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Problematizing Second Language (L2) Learning using Emerging VR Systems

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Abstract

There is little doubt that there is nothing like being immersed in the country of the language you are trying to learn. Not only do students who wish to learn English as a Second Language (ESL) enjoy the experience of inter-cultural learning contexts from a sensory and affective sense, it is often the case that they gain emotional and intellectual maturity while living abroad. The reality of travelling abroad to learn English however for many International students is often a difficult transitional one especially at pre-sessional or beginner/foundation levels in terms of language acquisition, expense, feelings of isolation while in some cases, struggling with pressures to maintain scholarships. As it stands, existing English language centres work hard to advance students onto higher levels of language competencies. They offer students opportunities to avail of further language courses, which help them progress onto undergraduate studies. As part of such programmes, colleges often plan visits to historical and cultural sites to encourage non-formal learning. Such trips often impart historical information, however, that is outside students' immediate language levels, and this oversight does not optimise the experience as potentially pedagogical in developing competencies as outlined by the Common European Framework of Reference for Languages (CEFR). While not intending to replace present ESL courses, we propose that the use of VR systems can successfully compliment Internationalisation programmes in Ireland.

The emergence of commercially available VR head-mounted displays offers opportunities for immersive ESL virtual environments. VR technology can enable spaces for creative learning structures during foundation/beginner courses by delivering VR-based learning within Irish virtual site visits from their home-based colleges. This will work to tailor courses to where students' levels are at in actuality before they progress to their respective host English-speaking countries at higher levels in class-based environments. While in Ireland, it is envisaged that the VR supports will facilitate visits to on-site locations that are followed up by virtual site equivalents to maximise language learning in structured, innovative ways. VR can also engage with online colleges that do not have a physical campus in offering students a diversity of online courses while offering students the option to stay at home to best suit their own personal life situations.

A collaborative project between researchers at Limerick Institute of Technology and Hibernia College Dublin aims to capture the structural and acoustic data of various historical buildings and iconic landmarks in Ireland. The acquisition of structural features will involve the use of a 3D laser scanner and a record of construction materials. The acquisition of acoustic data will involve measuring the impulse response of the space using a dodecahedron speaker, reference and binaural microphones. Using this data, digital equivalents incorporating spatial attributes of both auditory and visual modalities will be rendered for the Oculus Rift VR headset and standard headphones. These renders will seek to position both the ESL learner and English language lecturer at virtual Irish historical sites to articulate immersive learning to find full expression in realising the digital campus.

Introduction

The change that overshadows all other changes is the availability of broadband wireless internet access...This ubiquity of wireless access and the range of devices create both a challenge and an opportunity because it wasn't planned from a pedagogical perspective. Howard Rheingold (2012)

Critic, educator and credited inventor of the term, 'virtual communities', Howard Rheingold's above statement was in response to the ways in which learning spaces have changed as a forward to Physical and Virtual Learning Spaces in Higher Education: Concepts for the Modern Learning Environment (2013). In respect of learning spaces, Rheingold calls for a "re-configurability" in transforming semiotics and pedagogical standpoints in a deliberate move away from "the movie theatre effect" of learning as a passive and consumer-based transaction. The primary focus of this paper is to highlight a collaborative need for educators to problematize the pedagogical uses of head-mounted displays (HMDs) as a means of improving second language (L2) learning and communicative competence. Communicative competence is understood here as a competent language user that should possess not only knowledge about language but also the ability and skill to activate that knowledge in a communicative event (Bagarić & Djigunović 2007, p.100).

With over three billion internet users recorded in 2014 (Internetworldstats, 2014), it is not surprising that learning in today's global knowledge economy is characterized by the use of English as a language of high-tech environment (Benabdallah 2012). When figures are distributed by world regions, ranking at 45.7%, Asia are the world leaders in internet usage. It is not surprising then to find Western universities "turning away from their saturated domestic markets to build campuses overseas in the Middle and Far East with which to attract a new generation of international students" (Thomas, Reinders & Warschauer, 2013 p.3). There is a fast-paced global market demand for digital English language learning marked by cost-efficient technology-based products and the migration away from classroom-based learning. According to Ambient Insight's Premium Report (2014), an international market research firm that specialises in e-learning and mobile learning, "the global market for digital English language learning products reached \$1.8 billion in 2013. The worldwide five-year compound annual growth rate (CAGR) is 11.1% and revenues will surge to \$3.1 billion by 2018" (p.15). In the case of Ireland, International education continues to be a strong revenue earner. With overall registered student numbers at higher education institutions remaining comparatively stable at around 32,000 in the academic year 2011/12, as a whole, international students contribute to €1 billion to the Irish economy (Education Ireland, 2012, p.4).

Benabdallah (2012, p.2) insightfully reminds us that language learning does not occur in vacuum but is used to carry out meanings in specific contexts. The Common European Framework of Reference for Languages: Learning, teaching, assessment (CEFR) acknowledges that a language learner "does not cease to be competent in his or her mother tongue and the associated culture. Nor is the new competence kept entirely separate from the old. The learner does not simply acquire two distinct, unrelated ways of acting and communicating" (CEFR, 2012, p.43). If we accept the axiom that within language is ideology, we need to firstly interrogate the constructions we make about learning and learners before we turn to technology. As educators, we must be novel in critically reflecting, situating and appraising our beliefs and learning paradigms that fundamentally inform our pedagogical practices. Crucially, technology does not make or substitute language teachers; it does

not in itself, “bring about reform, but instead tends to amplify extant beliefs and practices” (Warschauer, 2011, p.115). Learning models and theories be they behaviourist, constructivist or experiential (to name just three) are directly magnified through the lens of technology. Put plainly, socio-political positions and practices educators uphold within a physical university campus is inevitably reflected in the realisation of a digital terrain.

On problematizing L2 learning in emerging VR systems, the authors envisage the pedagogical potentiality of HMDs as enabling constructivist spaces as places of learning. Software environments that are carefully designed offer learners opportunities to skills in coping with problem-solving, task-based, communicative contexts. Undeniably, this would be an intricate and collective implementation process across the higher education sector rather than a simple ‘plug-and-play’ based solution (Cuban, 2001). Until recently, Contemporary Computer-Assisted Language Learning (CALL) has been considered “rather too technical and not pedagogically informed enough by classroom teachers, or alternatively, not technically sophisticated enough by those for a computing background” (Thomas et al, 2013, p.3). Amidst the speed of new technologies and especially Web-based learning, CALL has however been recognised as having a solid theoretical and practical background in creating new instructive developments towards realising the digital campus, particularly recognised in the area of L2 learning in the 21st century. As highlighted by Thomas et al. (2013), the use of new digital technology requires cautious planning, integration of sound pedagogy practices and collaboration between experts in all the relevant fields so as to successfully transition the learner from legacy environments to new and innovative technological ones that Rheingold advocates. A major pitfall of introducing new technology in education however has been to map teaching principles from one domain to another that do not necessarily fit. We see how current VLEs have often been underutilized and simply become digital repositories for lecture notes and assessment submissions. The authors acknowledge that this is a two way challenge, firstly in terms of educator and learner attitudes toward the digital educational environment; and secondly how effective the technology is in facilitating innovative teaching practice and adapting these accordingly to diverse learning styles. With the emergence of immersive VR technology, it is clear that we can learn from the Web 2.0 experience. Therefore, the authors propose to outline a design framework that calls for collegial collaboration in relevant fields to plan, map, evaluate, define and implement best practice for teaching and learning within a multimodal, immersive, HMD-based VLE.

Multimodal Learning Environments

Compatibility with human perceptual and cognitive processes is central to designing any system whereby human users are presented with dynamically changing information. Considering how users are increasingly exposed to abstracted digital environments, this design principle becomes paramount, especially where the acquisition of new knowledge is the key objective. Typically, technological advancement far outpaces the establishment of fundamental design frameworks and principles that ensure such compatibilities are fully realised. This challenge is further compounded

considering the exponential technological development curve. User Experience (UX) designers continue to rectify many of these problems in areas such as accessibility, mobile consumer devices, and product development processes. Magnifying the challenges of this work is the vast amount of information made available in different formats, modalities and design. These formats often lack in-depth acknowledgement of inherent cognitive limitations of the human perceptual system, not to mention specific mechanisms by which that system intakes processes and organises information streams.

The move away from the rather abstract presentation of information on flat computer displays with stereo audio to immersive virtual spatial multi-sensory environments has the potential to interface the L2 user with perhaps a more familiar simulation of our real-world environment. An important distinction is made here between avatar-based 'virtual' environments, which essentially retain the abstracted conventional screen-based interface, and the upcoming commercialisation of head-mounted displays (HMDs) with binaural audio and wearable actuators and sensors. This promising advantage, however, may quickly fracture if the incompatibilities mentioned above are allowed to prevail in terms of the ways information is communicated to L2 learners, and possibly accentuated given the multimedia options allotted to content producers. These concerns have been recognised, and in many respects tackled, by educators, cognitive scientists, and technologists since the advent of Web 2.0 (see Thomas et al., 2013; Keppell et al., 2013). Although the term 'multimodal' or 'multimedia' is often associated with Web 2.0, from an interface design and sensory science point-of-view, the technology is neither immersive or multi-dimensional. However, this not its primary fault, but rather the content producer's often disorganised and haphazard methods of presenting information to the L2 learner using one or more modalities with little thought given as to how information streams interact at the peripheral sensory level; how streams are segregated or consolidated; how attention mechanisms are influenced and directed; and how top-down cognitive mechanisms determine how that information is integrated with existing cognitive schemas.

To date, research has yet to extrapolate how HMD-based tools can be effectively used to stimulate active learning. According to Dörnyei (1998), motivation provides the primary impetus to initiate L2 learning as "all the other factors involved in L2 acquisition presuppose motivation to some extent" (p.117). Research has shown that under certain circumstances, if learners are sufficiently self-determined and internalised-extrinsic rewards can be combined with, or can even lead to, intrinsic motivation (see Dörnyei 1998). Adapting these elements into a software design framework requires the use of modularised test scenarios to match the VR environment with learner motivations, expectations and achievement goals. Indeed, just as we can learn from the pitfalls of Web 2.0 educational environments to date, we can also springboard from both its inherent successes and the models used to improve the Web 2.0 experience. Interestingly, Shin and Kim (2008) link extrinsic and intrinsic motivations to users' attitudes and intentions of social online technologies (p. 380), and employ an adaptation of the Technology

Acceptance Model (TAM) to analyse the use of social media sites. TAM, adapted by Davis, Bagozzi and Warshaw (1992) is employed to assess the effectiveness of newly introduced technology in a wide variety of online contexts, and sets out to evaluate perceived usefulness and ease-of-use. In addition, Shin and Kim (2008) include perceived synchronicity, perceived involvement, and the user's flow experience as important factors for enhancing user engagement with new technology. While such models have some shortcomings, they form pre-existing starting points to develop further defined models specifically aimed at VR-based learning technology. The authors suggest two primary model categories to investigate issues surrounding L2 acquisition, namely, the macro-model category and the micro-model category. Within each category are modularised stages for empirical test scenarios.

Design Framework

To achieve some degree of compatibility with the L2 language user, the system design needs to incorporate macro- and micro-models of the various stages of human perception and cognition. These two model categories tackle different, but interrelated, stages of human cognition. Macro-models, which are design principles incorporating higher-level cognitive influences, need to be flexible so as to adapt to various aspects of human interaction that is somewhat personalised in nature, such as learning styles, cultural nuances, personal experiences and personal motivations. Given the complexities involved, macro-models need to employ software learning algorithms and perhaps distributed multi-agent tutoring systems to sufficiently adapt to the dynamic shifts in interaction that users initiate. The concept of utilising aspects of Artificial Intelligence (AI) in educational settings is not new (Alves, 2010), but rapid development in AI in recent years has led to more successful applications and modelling (Adenowo & Patel, 2014). Micro-models are more immediate and primarily concerned with content provision in the spatialised VR world. These models would incorporate primitive but universal perceptual traits such as working memory limitations; information stream segregation; cross-modal interactions; attention mechanisms; and principles of perceptual sensory organisation. Both macro- and micro-models, although modularised for empirical testing, are not mutually exclusive, and would need constant cross-evaluation to embody the holistic nature of human perception and cognition. Fig 1 outlines this approach and the various elements come under scrutiny.

Moreno (2006) encapsulates a similar approach to recognising primitive perception stages and higher cognitive integration in her cognitive theory of learning with media (CTLM) framework and derived principles (p. 65). Much research remains to be done in terms of establishing a greater level of detail for each micro-model stage in Fig 1. For example, it is acknowledged that working memory is a key factor in higher cognitive processing (Gevins & Smith 2000), acting as a real-time bridge between incoming sensory data and higher level contextualisation and organisation. Working memory limitations have also been regularly quantified for various modalities (Cowan 2010; Baddeley 2004). Furthermore, destructive interference, such as background irrelevant noise, can affect attention mechanisms associated with working

memory tasks when presented congruently. However, the underlying mechanisms of working memory and the models outlined by Baddeley and Hitch (1974) and Cowan (1999) continue to be debated (Chein & Fiez, 2010).

Indeed, some assumptions that certain modalities remain segregated in working memory is also disputed, such as is in the case of non-speech auditory information interfering with reading tasks. Jones and Macken (1993) demonstrated that background speech-based auditory streams were not the only auditory stream type to negatively impact a reader's ability to retain working memory capacity on his/her primary reading task. Despite the assumption that the impingement of background speech streams on reading tasks was due to some lexical interference (and aptly called the 'Irrelevant Speech Effect'), Jones and Macken (1993) were able to elicit similar effects using background non-speech auditory streams - giving rise to a re-evaluation of the terminology used to reflect this phenomena - the 'Irrelevant Sound Effect'. Jones & Macken (1993) attribute this effect to what they term as the 'The Changing-State Hypothesis', indicating that congruent background auditory streams that change rapidly in structure negatively impact working memory efficiency during reading tasks. From a VLE point-of-view, these details should be central to human compatible design, and perhaps more importantly, should inform decisions educators make regarding multi-media content. If, for example, L2 learners are required to read text-based content within the virtual world, any background auditory streams used for contextualisation must be carefully designed so as to reinforce rather than distract from the primary reading task. However, the spatialisation of background information streams may perform very differently in this context, which opens up many unexplored avenues for fully immersive virtual environments.

In relation to macro-model aspects, further opportunities arise for cross-campus educators, cognitive scientists and programmers to collaborate and create accessible ways that offer learners a really useful digital campus as a bedrock for knowledge. In many respects, the macro-model concepts are much more complex than the micro-model due to the non-generalised attributes involved. At the core of the macro-model stage is the concept of learner motivation, which has an inherent knock-on effect on L2 learner engagement, goal achievement and ultimately the acquisition of relevant knowledge. As users of this technology therefore, L2 learners will 'need to see a reason for its 'being'' (Reushle, 2012, p.91) and need to be at the heart of this realisation. Previous research has used data from the experiences of students on how they receive positive and encouraging feedback in personal, social and cultural interactions, both in class as well as virtually, as a useful way of building motivation into designs (e.g. Dillon, Seeto & Berry, 2012, p.173). Tremblay and Gardiner's (1995) model of L2 motivation forms a comprehensive modular starting point for testing some of these macro-model theories. The details they present can be assimilated into the top-down influence exhibited by the learner's cognitive schemas and inform designers on how L2 learners engage with and choose the most relevant incoming sensory streams at the micro-model stages (see fig 1). In addition, the influence of the educator in relation to his/her beliefs in the system, as well as

curriculum and assessment structures (Steel and Andrews 2012 p.249), must also be considered at this macro-model level. If adequately embedded in immersive VR technology employing learning-algorithms, the learner is offered the opportunity to engage with a deeply personalised, efficient, engaging and immersive educational environment.

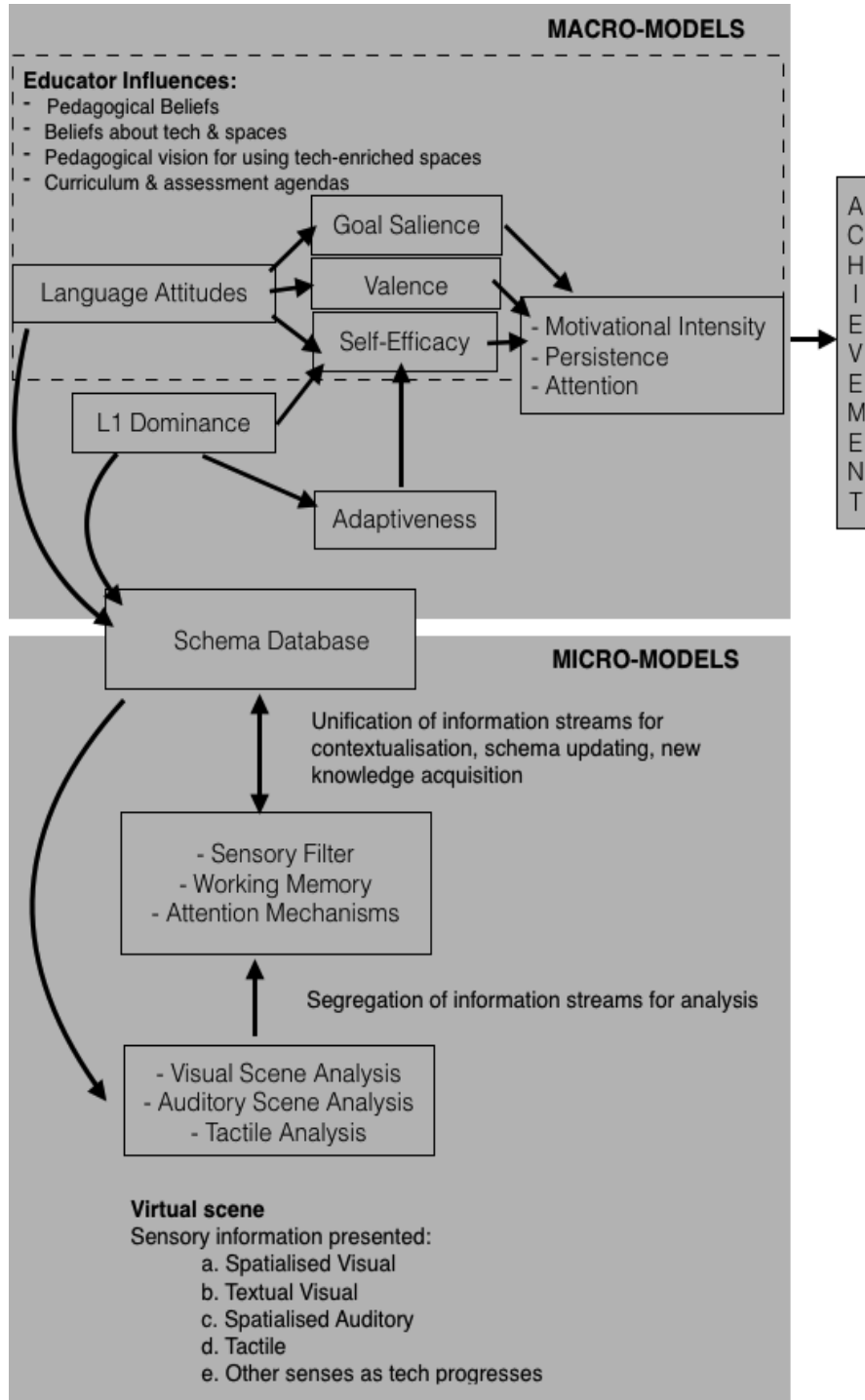


Fig 1: Macro- and micro-models. Macro-models adapted from Tremblay & Gardiner (1995) and Steel & Andrews (2012). Micro-models adapted from Neff, Kehoe & Pitt (2007).

Discussion

Realising a technology-enriched campus as an enabling space that offers meaningful opportunities for L2 learning and communicative competence hinges on the quality of engagement between all stakeholders involved. Collaborations between educators, software developers and cognitive scientists is paramount so as to ensure a balanced approach to the design of immersive VR education systems. With little cross-collaboration, holistic designs are impossible. For example, many Intelligent Tutoring Systems (ITS) have merely been a testbed for AI techniques rather than for advancing pedagogical approaches, and many VLEs are designed on direct mapping of pedagogy to new digital environments without consideration to technical constraints or the workings of perception and cognition. Adenowo and Patel's (2014) Augmented Conversation and Cognitive Apprenticeship Metamodel (ACCAM) is an example of a more balanced approach, whereby it is based on assessing both effective pedagogy as well as evaluating AI techniques, ultimately forming a more comprehensive, realistic and relevant points of learner-centred engagement. Similarly, the framework outlined in Fig 1 needs to ensure the same balance takes place when testing different modular stages. Some of these stages include aspects of AI, while additionally, the overall system incorporates a novel immersive environment that requires significant technical evaluation in visual and auditory spatialisation techniques and haptic feedback. Indeed, these technical attributes bring with them another set of variables that need evaluation within the context of L2 learning - variables associated with the sense of 'Presence', or that 'feeling of being there' (Nash et al. 2000).

The sense of presence is often associated with VR-based technologies and considered one of the primary design goals in achieving user engagement and enhanced user experience. Harrington (2011) cites how existing 'virtual' environments are not without a sense of 'Presence' but are ranked significantly lower than real-world environments. However, this is again based on environments that retain contemporary screen-based interfaces and do not reflect newer and significantly different HMD-based VR systems. The vision remains the same in realising a campus that is digitally innovative and depends greatly on the effectiveness of HMD-based VR to act as a conduit 'to increase the probability of enhanced awareness, knowledge acquisition, and constructive creativity' (Harrington, 2011, p.176). Imagining a digital campus that capitalises on the progression to immersive 3D environments is realisable when a) clear, defined moves towards fully spatialised, multimodal environments critically incorporates collective interpretations of sensory inputs, and b) includes a modifiable top-down schema model to reflect aspects of personal motivation, cultural nuances, learner satisfaction and progression, within a robust pedagogical framework.

The rewards of evenly balanced, well-thought out campus-wide collaborations could "potentially become an integral component of any and all subject areas currently taught in higher education institutions" (Thorne, 2013, p.12) for the twenty-first century.

Strategic frameworks that support and embed an array of innovative pedagogy in a campus-wide approach will enhance both L2 learners' and teachers' sense of connectedness and being in virtual internationalisation partnerships.

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