacks; ii) measurement: it covers the pilot's impacts, its constraints (if any), and the requirements to implement it; iii) guidelines: how each one of the pilots should be implement to cover specific learning activities.

The final section presents the main contribution of this work. The **Technology Supporting Educational Dimensions (TSED)** framework to be used when analysing if a new technology should be implemented into a learning scenario, and if so, what specific activities would be covered by it. The TSED framework is flexible enough to be used on a variety of teaching/educational scenarios. It has been extensively tested on over 400 students. Due to access limitation, all the students were part of the Computer Science Department of a Higher Education degree. More practical research is needed on different faculties or/and teaching levels.

The framework objective is to provide an overall insight of what educational dimensions the implemented technologies are covering. By doing so, it will be easier to understand: i) what dimensions lacks technological support; ii) if a technology is not effectively supporting any academic area and should be deprecated. If successfully implemented, the TSED framework has the potential to improve: i) content delivery: reaching more people; ii) communication: improving communication between academics and students; iii) assessment: supporting the implementation of efficient and fair assessment practices; iv) feedback: improving the feedback provided to students on their work and to staff on their practice. During this project, six pilots were added to the framework. The initial analysis of feedback surveys shows that students have seen progress on the previously mentioned criteria. Further work can be done to analyse the data more in depth.

6.2 Reflections and lesson learnt

An attempt was made to ensure that the pilot studies conducted were implemented in the highest possible standard. As always, there is room for improvement, as a number of factors that affected the data collection were not under the direct control of the research team. For example, room layout, timetabling, external events and restrictions due to other learning modules have affected the collection of data. Ideally having less variables affecting the pilot studies that are outside the researcher's immediate control is more likely to lead to more accurate data sets. For those dimensions that are outside the researcher's control, it would be better to collect the data more systematically. For example: have specific question if the pilot being implemented covers the pre-supposed learning activity. Furthermore, the surveys between different pilots should be more standardise so they can be more directly compared.

With regards to the technology being used, a couple of factors must be taken in consideration: i) how easy is it to use? If the technology's interface is not popular and there is a steep learning curve, it may affect negatively the feedback provided by the user, who may, indirectly or not, blame the device/software instead of the actual experiment. ii) how good is the hardware/software? It may be easy to use, but if it may have other weaknesses that affect the user experience, such as: being too slow, having a low battery duration, being uncomfortable during long term use, overheating, being hard to put it on or take it off, and so on. The better the quality of the device/system the more precise the user feedback will be in regards the pilots itself.

Lastly, it would be ideal to run the experiment for longer period. This would allow the user to get more familiar with what is need of it, understand the concept better, and therefore having a better reflection of the whole thing.

6.3 Future work

Six pilots and one proposed framework were covered in this project. The list below contain suggestions on how other researches can take this work further:

- Analyse and correlate the data collected in order to find pattern between the profiling surveys, the pilots' performance, and the feedbacks received.
- Implement new pilots, with new technologies, and apply it to the proposed framework.
- Expand the pilots to:
    - Different teaching level, such as masters: in order to compare their education level with the pilot feedback provided.
    - Other departments: as they are likely to have different familiarity with technology.
    - Other universities: as they are likely to have a different teaching methodology.
    - Other countries: as different cultures may provide a different point of view.

7. References

Abbruzzese, J., 2015. *Augmedix raises $16 million to make Google Glass a must-have for doctors.* [Online]
Available at: https://mashable.com/2015/01/12/augmedix-google-glass-doctors/?europe=true#aDZhhLq2aPqi
[Accessed 18 12 2018].

Abrami, P. & Barrett, H., 2005. Directions for research and development on electronic portfolios. *Canadian Journal of Learning and Technology,* 31(3), pp. 1-15.

Adams, J. S., 1963. Toward an understanding of inequity. *Journal of Abnormal and Social Psychology,* 67(5), p. 422–436.

Adizes, 2012. *Understanding Adizes Management Styles.* [Online]
Available at: http://adizes.com/management_styles/
[Accessed 10 08 2018].

Adizes, 2015. *Adizes History.* [Online]
Available at: http://adizes.com/history/
[Accessed 10 08 2018].

Admiraal, W., Wubbels, T. & Pilot, A., 1999. College teaching in legal education: Teaching method, students' time-on-task, and achievement. *Research in Higher Education,* 40(6), pp. 687-704.

Aldrich, H. E., 1979. *Organizations and Environments.* Englewood Cliffs, New Jersey: Prentice-Hall. .

Allen, C., 2004. *Tracing the Evolution of Social Software.* [Online]
Available at: http://www.lifewithalacrity.com/2004/10/tracing_the_evo.html
[Accessed 29 08 2018].

Androutsopoulos, K. et al., 2018. *MIRTO: an open-source robotic platform for education.* Seeon, Germany, 3rd European Conference on Software Engineering Education.

Aritzeta, A., Swailes, S. & Senior, B., 2007. Belbin's Team Role Model: Development, Validity and Applications for Team Building. *Journal of Management Studies,* 44(1), pp. 96-118.

Askew, S. & Lodge, C., 2000. Gifts, ping-pong and loops—linking feedback and learning. In: *Feedback for learning.* London: Routledge.

Attwell, G., 2010. Can Web 2.0 and Social Software Help Transform How We Measure Quality in Teaching, Learning, and Research?. In: U. Ehlers & D. Schneckenberg, eds. *Open Content, Open Learning 2.0: Using Wikis and Blogs in Higher Education.* London: Springer, pp. 433-446.

Bailey, R. & Garner, M., 2010. Is the Feedback in Higher Education Assessment worth the Paper It is Written on? Teachers' Reflections on Their Practices. *Teaching in Higher,* 15(2), pp. 187-198.

Bales, R. F., 1950. A set of categories for the analysis of small group interaction. *American Sociological Review,* 15(7), pp. 257-263.

Barbe, W. B., Swassing, R. H. & Milone, M. N., 1979. *Teaching through modality strengths: concepts and practices.* Columbus, Ohio: Zaner-Bloser.

Barrett, H. C., 2004. *Competing Paradigms in Portfolio Approaches.* [Online]
Available at: https://electronicportfolios.org/systems/paradigms.html
[Accessed 21 12 2018].

Barrett, H. & Carney, J., 2005. Conflicting paradigms and competing purposes in electronic portfolio development. *Educational Assessment, an LEA Journal,* July.Issue Assessing Technology Competencies.

Becker, K., Kehoe, J. & Tennent, B., 2007. Impact of personalized learning styles on online delivery and assessment. *Campus-Wide Information Systems,* 24(2), pp. 105-119.

Belbin, R. M., 1981. *Management Teams: Why they Succeed or Fail.* London: Heinemann.

Belbin, R. M., 1993. *Team Roks at Work.* Oxford : Butterworth-Heinemann.

Benjamin, J. G. & Tullis, S. A., 2011. On the effectiveness of selfpaced learning. *Journal of Memory and Language,* 64(2), pp. 109-118.

Benne, K. D. & Sheats, P., 1948. Functional roles of group members. *The Society for the Psychological Study of Social Issues,* 4(2), pp. 41-49.

Bernadette, T., 2015. *Second Life Creator Linden Lab Prepares To Test Parallel VR Universe.* [Online]
Available at: https://xconomy.com/san-francisco/2015/06/25/second-life-creator-linden-lab-prepares-to-test-parallel-vr-universe/
[Accessed 14 12 2018].

Bernard, H. R., Killworth, P. D. & Sailer, L., 1982. Informant Accuracy in Social-network Data V. An Experimental Attempt to Predict Actual Communication from Recall Data. *Social Science Research,* 11(1), pp. 30-66.

Bhattacharya, M. & Hartnett, M., 2007. *E-portfolio Assessment in Higher Education.* Milwaukee, WI, s.n.

Biggs, J., 1999. *Teaching for Quality Learning at University.* Buckingham:: Open University Press.

Black, P. & Wiliam, D., 1998. Inside the Black Box: Raising Standards Through Classroom Assessment. *Phi delta kappan,* 80(2), pp. 139-148.

Blair, A. & McGinty, S., 2012. Feedback-Dialogues: Exploring the Student Perspective. *Assessment & Evaluation in Higher Education,* 38(5), pp. 554-566.

Blanco, M., Estela, M. R., Ginovart, M. & Saà, J., 2009. Computer assisted assessment through moodle quizzes for calculus in an engineering undergraduate course. *Quaderni Di Ricerca in Didattica (Scienze Matematiche),* Volume 9, pp. 78-84.

Boatman, K., Courtney, R. & Lee, W., 2008. See how they learn: the impact of faculty and student learning styles on student performance in introductory economics.. *American Economist,* 52(1), pp. 39-48.

Bodle, K. A., Malin, M. & Wynhoven, A., 2017. Students' experience toward ePortfolios as a reflective assessment tool in a dual mode indigenous business course. *Accounting Research Journal,* 30(3), pp. 333-350.

Book, C. L., 1985. Providing Feedback: The Research on Effective Oral and Written Feedback Strategies. *Communication Studies,* 36(2), pp. 14-23.

Boyd, D., 2006. *The Significance of Social Software.* [Online]
Available at: http://www.danah.org/papers/BlogTalkReloaded.html
[Accessed 29 08 2018].

Bradshaw, D., 1989. Higher education, personal qualities and employment: teamwork. *Oxford Review of Education,* 15(1), pp. 55-71.

Brockbank, A. & McGill, I., 1998. *Facilitating Reflective Learning in Higher Education.* Buckingham: Open University Press.

Brosnan, M. J., 1998. The impact of computer anxiety and self-efficacy upon performance. *Journal of Computer Assisted Learning,* 14(3), pp. 223-234.

Broughton, S., Robinson, C. & Hernandez-Martinez, P., 2013. Lecturers' perspectives on the use of a mathematics-based computer-aided assessment system. *Teach. Math. Appl,* Volume 23, pp. 1-14.

Brown, E. & Glover, C., 2006. Evaluating Written Feedback. *Innovative Assessment in Higher Education,* p. 81–91.

Brown, R. & Carasso, H., 2013. *Everything for Sale? The Marketisation of UK Higher.* London: Routledge.

Butler, A. C., 2010. Repeated testing produces superior transfer of learning relative to repeated studying. *Journal of Experimental Psychology: Learning, Memory, and Cognition,* 36(5), pp. 1118-1133.

Carless, D., 2006. Differing Perceptions in the Feedback Process. *Studies in Higher Education,* 31(2), pp. 2019-233.

Chandler, A. D., 1962. *Strategy and structure: Chapters in the history of American industrial enterprise..* Cambridge, Massachusetts: The MIT Press.

Chen, C. F., Syn, Y. P. & Lin, M. H., 2005. *The study of multimedia evaluation authoring system of MOODLE teaching platform.* Taichung, TANET2005.

Clark, E. & Eynon, B., 2009. ePortfolios at 2.0 – surveying the field. *Peer Review - Emerging Trends and Key Debates in Undergraduate Education,* 11(1), pp. 18-23.

Clark, L., 2015. *Oculus joins with VR filmmakers Felix & Paul.* [Online]
Available at: https://www.wired.co.uk/article/oculus-rift-joins-felix-and-paul-vr-film-studios
[Accessed 2018 17 07].

Clark, T., n.d. *Computer Science: An Approach to Teaching and Learning.* [Online]
Available at: https://www.mdx.ac.uk/about-us/what-we-do/faculty-of-science-and-technology/computer-science/computer-science-an-approach-to-teaching-and-learning
[Accessed 18 12 2018].

Coffield, F., Moseley, D., Hall, E. & Ecclestone, K., 2004. *Learning styles and pedagogy in post-16 learning: a systematic and critical review.* London: Learning & Skills Research Centre.

Collins, A., Hawkins, J. & Frederiksen, J. R., 1994. Three Different Views of Students: The Role of Technology in Assessing Student Performance. *The Journal of the Learning Sciences,* 3(2), pp. 205-217.

Curtis, J., 1999. *Using Oral Presentation to Improve Teaching, Learning and Assessment: A Report into Higher Education Practice.* London: Middlesex University.

Daily, S., 2016. *Play slots with an Oculus Rift.* [Online]
Available at: https://www.slotsdaily.co.uk/play-slots-with-an-oculus-rift/
[Accessed 13 12 2018].

Daw, N. D. & Frank, M. J., 2009. Reinforcement learning and higher level cognition: Introduction to special issue. *Cognition,* 113(3), pp. 259-261.

Dawson, P., 2017. Assessment rubrics: towards clearer and more replicable design, research and practice. *Assessment & Evaluation in Higher Education,* 42(3), pp. 347-360.

Day, I. N. Z., Van Blankenstein, F. M., Westenberg, P. M. & Admiraal, W. F., 2018. Explaining individual student success using continuous assessment types and student characteristics. *Higher Education Research & Development,* Volume 37(5), pp. 937-951.

de Kleijn, R. A. M. et al., 2013. Students' motives for using online formative assessments when preparing for summative assessments. *Medical Teacher,* 35(12), pp. 1644-1650.

De Nisi, A. & Kluger, A. N., 2000. Feedback Effectiveness: Can 360-Degree Appraisals Be Improved?. *Academy of Management Executive,* Volume 14, pp. 129-139.

Digital Science and Research Solutions Inc., 2018. *Dimensions.* [Online]
Available at:
https://app.dimensions.ai/analytics/publication/overview/timeline?search_text=%22Assessment%20rubric%20%22&search_type=kws&search_field=full_search&local:indicator-y1=overview-publications
[Accessed 08 August 2018].

Dobson, S., 2006. The assessment of student PowerPoint presentations—attempting the impossible?. *Assessment & Evaluation in Higher Education,* 31(1), pp. 109-119.

Domenech, J., Blazquez, D., de la Poza, E. & Munoz-Miquel, A., 2015. Exploring the impact of cumulative testing on academic performance of undergraduate students in Spain. *Educational Assessment Evaluation and Accountability,* 27(2), pp. 153-169.

Dornyei, Z., 2005. *The Psychology of the Language Learner: Individual Differences in Second Language Acquisition.* 1st ed. Mahwah, NJ: Lawrence Erlbaum.

Dunn, D. S., Wilson, J. H., Freeman, J. E. & Stowell, J. R., 2011. *Best practices for technology-enhanced teaching and learning.* New York: Oxford University Press Inc..

Dunn, D. S., Wilson, J. H., Freeman, J. E. & Stowell, J. R., 2011. *Best practices for technology-enhanced teaching and learning.* New York: Oxford University Press Inc.

Ehrman, M., 1996. *Understanding Second.* Arlington, Virginia: SAGE.

Eicher, J., 1987. *Making the message clear.* Santa Cruz, CA: Grinder, DeLozier,.

Felix, U., 2002. The web as vehicle for constructivist approaches in language teaching. *ReCALL,* 14(1), p. 16–31.

Felix, U., 2002. The web as vehicle for constructivist approaches in language teaching. *ReCALL,* 14(1), pp. 16-31.

Fleenor, J., 2001. Review of the Myers-Briggs Type Indicator, Form M. In: J. Impara & B. Black, eds. *The fourteenth mental measurements yearbook.* Lincoln, NE: Buros Institute of Mental Measurement.

Fleming, N. D., 1995. I'm different; not dumb. Modes of presentation (V.A.R.K.) in the tertiary classroom. *Research and development in higher education, Proceedings of the 1995 Annual Conference of the Higher Education and Research Development Society of Australasia (HERDSA), HERDSA,* Volume 18, pp. 308-313.

Fleming, N. D., 2001. *Teaching and learning styles: VARK strategies.* Christchurch, New Zealand: N.D. Fleming.

Fleming, N. & Mills, C., 1992. Not Another Inventory, Rather a Catalyst for Reflection. *To Improve the Academy,* Volume 11, pp. 137-155.

Furnham, A., 1996. The big five versus the big four: The relationship between the Myers-Briggs Type Indicator (MBTI) and NEO-PI five factor model of personality.. *Personality and Individual Differences,* 21(2), pp. 303-307.

Garrison, R., Anderson, T. & Archer, W., 2001. Critical thinking, cognitive presence and computer conferencing in distance education. *American Journal of Distance Education,* 15(1), pp. 7-23.

Gaytan, J. & McEwen, B. C., 2007. Effective Online Instructional and Assessment Strategies. *American Journal of Distance Education,* 21(3), pp. 117-132.

Gedye, S., 2009. GEES, employability and the credit crunch. *Planet,* Volume 22, pp. 2-5.

Gemperle, F. et al., 1998. Design for wearability. *Proceedings of the 2nd IEEE International Symposium on Wearable Computers*, November, pp. 116-122.

Gerbic, P., Lewis, L. & Northover, M., 2009. Student perspectives of eportfolios: A longitudinal study of growth and development. *Same Places, Different Spaces,* pp. 327-331.

Gibbs, G., 2000. *Changing student learning behaviour outside of class. Essays on Teaching Excellence.* 11 ed. s.l.:The Professional .

Gibbs, G., 2010. *The Assessment of Group Work: Lessons from the Literature.* s.l.:Assessment Standards Knowledge Exchange.

Gibbs, G. & Dunbat-Goddet, H., 2007. *The effects of programme assessment environments on student learning.* Oxford, UK: Oxford Learning Institute.

Gibbs, G. & Simpson, C., 2004. Conditions under Which Assessment Supports Students' Learning. *Learning and Teaching in Higher Education,* 1(1), pp. 1-31.

Glaros, C. & I. Fotiadis, D., 2005. Wearable Devices in Healthcare. *Intelligent Paradigms for Healthcare Enterprises*, pp. 237-264.

Glaros, C. & I. Fotiadis, D., 2005. Wearable Devices in Healthcare. *Intelligent Paradigms for Healthcare Enterprises*, pp. 237-264.

Glaros, C. & I. Fotiadis, D., 2005. Wearable Devices in Healthcare. *Intelligent Paradigms for Healthcare Enterprises,* pp. 237-264.

Gleasure, R. & Feller, J., 2016. A Rift in the Ground: Theorizing the Evolution of Anchor Values in Crowdfunding Communities through the Oculus Rift Case Study. *Journal of the Association for Information Systems,* 17(10), pp. 708-736.

Gold, J. R. et al., 1991. *Teaching Geography in Higher Education: A Manual of Good Practice.* 1 ed. Oxford, UK: Blackwell Pup.

Google Trends, 2015. *Google glass, Oculus Rift, Microsoft HoloLens - Google Trends.* [Online]
Available at:
http://www.google.co.uk/trends/explore#q=Google%20glass%2C%20Oculus%20Rift%2C%20Microsoft%20HoloLens&date=1%2F2012%2041m&cmpt=q&tz=
[Accessed 2018 12 2018].

Google, 2018. *XE16.2 release notes.* [Online]
Available at: https://support.google.com/glass/answer/6023504?hl=en-GB&ref_topic=6023496
[Accessed 16 12 2018].

Griffiths, C., 2012. Learning Styles: Traversing the Quagmire. In: M. S., R. S. & W. M., eds. *Psychology for Language Learning.* London: Palgrave Macmillan, pp. 151-168.

Hakkinen, P., 1994. Changes in computer anxiety in a required computer course. *Journal of Research on Computing in Education,* 27(2), pp. 141-153.

Hattie, J. & Timperley., H., 2007. The Power of Feedback. *Review of Educational Research,* 77(1), pp. 81-112.

Hayes, E., 2006. *Situated learning in virtual worlds: the learning ecology of second life.* s.l., Proceedings of Adult Education Research Conference 2006.

Healey, M. & Matthews, H., 1996. earning in small groups in university geography courses: designing a core module around group projects. *Journal of Geography in Higher Education,* 20(2), p. p167.

Healey, M. & Matthews, H., 1996. Learning in small groups in university geography courses: designing a core module around group projects. *Journal of Geography in Higher Education,* 20(2), p. 14.

Henderson, R. & Robertson, M., 1999. Who wants to be an entrepreneur?. *Young adult attitudes to entrepreneurship as a career, Education and Training,* 41(5), pp. 236-245.

Hepplestone, S. & Chikawa, G., 2014. Understanding How Students Process and Use. *Practitioner Research in Higher Education,* 8(1), pp. 41-53.

Herring, S. C., 1996. *Computer-mediated communication: linguistic, social and cross-cultural perspectives. Pragmatics & beyond new series..* Amsterdam: John Benjamins B.V..

Higher Education Academy, 2013. *Feedback toolkit,* York: Higher Education Academy.

Hippner, H. & Wilde, T., 2005. Social software. *Wirtschaftsinformatik,* 47(6), pp. 441-444.

Holmes, N., 2015. Student perceptions of their learning and engagement in response to the use of a continuous e-assessment in an undergraduate module. *Assessment & Evaluation in Higher Education,* 40(1), pp. 1-14.

Horwitz, E. K., 2010. Foreign and second language anxiety. *Language Teaching,* Volume 43, pp. 154-167.

Horwitz, E. K., Horwitz, M. B. & Cope, J. A., 1986. Foreign language classroom anxiety. *The Modern Language Journal,* 70(2), pp. 125-132.

Houldsworth, C. & Mathews, B. P., 2000. Group composition, performance and educational attainment. *Education + Training,* 42(1), pp. 40-53.

Huitt, W., Hummel, J. & & Kaeck, D., 2001. *Assessment, measurement, evaluation, and research.* Valdosta, GA, s.n.

Issenberg, B. S. et al., 2005. Features and Uses of High-fidelity Medical Simulations that Lead to Effective Learning: A BEME Systematic Review. *Medical Teacher,* 27(1), pp. 10-28.

Jung-Ivannikova, L., 2016. Communication challenges learners face online: Why addressing CMC and language proficiency will not solve learners' problems.. *British Journal of Educational Technology,* 47(2), pp. 239-247.

Kerr, N. L. & Bruun, S. E., 1983. Dispensability of member effort and group motivation losses: Free-rider effects. *Journal of Personality and Social Psychology,* 44(1), pp. 78-94.

Kirschner, P. A., Sweller, J. & Clark, R. E., 2006. Why minimal guidance during instruction does not work: An analysis of the failure of constructivist, discovery, problem-based, experiential, and inquiry-based teaching. *Educational Psychologist,* 41(2), pp. 75-86.

Koong, C.-S. & Wub, C.-Y., 2009. An interactive item sharing website for creating and conducting on-line testing. *Computers & Education,* Volume 55, pp. 131-144.

Kornell, N., 2009. Optimising learning using flashcards: Spacing is more effective than cramming. *Applied Cognitive Psychology,* 23(9), pp. 1297-1317.

Kreijns, K., Kirschner, P. A. & Jochems, W., 2003. Identifying the pitfalls of social interaction in computer-supported collaborative learning environments: a review of the research. *Computers in Human Behavior,* 19(3), p. 335–353.

Kuehn, B. M., 2018. *Virtual and Augmented Reality Put a Twist on Medical Education.* [Online]
Available at: https://jamanetwork.com/journals/jama/article-abstract/2672460
[Accessed 14 12 2018].

Kuh, G., Kinzie, J., Schuh, J. & Whitt, E., 2005. *Student Success in College: Creating Conditions that Matter.* San Francisco: Jossey-Bass.

Lakhani, K. R. & von Hippel, E., 2003. How open source software works: “free” user-to-user. *Research Policy,* 32(6), p. 923–943.

LAMKIN, P., 2015. *The best smartglasses: The Google Glass alternatives.* [Online]
Available at: http://www.wareable.com/headgear/the-best-smartglasses-google-glass-and-the-rest
[Accessed 19 03 2015].

Lawrence, S., 1974. The team road to success. *Personnel Management,* p. 28–32.

Lawson, D., 1999. Formative assessment using computer-aided assessment. *Teach. Math. Appl,* Volume 18, pp. 155-158.

Leite, W. S. M. &. S. Y., 2010. Attempted Validation of the Scores of VARK: Learning Style Inventory with Multitrait-Multimethod Confirmatory Factor Analysis Models. *Educational and Psychological Measurement,* 70(2), pp. 323-339.

Lerner, J. & Tirole, J., 2002. The simple economics of open source. *Journal of Industrial Economics,* 50(2).

LG, 2015. *Lg G3 And Google Cardboard Bring Mobile Virtual Reality To Everyday Life..* [Online]
Available at: http://www.lgnewsroom.com/2015/02/lg-g3-and-google-cardboard-bring-mobile-virtual-reality-to-everyday-life/
[Accessed 09 12 2018].

Livingstone, D. & Lynch, K., 2002. Group project work and student-centred active learning: two different experiences. *Journal of Geography in Higher Education,* 26(2), pp. 217-237.

Locke, E. A., Shaw, K. N., Saari, L. M. & Latham, G. P., 1981. Goal setting and task performance: 1969–1980. *Psychological Bulletin,* Volume 90, p. 125–152.

Lomas, N., 2014. *Google Glass Is Being Trialled At European Airport.* [Online]
Available at: https://techcrunch.com/2015/02/09/glass-schiphol/
[Accessed 17 12 2018].

Maclellan, E., 2001. Assessment for Learning: The Differing Perceptions of Tutors and Students. *Assessment & Evaluation in Higher Education,* 26(4), pp. 307-318.

Mann, S., 1997. An historical account of the 'WearComp' and 'WearCam' inventions developed for applications in 'personal imaging'. *IEEE,* pp. 66-73.

March, B., 2014. *Review: The first Google Glass makeup tutorial service.* [Online]
Available at: https://www.cosmopolitan.com/uk/beauty-hair/makeup/news/a31715/review-ysl-google-glass-makeup-lesson/
[Accessed 17 12 2018].

Martin, F. et al., 2018. Middle School Students' Social Media Use.. *Journal of Educational Technology & Society,* 21(1), pp. 213-224.

Martins, S. G., 2017. Weekly online quizzes to a mathematics course for engineering students, Teaching Mathematics and its Applications. *An International Journal of the IMA,* 36(1), pp. 56-63.

Marton, F. & Säljö, R., 1984. Approaches to Learning. *The Experience of Learning,* pp. 36-55.

McAfee, A., 2005. Enterprise 2.0: The Dawn of Emergent Collaboration. *Sloan Management Review,* 46(2), pp. 78-84.

McConnell, D., 1994. *Implementing Computer Supported Cooperative Learning.* London: Kogan Page.

Meeus, W., Questier, F. & Derks, T., 2006. Open source ePortfolio: development and implementation of an institution-wide electronic portfolio platform for students. *Educational Media International,* 43(2), pp. 133-145.

Messick, S., 1989. Educational measurement. In: *Validiy.* New York: Macmillian.

Meta, 2018. *Meta - Augmented Reality.* [Online]
Available at: https://www.metavision.com/
[Accessed 17 12 2018].

Microsoft, 2018. *Microsoft HoloLens.* [Online]
Available at: https://www.microsoft.com/en-us/hololens/
[Accessed 18 12 2018].

Moro, C., Štromberga, Z. & Stirling, A., 2017. Virtualisation Devices For Student Learning: Comparison Between Desktop-Based (Oculus Rift) And Mobile-Based (Gear Vr) Virtual Reality In Medical And Health Science Education. *Australasian Journal of Educational Technology,* 33(6).

Mulliner, E. & Tucker, M., 2017. Feedback on feedback practice:perceptions of students and academics. *Assessment & Evaluation in Higher Education,* 42(2), pp. 266-288.

Murphy, K. & Barry, S., 2016. Feed-forward: students gaining more from assessment via deeper engagement in video-recorded presentations,. *Assessment & Evaluation in Higher Education,* 41(2), pp. 213-227.

Myers, C., 2007. Assessing assessment: the effects of two exam formats on course achievement and evaluation. *IHE ,* Volume 31, p. 227.

Najjar, L., Thompson, C. & Ockerman, J., 1999. Using a wearable computer for continuous learning and support. *Mobile Networks and Applications,* 4(1), pp. 69-74.

Nicol, D. J. & Macfarlane-Dick, D., 2006. Formative Assessment and Self-Regulated Learning. *Studies in Higher Education,* Volume 31, pp. 199-218.

O'Brien, R. & Sparshatt., L., 2008. Exploring Staff and Students' Mental Maps: Creating Narratives for Successful Assessment Feedback. *Transforming the student experience: Higher Education Academy Annual*, 1 07.

O'Connor, F., 2015. *Mozilla's enhanced Oculus Rift support a step towards broader plans for VR.* [Online]
Available at: http://www.pcworld.com/article/2873492/mozillas-added-support-for-oculus-rift-a-step-in-broader-plans-for-vr.html
[Accessed 17 12 2018].

Oculus, 2014. *YouTube.* [Online]
Available at: https://www.youtube.com/watch?v=addUnJpjjv4
[Accessed 16 12 2018].

ODG Store, 2018. *R-7 Smartglasses System.* [Online]
Available at: https://www.amazon.co.uk/ODG-STORE-R-7-Smartglasses-System/dp/B079KSW4F6/
[Accessed 17 12 2018].

O'Reilly, T., 2005. *What Is Web 2.0.* [Online]
Available at: https://www.oreilly.com/pub/a/web2/archive/what-is-web-20.html
[Accessed 29 08 2018].

Orth, M., Russo, P. & Gershenfeld, N., 2000. E-Broidery: Design And fabrication of textile-based computing. *Diagno Microbiol Infe,* 39(4), p. 840.

Oxford, R., 2011. *Teaching and Researching.* Harlow: Pearson Longman.

Palloff, R. M. & Pratt, K., 2005. *Collaborating online: learning together in community.* San Francisco, CA: Jossey-Bass.

Parkinson, R., 1995. Belbin's team role model - a silk purse from a sow's ear?. *Organisations and People,* 2(1), pp. 22-25.

Partington, D. & Harris, H., 1999. Team role balance and team performance: an empirical study. *Journal of Management Development,* 18(8), pp. 694-705.

Partington, D. & Harris, H., 1999. Team role balance and team performance: an empirical study. *Journal of Management Development,* 18(8), pp. 694-705.

Pawson, E. et al., 2006. Problem-based learning in geography: towards a critical assessment of its purposes, benefits and risks. *Journal of Geography in Higher Education,* 30(1), pp. 103-116.

Paych, M., 2018. *There are 4 leadership styles. What's yours?.* [Online]
Available at: https://medium.com/drupal-stories-an-insiders-view/paei-leadership-styles-a1fde32e7179
[Accessed 10 08 2018].

Pfarr, B., Rice, M. W., Fatig, C. C. & Green, D., 2001. Wearable computers for NASA applications. *Aerospace Conference,* Volume 7, pp. 7-3497.

Picciano, A. G., 2002. Beyond student perceptions: issues of interaction, presence, and performance in an online course. *Journal of Asynchronous Learning Networks,* 6(1), pp. 21-40.

Pittenger, D. J., 1993. The Utility of the Myers-Briggs Type Indicator. *Review of Educational Research,* 63(4), pp. 467-488.

Pitt, E. & Norton, L., 2017. 'Now that's the feedback I want!' Students' reactions to feedback on graded work and what they do with it. *Assessment & Evaluation in Higher Education,* 42(4), pp. 499-516.

Popham, W. J., 1997. What's Wrong – and What's Right – with Rubrics. *Educational Leadership,* 55(2), pp. 72-75.

Porter, L. W. & Lawler, E. E., 1968. *Managerial attitudes and performance.* Homewood: Irwin and Associates.

Poulos, A. & Mahony, M. J., 2008. Effectiveness of Feedback: The Students' Perspective. *Assessment & Evaluation in Higher Education,* Volume 33, pp. 143-154.

POUSHTER, J., BISHOP, C. & CHWE, H., 2018. *Social Media Use Continues to Rise in Developing Countries but Plateaus Across Developed Ones.* [Online]
Available at: http://www.pewglobal.org/2018/06/19/social-media-use-continues-to-rise-in-developing-countries-but-plateaus-across-developed-ones/
[Accessed 15 01 2019].

Prensky, M., 2001. Digital natives, digital immigrants.. *On the Horizon,* 9(5), pp. 1-6.

Price, L. & Richardson, J. T. E., 2003. Meeting the Challenge of Diversity: a cautionary tale about learning styles. In: C. Rust, ed. *Proceedings of the 2002 10th International Symposium of Improving Student Learning, Improving Student Learning Theory and Practice - 10 Years On.* Oxford, UK: The Oxford Centre for Staff & Learning Development, pp. 285-295.

Quigley, B. L. & Nyquist, J. D., 1992. Using Video Technology to Provide Feedback to Students in Performance Courses. *Communication Education,* 41(3), pp. 324-334.

Quigley, B. L. & Nyquist, J. D., 1992. Using Video Technology to Provide Feedback to Students in Performance Courses. *Communication Education,* 41(3), pp. 324-334.

Quinton, S. & Smallbone, T., 2010. Feeding Forward: Using Feedback to Promote Student Reflection and Learning – A Teaching Model. *Innovations in Education and Teaching International,* 47(1), pp. 125-135.

Ramsden, P., 2003. *Learning to Teach in Higher Education.* London: Routledge Ltd.

Raymond, E. S., 1999. *The Cathedral and the Bazaar.* Sebastopol, CA: O'Reilly Media.

Rees, C. & Harris, P., 1992. Using Student Seminar Presentations as a Learning Method: Rationale and Practical Guidelines. *Group of Teachers of Psychology Newsletter,* Volume 12, pp. 20-28.

Reid, J. M., 1987. The Learning Style Preferences of ESL Students. *TESOL Quarterly,* 21(1), pp. 87-111.

Rezaei, A. R., 2015. Frequent collaborative quiz taking and conceptual learning. *Active Learning in Higher Education,* 16(3), pp. 187-196.

Robertson, A., 2014. *Inside High Fidelity, the virtual reality successor to 'Second Life'.* [Online]
Available at: https://www.theverge.com/2014/5/19/5732386/high-fidelity-philip-rosendale-telepresence-second-life-hands-on
[Accessed 07 12 2018].

Roediger, H. L. I. & Karpicke, J. D., 2006. The power of testing memory: Basic research and implications for educational practice. *Perspectives on Psychological Science,* 1(3), pp. 181-210.

Rogers, K., 2009. A preliminary investigation and analysis of student learning style preferences in further and higher education. *Journal of Further and Higher Education,* 33(1), pp. 13-21.

Russell, J., Elton, L., Swinglehurst, D. & Greenhalgh, T., 2006. Using the online environment in assessment for learning: a case-study of a web-based course in primary care. *Assessment & Evaluation in Higher Education,* 31(4), pp. 465-478.

Sadler, D., 1989. Formative assessment and the design of instructional systems. *Instructional,* Volume 18, pp. 119-145.

Sadler, D. R., 2010. Beyond Feedback: Developing Student Capability in Complex Appraisal. *Assessment & Evaluation in Higher Education,* Volume 35, pp. 535-550.

Salmon, G., 2000. *E-moderating: the key to teaching and learning on-line.* London: Kogan Page.

Salmon, G., 2011. *E-moderating: the key to teaching and learning online.* 3rd ed. Oxon: Routledge.

Samsung, 2014. *[Infographic] Samsung Gear VR Innovator Edition.* [Online]
Available at: http://www.samsungmobilepress.com/2014/09/11/[Infographic]-Samsung-Gear-VR-Innovator-Edition
[Accessed 19 03 2015].

Samsung, 2014. *Samsung Explores the World of Mobile Virtual Reality with Gear VR.* [Online]
Available at: http://www.samsungmobilepress.com/2014/09/03/Samsung-Explores-the-World-of-Mobile-Virtual-Reality-with-Gear-VR-1
[Accessed 19 03 2015].

Sander, P., L. Sanders & Stevenson, K., 2002. Engaging the Learner: Reflections on the use of Student Presentations.”. *Psychology Teaching Review,* 10(1), pp. 76-89.

Savov, V., 2017. *Google Glass gets a second chance in factories, where it’s likely to remain.* [Online]
Available at: https://www.theverge.com/2017/7/18/15988258/google-glass-2-enterprise-edition-factories
[Accessed 17 12 2018].

Scanlan, C. L., 2010. *Assessment, Evaluation, Testing and Grading.* [Online]
Available at: http://www.umdnj.edu/idsweb/idst5350/assess_eval_test_grade.htm
[Accessed 15 01 2019].

Sester, A., Eder, B. & Scheichel, C., 2006. *Blessing or curse? A taxonomy for virtual product communities.* Acapulco, Mexico, AMCIS.

Shah, S. K., 2004. Understanding the nature of participation and coordination in open and gated source software development communities. *Academy of Management Proceedings,* Volume 1.

Shiva, H. & Hassan, T., 2016. Study of Conflict between Adizes's Leadership Styles and Glasser’s Five Basic Needs. *Mediterranean Journal of Social Sciences,* 7(3), pp. 89-96.

Shorter, N. & Young, S., 2011. Comparing assessment methods as predictors of student learning in an undergraduate mathematics course. *International Journal of Mathematical Education in Science and Technology,* Volume 42, p. 1061.

Siew, P.-F., 2003. Flexible on-line assessment and feedback for teaching linear algebra. *International Journal of Mathematical Education in Science and Technology,* 31(1), pp. 43-51.

Sinclaire, J. K., 2012. VARK learning style and student satisfaction with traditional and online courses.. *International Journal of Education Research,* 7(1), pp. 77-89.

Smith, M., Polglase, G. & Parry, C., 2012. Construction of Student Groups Using Belbin: Supporting Group Work in Environmental Management. *Journal of Geography in Higher Education,* 36(4), pp. 585-601.

Sony, 2018. *Specifications - SmartEyeglass SED-E1 - Sony Developer World.* [Online]
Available at: https://developer.sony.com/develop/smarteyeglass-sed-e1/specifications
[Accessed 18 12 2018].

Spronken-Smith, R., 2005. Implementing a problem-based learning approach for teaching research methods in geography. *Journal of Geography in Higher Education,* 29(2), pp. 203-221.

Statista, 2019. *Most popular social networks worldwide as of January 2019, ranked by number of active users (in millions).* [Online]
Available at: https://www.statista.com/statistics/272014/global-social-networks-ranked-by-number-of-users/
[Accessed 01 02 2019].

Stefanidis, D., Jr, J. R. K., Heniford, B. T. & Scott., D. J., 2007. Limited Feedback and Video Tutorials Optimize Learning and Resource Utilization During Laparoscopic Simulator Training. *Surgery,* 142(2), pp. 202-206.

Sternberg, R. J., 1994. Allowing for Thinking Styles. *Strategies for Success,* 52(3), pp. 36-40.

Sternberg, R. J. & Grigorenko, E. L., 1997. Are cognitive styles still in style?. *American Psychologist,* 52(7), pp. 700-712.

Sternberg, R. J., Grigorenko, E. L. & Zhang, L.-f., 2008. Styles of Learning and Thinking Matter in Instruction and Assessment. *Perspectives on Psychological Science,* 3(6), p. 486–506.

Tapscott, D., 1998. *Growing up digital: the rise of the Net generation..* New York: McGraw-Hill.

Taylor, J. C., 2002. *Teaching and learning online. The workers, the lurkers and the shirkers..* Hong Kong, Conference on Research in Distance & Adult Learning in Asia.

Thomas, B., 2012. Have We Achieved the Ultimate Wearable Computer?. *IEEE,* pp. 104-107.

Thorne, A. & Gough, H., 1999. *Portraits of type: an MBTI research compendium.* 2nd ed. Gainesville, FLA: Center for Applications.

Tosh, D. et al., 2006. The Learning Landscape: A Conceptual Framework for ePortfolios. In: *Handbook of Research on ePortfolios.* s.l.:ePortConsortium, pp. 24-32.

Tu, C. H. & McIssac, M., 2002. The relationship of social presence and interaction in online classes.. *The American Journal of Distance Education,* 16(3), pp. 131-150..

Tuckman, B., 1998. Using tests as an incentive to motivate procrastinators to study. *The journal of experimental education,* Volume 66.

Tugrul, T. O., 2012. Student Perceptions of an Educational Technology Tool: Video Recordings of Project Presentations. *Procedia-Social and Behavioral Sciences,* Volume 64, pp. 133-140.

Van Laerhoven, K., Schmidt, A. & Gellersen, H., 2002. Multi-Sensor Context Aware Clothing. *IEEE,* pp. 49-56.

Vermunt, J. D., 1998. The regulation of constructive learning processes. *British Journal of Educational Psychology,* 68(2), pp. 149-171.

vom Brocke, J., White, C., Walker, U. & vom Brocke, C., 2009. Making User-Generated Content Communities Work in Higher Education – The Importance of Setting Incentives. In: S. D. Ehlers UD., ed. *Changing Cultures in Higher Education.* Berlin: Springer, pp. 149-166.

von Rosenstiel, L., 2003. *Grundlagen der Organisationspsychologie – Basiswissen und Anwendungshinweise.* 5th ed. Stuttgart: Schäffer-Poeschel.

Vroom, V. H., 1964. *Work and motivation.* New York: Wiley.

Weinert, A. B., 1998. *Organisationspsychologie – Ein Lehrbuch.* 4th ed. Weinheim: Psychologie Verlags Union.

Wenger, E., White, N. & Smith, J., 2010. Learning in Communities. In: U. Ehlers & D. Schneckenberg, eds. *Open Content, Open Learning 2.0: Using Wikis and Blogs in Higher Education.* London: Springer, pp. 257-283.

Wheatley, M., 1992. *The future of middle management.* Corby: British Institute of Management.

White, C., 2003. *Language learning in distance education.* Cambrige: Cambridge University Press.

White, D., Warren, N., Faughnan, S. & Manton, M., 2010. *Study of UK online learning,* Oxford: University of Oxford.

Wray, L., 2015. *We're graduating from Google[x] labs It's hard to believe that Glass started....* [Online]
Available at: https://plus.google.com/+LisaWrayZeitouni/posts/RvMWHo1CXe6
[Accessed 17 12 2018].

Xiahou, S., Chen, D. & Huang, Z., 2006. A Wearable Learning and Support System for Manufacture Application. *Technologies for E-Learning and Digital Entertainment,* pp. 726-734.

Yahoo!-ABC News Network, 2015. *Google to Discontinue Google Glass.* [Online]
Available at: https://abcnews.go.com/Technology/video/google-discontinue-google-glass-28276927
[Accessed 17 12 2018].

Yamkate, K. & Intratat, C., 2012. Using Video Recordings to Facilitate Student Development of Oral Presentation Skills. *Language Education in Asia,* 3(2), pp. 146-158.

Yancey, K., 2009. Electronic portfolios a decade into the 21st century: what we know, what we need to know. *Peer Review - Emerging Trends and Key Debates in Undergraduate Education,* 11(1), pp. 28-32.

Yang, M. & Carless, D., 2013. The Feedback Triangle and the Enhancement of Dialogic Feedback Processes. *Teaching in Higher Education,* 18(3), pp. 285-297.

Zapalska, A. & Brozik, D., 2006. Learning styles and online education. *Campus-Wide Information Systems,* 23(5), pp. 325-335.