A proposed use of Virtual and Augmented Reality for supporting Inquiry Based Learning

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Abstract — The research proposed in this paper will embrace the possibilities that eLearning tools can bring to Science education. A number of Virtual and Augmented Reality (VR and AR) devices are appearing on the market for research and development. The plan is to develop an Augmented Reality learning object, a software that will enable students to interact with learning resources and scenarios and allow them to experience inquiry-based learning (IBL) in science education.

Keywords—virtual and augmented reality, learning about inquiry, learning to do inquiry, practitioner research.

I. INTRODUCTION AND MOTIVATION

Over the past 15 years there have been European and Government initiatives to facilitate the effective use of eLearning in schools. Many of these initiatives were based on blue-sky thinking and aimed primarily on "developing technical standards, educational software applications and digital publications, metadata schemes, and specifications for system interoperability" [2]. In a similar vein many of the inquiry based learning (IBL) science education initiatives provided only a framework to learn about inquiry but failed to provide the practical application, 'the learning to do inquiry' [3] [4]. Learning to do inquiry includes a set of skills that students need to master to "do science", but it also goes beyond mere process skills. Learning to do inquiry also means combining these processes with scientific knowledge, reasoning and critical thinking to develop scientific knowledge Learning about inquiry is about knowing how scientific knowledge is developed through inquiry approaches [4]. Lederman was also a key contributor to the ideas of Learning to do and Learning about inquiry in IBSE. [5].

The main aim of the Inspiring Science Education (ISE) project is to support two particular European Commission reports, which established a vision for the future of science education in Europe for the 21st century. In 2007 the publication of 'Science Education Now: A renewed Pedagogy for the Future of Europe' [6] brought science by inquiry back to the top of the science education agenda in Europe. Later in 2010 the publication of 'A Digital Agenda for Europe' [7] and in particular Action 68, brought eLearning into the educational mainstream of Europe; placing eLearning as an integral part in the future of education. The ISE project aligns with the Rocard Report and the Digital Agenda for Europe Report in the following ways:

a. The implementation of the "Digital Agenda for Europe" promoting the mainstreaming of eLearning into the national policies of member states at school level.
b. The adoption of an inquiry-based, 'learning-by-doing' approach in the science curricula of member states as per the recommendation of the Rocard Report.

II. BACKGROUND: WHAT IS THE STATE OF THE ART IN TERMS OF EXISTING SOLUTIONS

1. New technologies are always coming on stream and if used in the right way can 'evolutionise' how we learn. For example Virtual and Augmented Reality (VR and AR) are immersive interfaces in which users and participant avatars interact with computer based agents and digital artifacts or mixed reality contexts [8]. In 2016 a number of further VR and AR devices will appear on the market for research and development, for example Microsoft HoloLens that is described as a see-through holographic computer. In an experience called mixed reality it places high definition holograms in the physical world that one can interact with and change. The AR device is hardware and there is some developed software such as Minecraft and future software such as that from Microsoft HoloLens' partnership with Case Western Reserve University (https://www.youtube.com/watch?v=SKpKlh1-en0) with the potential for IBL. The Oculus Rift is a virtual reality mounted display developed by Oculus VR and has been described as "the first really professional PC-based VR headset" [8]. While Oculus has stated that the Rift is primarily a gaming device there are ways in which it can be programmed to support IBL in science. The Oculus Rift Development Kit 2 (DK2) was a possible option for development work in 2015, however it is no longer available as the company has shifted the focus on preparing for the launch of the Oculus Rift Consumer version due to be released in the first quarter of 2016.

The current state of the European Inspiring Science Education (ISE) project is that it has advanced from initial 'demonstrators' of the mapped technologies, to the Large Scale Pilots, fostering multi- stakeholder partnership to

leverage commitment and to support practitioner- led innovation. This European wide project provides eLearning tools and digital educational resources and enables teachers to connect with like-minded teachers and schools across Europe to share experiences and collaborate on projects using IBL approach. ISE's digital repository provides interactive and games based applications, VR and AR applications, online and remote labs as well as templates, scenarios, methodologies and guidelines to support science teachers and teacher educators. This research proposal will contribute to the European Inspiring Science Education project.

ISE builds on previous initiatives such as the European Seventh Framework Project to spread the use of IBL in European schools. ISE is a practitioner-led initiative, a stance it has embraced with the changing dynamics of education in Europe, "first from uniform prescription in the 1980`s; to informed prescription; then towards practitioner-led change" [9]. The success of the ISE project relies on the response of the teaching communities and the fostering of practitioner-led innovation

The European Inspiring Science team view VR and AR as potentially powerful educational tools, contextualised systems that can support conceptual change but only if it can fulfill the following conditions:

1. Intelligent: the classroom technology should be highly context-aware and adaptively support tasks that originally require excessive human interventions.
2. Interactive: the classroom technology should facilitate interactions between the teacher and the students.
3. Personalised: the classroom technology should react differently in accordance to individual user.
4. Integrated: the classroom technologies should be integrated as one system instead of many separate systems [10].

III. GOALS AND OUTCOMES

The form of evaluation will draw on the research approaches and workplace practices developed by the International Centre for Innovation and Workplace Learning, (ICIWL) at Dublin City University. The Centre focuses on creating conditions that support practitioners in bringing about change and improvement by developing knowledge, skills, attitudes and capacities in three key areas: 1. Practice-Based Research and Design. 2. Technology and Workplace Learning. 3. Professional and Personal Development. The promotes an entrepreneurial [11] and reflexive approach as it considers the potentiality for creative action of all relevant participants, including the researcher, and relates to the wider social environments [12].

In order for IBL eLearning to take place teachers and students need to master the skills of 'Learning about IBL by eLearning' and 'Learning to do IBL by eLearning'. Successful adoption by teachers and students will require direct examples of IBL using eLearning, its successful implementation along with rich descriptions of both the teachers and students role in the eLearning-Inquiry process. To facilitate and support this process the research will develop IBL inquiry videos, which will disseminate example practices with relevant examples of successful IBL-eLearning implementation and rich descriptions of both teacher and student roles in the classroom.

In addition ISE provides a ready-made system, a systematic evaluation framework based on PISA 2012 – Programme for International Student Assessment. PISA (2012) - a framework developed for the assessment of students' problem solving competence, a framework, which has been used in over 20 countries and economies since the year 2000. Problem solving is a central tenet within the education programs of many countries [13] and it provides the bases for an effective member of society, an independent learner who can apply what they have learnt to different situations. The study of a students` problem solving strengths provides a window into that person's ability to "employ basic thinking" and "other general cognitive approaches" to life's future challenges [14].

Adopting Inspiring Science`s PISA evaluation framework offers the possibility of comparing the impact and the effectiveness of Virtual and Augmented based IBL scenarios on students problem solving competence against the national standards of participating Inspiring Science countries and schools. Teachers are able to develop and include assessment tasks for students' problem-solving competencies based on the PISA 2012 problem-solving framework [15].

IV RESEARCH PLAN

This study will research the use of Virtual and Augmented Reality in Inquiry Based Learning along 3 areas:

2. **An Augmented Reality Learning Object** - With the AR device, it is proposed to design and develop specific AR IBL software to investigate the viability and potential of AR for student learning Science through IBL. A 4th year student in the School of Computer Applications (CA) at Dublin City University (DCU) will be part of the development team.

3. **An Augmented Reality Inquiry Based Science Education Approach** - It is proposed to research and develop a flexible approach to AR IBL. This will be done in an interactive and dynamic way. In this way, new intellectual understandings can arise out of the very act of application [16].

4. **An Augmented Reality (eLearning) Inquiry Based Science Education Instructional video** - through a symbiotic relationship with students it is proposed to develop AR IBL instructional based videos, which will provide relevant examples of successful AR IBL

implementation; with rich descriptions of both teacher and students roles in this type of classroom setting. Thus creating a format and path for other teachers and students to experience science by inquiry through Augmented Reality and in turn to adopt these approaches based on their own educational practices.

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