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Victor C.X. Wang
Florida Atlantic University, USA

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Chapter 55
Personalised E-Learning:
The Assessment of Students' Prior Knowledge in Higher Education

Eileen O'Donnell
Trinity College Dublin, Ireland

Vincent Wade
Trinity College Dublin, Ireland

Mary Sharp
Trinity College Dublin, Ireland

Liam O'Donnell
Dublin Institute of Technology, Ireland

ABSTRACT

Society's use of mobile applications that instantaneously dynamically adapt to input has had the effect of users expecting immediate feedback from all applications based on their specific needs. The traditional concept of a one size fits all approach to managing an online learning environment could perhaps be improved by the inclusion of personalised learning experiences for students based on their prior knowledge. The purpose of personalised e-learning is to tailor learning content to the specific learning requirements of individual students. The focus of this chapter is to review the topic of personalised e-learning and discuss the issues and problems educators may encounter in assessing students' prior knowledge. Information on students' prior knowledge is required to inform the process to facilitate personalised e-learning experiences based on prior knowledge.

INTRODUCTION

In recent years, human communication and interaction has changed dramatically. Mobile devices have played a large part in the changing communication patterns of society. For centuries people gathered around fires, or met at the crossroads to share information and news. No longer is there a need to physically meet to communicate. Information is readily available from all over the world at the touch of a button. For many years, players challenged each other across tables or in fields playing games. Now, gamers can challenge the wits of others through online games like RUZZLE (MAG-Interactive, 2013). And players can challenge the skills of others through online games like FIFA 14 (Fifplay, 2013), from anywhere around the world through the use of mobile devices and the Internet. Some online games are highly addictive (Chih-Chien & Yi-Shiu, 2007; McCormack & Griffiths, 2012; Wan & Chiou, 2007; Young, 2009).

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Online personalisation is rapidly increasing. Personalisation enables users to work with professionals to obtain a service best suited to their specific needs (Hartley, 2007). Many retailers store information on their customers and potential customers in order to target them with products considered necessary, suitable or desirable to that classification of individual.

One possible way to make e-learning more appealing to students is to personalise the content to suit individual students learning requirements. Chen (2009) observes that no fixed learning pathway will suit the learning requirements of all students. The objective of personalised e-learning is to provide learners with pedagogically sound content which is tailored to their specific requirements and preferences (Conlan, O'Keeffe, Brady, & Wade, 2007; Dagger, Wade, & Conlan, 2005). One of the challenges to educators today is to provide flexible, independent learning which is ubiquitously available (Huang, Webster, Wood, & Ishaya, 2006; Koper & Manderveld, 2004). Another challenge for educators is to employ the use of the semantic Web to facilitate personalised learning experiences (Huang et al., 2006; Yalcinalp & Gulbahar, 2010).

Learning Object Metadata (LOM) is the main standard in use for describing learning content (Huang et al., 2006). LOM is saved data which is used to assist easy and relevant retrieval of learning objects. Interoperability is an important factor when considering using LOM or the semantic Web for the purpose of delivering personalised e-learning. Huang et al. (2006) suggest LOM is not adopted as the standard for most Learning Management Systems.

Personalised e-learning would afford educators the opportunity to target students with content considered necessary, suitable or desirable to that classification of student. O'Donnell, Sharp, Wade, & O'Donnell (2012) in a study found that sixty percent of academics surveyed were of the opinion that there is a need to personalise e-learning. Fifty-five percent of academics thought the most important student characteristic on which to base personalisation was the student's prior knowledge and 48% thought personalisation based on prior knowledge would be the easiest to achieve (O'Donnell et al., 2012).

Chen, Lee, and Chen (2005) suggest the main research issues to be addressed in personalised e-learning systems are learner ability and cognitive overload. Traditional e-learning environments do not lend themselves to assessing individual students' learning ability. Therefore, all students participating in a course of study were presented with the same learning content. A proportion of the students due to prior knowledge may not require access to all of this content, while others may require access to course content on some basic or threshold concepts to assist their understanding of more complex concepts. In addition, the volume of content could lead to cognitive overload in some students. The traditional concept of a "one size fits all" approach to managing an online learning environment (De Bra, Stash, Smits, Romero, & Ventura, 2007) could perhaps be improved by the inclusion of personalised learning experiences for students based on their prior knowledge. A personalised e-learning experience would facilitate the students learning ability and reduce cognitive overload by presenting students only with content which was selected to suit their particular learning requirements.

When engaging with technology enhanced learning prior knowledge can influence students interaction with hypertexts and the learning achieved, while also possibly improving effectiveness, efficiency and user satisfaction (Weibelzahl & Weber, 2002). Prior knowledge is the most commonly used characteristic in determining personalisation in Adaptive Hypermedia (AH), prior knowledge includes conceptual knowledge, competencies, and skills (Sah, 2009). Prior knowl-

edge can influence future understanding (Donovan & Bransford, 2005) and learning performances (Stiller & Jedlicka, 2010).

In personalised e-learning educators collect and store data on students knowledge for the purpose of providing them with specific learning objects suited to their individual learning requirements. "Most conventional testing systems assign a score or status indicator to each student after testing, thus determining the learning status of that student, but do not consider how to improve upon it" (Hwang, Tseng, & Hwang, 2008, p. 78). Hwang, Tseng and Hwang (2008) suggest these test results would be put to better use if they were used to inform a personalised system which could then propose learning content to address the identified gaps in students knowledge. Students assessment results would be saved in learner profiles and accessed to inform the personalised e-learning process based on students individual characteristics (Lazarinis, Green, & Pearson, 2010).

Personalised e-learning would be accommodated by the addition of a module to the existing Learning Management System (LMS) in use by the Higher Education provider. A LMS is used for the delivery of online learning. A LMS is a "server-based or cloud-based software program" (Piña, 2013, p. 2) which provides functionality for: organising and administering online courses; storage facilities for student information, course notes, presentations and Web links; and, communication facilities for Web conferencing, discussion boards, and online chat.

In contrast to earlier societies, where the norm was for older members of society to pass knowledge and skills to younger members, now with the rapid advances in the use of technology, the younger generation are coming to grips with these devices and applications at a quicker pace than the older generation and are sharing their skills and knowledge with the older generations. The younger generation of technology consumers are generally referred to as the 'Net Generation' (Beyers, 2009; Evans & Forbes, 2012; Worley, 2011). Educators should be aware of the functionality of mobile devices to enable them to use these technologies to engage students with their studies. Personalising e-learning may be the way forward in the use of technology in higher education. "In recent years, we have seen an explosive growth in the use of Web-based technology in distance learning systems" (De Bra et al., 2007, p. 285).

The background section provides a brief introduction to the concept of prior knowledge and other key terms and definitions used in this chapter. The assessment of students' prior knowledge section discusses the significant impact which prior knowledge can have on current and future learning and reviews some approaches to assessing this knowledge. Some of the issues associated with assessing students' levels of prior knowledge, students' engagement with assessment strategies and how effective assessment strategies are in estimating students' level of prior knowledge are reviewed. The next section reviews some of the problems which may be encountered by educators who aspire to put in place a personalised e-learning system to enhance the learning experiences of their students. These problems may include: pedagogical; technological; ensuring the correct alignment of learning objects with the identified gaps in students knowledge; and the time constraints impacting on educators engagement with personalised e-learning systems. Further research is required to resolve some of the issues and problems in personalising e-learning before freely available online authoring tools to be used by non-technical authors are achievable. Concluding with the view that personalised e-learning based on prior knowledge is not as yet easily achievable by many educators.

BACKGROUND

The very fast and vast pace at which technology is advancing, the reduction in size of mobile devices and the prolific availability of applications,

all increase the complexity involved in educators effectively using technology to enhance the learning experience of students. An educator is one who engages with the theory, practice, skill and art of teaching.

The assessment of students' prior knowledge to gather data to inform an application for personalising e-learning is not easily achieved. There are both pedagogical and technological complexities involved in personalising e-learning (Huang et al., 2006; O'Donnell, Sharp, Wade, & O'Donnell, 2013).

Assessment of Prior Learning (APL) is used to establish students knowledge, skills and competences against a pre-determined standard (Brinke, Sluijsmans, & Jochems, 2009). "Prior Learning Assessment and Recognition is "learner-centred" in that it validates learning regardless of the vehicle whereby it is attained" (Bélanger, 1998, p. 117). Thus giving learners credit for what they already know and the opportunity to move forward and build on their existing knowledge. "The process of giving official acknowledgement to formal, informal and non-formal prior learning is commonly labelled as assessment, accreditation or recognition of prior learning (APL), representing a practice that is expanding in higher education in many countries" (Stenlund, 2010, p. 783). "Although APL is frequently used in workplaces and vocational education, it is practised less in universities, and research is lacking in this context" (Brinke et al., 2009, p. 61). As suggested by Brinke et al. (2009) research on APL in universities is lacking. To fill this identified gap in existing research, this chapter will focus on the assessment of prior learning in higher education. "APL is a specific form of assessment that learners take prior to the formal start of an educational programme" (Brinke et al., 2009, p. 63), in the context of this chapter APL and assessment of prior knowledge are synonymous; they both refer to the assessment of students' knowledge, skills and competences prior to engagement with a course of study. Gibbs and Armsby (2011) note "that the desire for recognition of prior learning is forming a central plank of lifelong learning by encouraging its more frequent use in the European Higher Education Area and its advocacy by ministers and others in the Bologna Process" (Gibbs & Armsby, 2011, p. 388).

The term e-learning refers to the use of Information Communications Technology (ICT), hardware and software to facilitate online learning. "The advent of ICTs has impacted prior learning assessment and recognition (PLAR) by expanding the potential for knowledge acquisition, expression, and delivery" (Brown, 2010, p. 1). The term personalised e-learning in the context of this book chapter means the tailoring of learning content to suit the specific learning requirements of individual students. Prior knowledge is the range of knowledge a student has accumulated on a specific domain prior to embarking on a course of study in that domain. Higher education refers to providers of education which have the authority to confer the following awards: Higher Diploma; Bachelor of Science, Bachelor of Arts, Post Graduate and Master Degrees; PhD, Doctorate and professional qualifications, across a range of disciplines, on successful completion of standardised courses of study or research.

ASSESSMENT OF STUDENTS' PRIOR KNOWLEDGE

Weibelzahl and Weber (2002) suggest the broad range of prior knowledge which students have when embarking on a course of study will impact on their engagement with the course content to such an extent that students may get bored if they have to revisit content with which they are already familiar. Weibelzahl and Weber (2002) propose assessing students prior knowledge through three different testing methods "multiple choice tests, forced choice tests, and gap filling tests" (Weibelzahl & Weber, 2002, p. 449), based on the information gathered in the pre-tests using

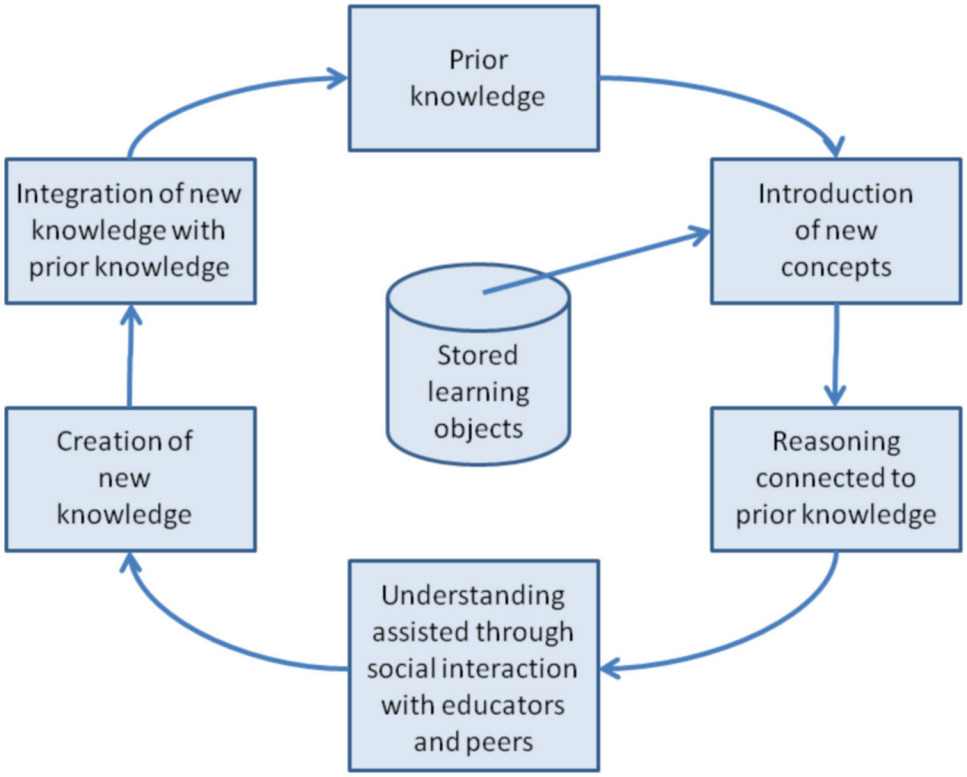
NetCoach students are directed to pages which relate to the identified gaps in their knowledge (Weibelzahl & Weber, 2002).

Bixler (2011) suggests teachers should assess students' level of prior knowledge either through questioning or observation, this process would also help the educator in identifying any misconceptions or misunderstandings the students may have. Once an educator identifies students' misconceptions and misunderstandings, they would then be in a better position to provide clarification on the concepts to ensure the students have a good foundation on which to base new knowledge.

Knowledge cannot be transmitted from educators to students irrespective of the learning environment, instead knowledge is synthesised through social encounters with educators and peers (Harris & Rausch, 2013), therefore the use of discussion boards and Web mediated communications must be carefully monitored to ensure the required learning outcomes are targeted.

Figure 1 illustrates some of the steps or building blocks involved in the process of building knowledge. Students bring prior knowledge to the equation when engaging with a new course of study. Educators share new concepts on a regular basis with the students on the course. The new concepts are stored as learning objects which the students can access electronically. A combination of: prior knowledge; attending lectures; engaging online; reasoning; understanding; social interaction with peers and educators, are all involved in the process of synthesising new concepts along with prior knowledge to create new knowledge.

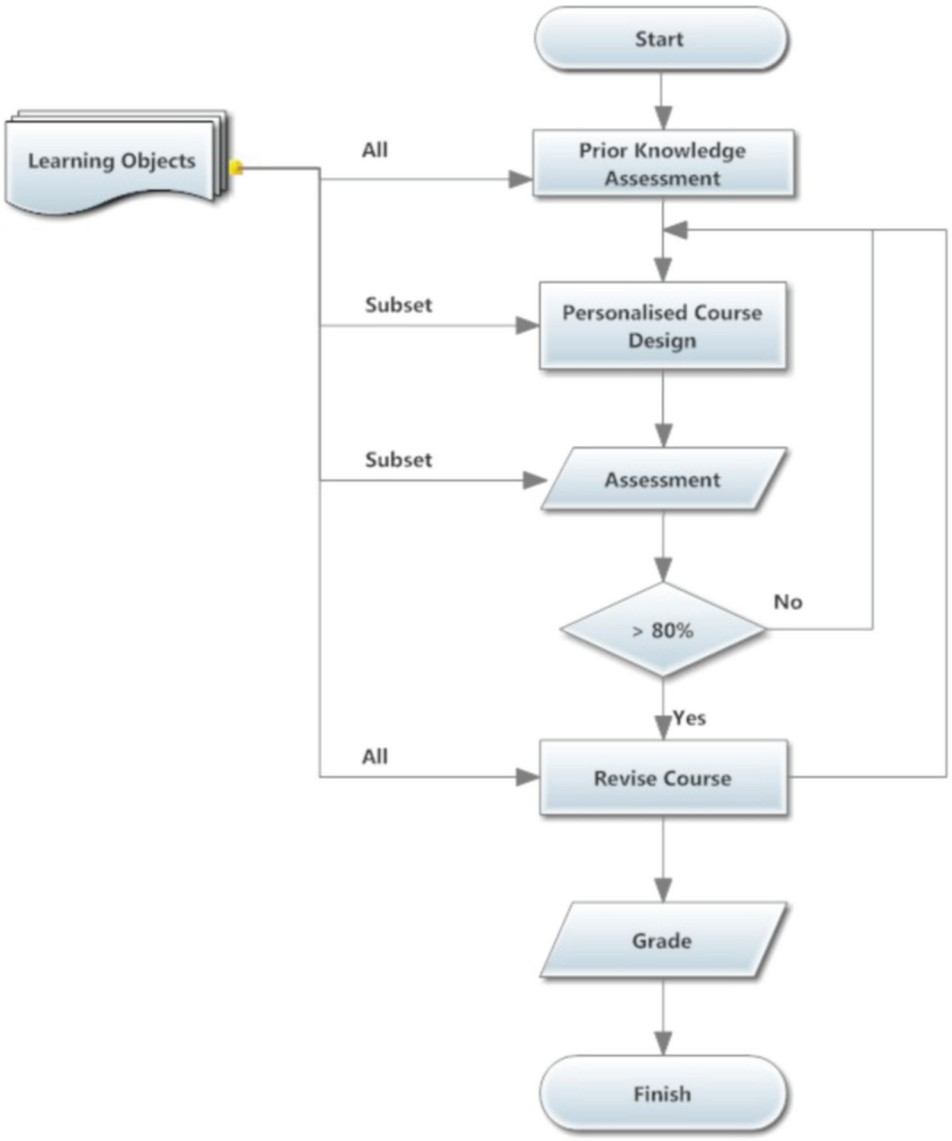
Figure 1. The building blocks which turn concepts into new knowledge



In time the new knowledge obtained will become prior knowledge to be used as a building block for the acquisition of further knowledge.

Figure 2 shows a process to recommend personalised learning objects to students based on each individual student's prior knowledge. At the start of a specific module in a course, each student is assessed on their prior knowledge in the domain based on all the learning objects in the module. Based on the results achieved, a personalised course is designed to suit each individual student's learning requirements. The students are provided access to their personalised learning portal and at an appointed time the students are again assessed on their knowledge of the domain. Students who achieve more than 80% in this assessment are advised to proceed. These students are facilitated with access to their personalised learning objects

Figure 2. Process to recommend learning objects based on a student's prior knowledge



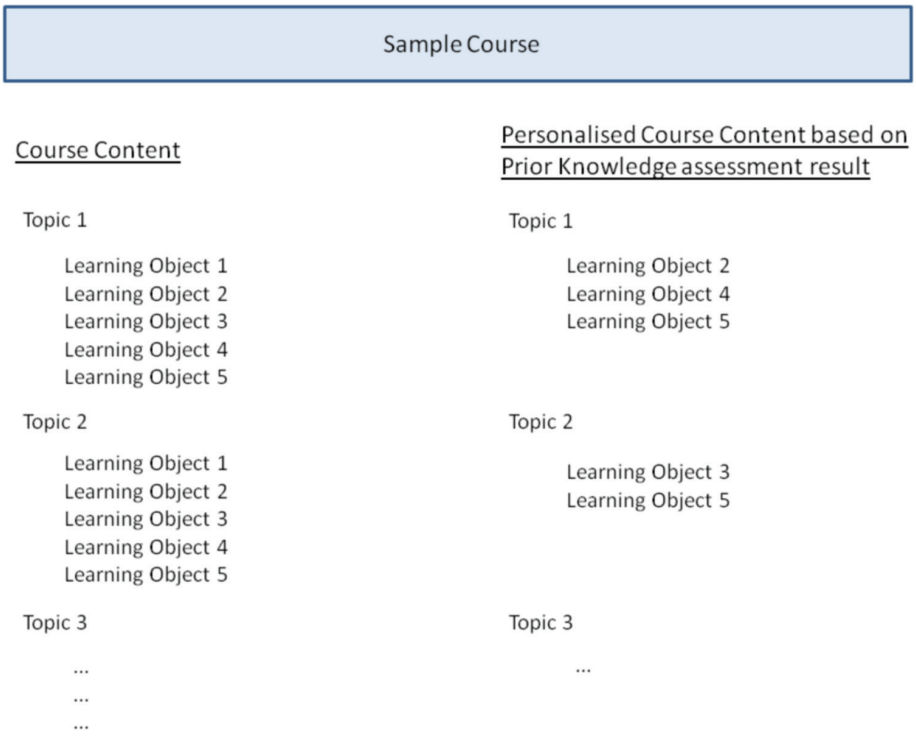
for revision purposes prior to summative examinations or end of module/term/year examinations. The students who achieved 80% or less in the assessment shown in Figure 2 are directed through the personalised course again to address questions about the learning objects which they answered incorrectly in the assessment.

Figure 3 illustrates course content for a sample course and how a subset of the course content is extracted to present to each student based on the results achieved in the assessments of their prior knowledge. The subset of the course content presented to each student should reduce as the student's knowledge increases due to engagement with the learning objects. The educator within the learning environment would still have to cover all the topics and learning objects required to comprehensively represent the syllabus required for that course of study. The personalised course content would be available online as an enhancement to the classroom learning experience in the form of blended learning. Alternatively, personalised e-learning could be used for courses delivered exclusively online, for example on distance learning programmes.

ISSUES

Johnson-Glenberg (2010) found that embedded quiz questions resulted in higher learning gains for lower prior knowledge users than experts, because the experts were adverse to mandatory quizzes and the content was already familiar. They also advocated "creating more adaptive systems based on stealth methodologies and balanced novelty that will maintain individual learners' in their appropriate, ongoing ZPD" (Johnson-Glenberg, 2010, p. 169). The Zone of Proximal Development (ZPD) is the difference between what one can learn by oneself and what one can learn with the assistance of others, this was a concept introduced

Figure 3. A subset of course content is selected to personalise the learning experience



by Lev Vygotsky (Cole, John-Steiner, Scribner, & Souberman, 1978). Students can learn from peers as well as educators.

Educators should spend some time considering what pedagogical impact they wish to achieve by personalising e-learning and regularly monitor the input and the output to ensure that the students are benefitting from the best possible learning experience the educator using the personalised e-learning system can provide. Educators must also ensure that the metadata collected to populate the personalised e-learning system is truly representative of students' prior knowledge.

Some students perform better in examinations than others for various different reasons. Therefore, the grade accredited to a student may not be truly representative of their understanding and knowledge. To subject students to an assessment of their level of prior knowledge may provide educators with a better insight into the students' level of understanding and knowledge of a subject. "It might be argued that capabilities are what we are seeking, for they might be more transferable in the real world than knowledge necessarily grounded in the past" (Gibbs & Armsby, 2011, p. 395). It is important that educators consider students prior knowledge, cultures and values for effective classroom practice (Larrotta & Serrano, 2011).

How can an educator be sure that the learning objects directed towards the students by the personalised application are relevant to their individual learning requirements? Some authoring tools or modules for personalisation operate like a black box; the academic authors are insufficiently competent in computer programming to have real control over the adaptation processes. Therefore, the only way academics can judge the effectiveness of the adaptive/personalised e-learning system, is to review the levels of prior knowledge achieved by students in comparison with the learning objects selected to further enhance the students learning experience. Student feedback could be sought and analysed to ensure the students are targeted with learning objects which reflect the gaps in their subject knowledge.

Some of the implementation issues to be considered when adding a plug in for personalisation to an existing Learning Management System are: cost; hardware, software and infrastructure requirements; technical expertise required to support users; training of staff and students; and time constraints and commitments.

PROBLEMS

The pedagogical and technological complexities involved in establishing students' prior knowledge in a specific subject area could prove problematic for many educators. Through discussion with peers and technical experts, educators could be assisted in understanding and dealing with the complexities encountered in designing personalised e-learning applications, and appropriate methods to use to assess the students' prior knowledge.

Another problem for educators to resolve is to ensure the correct alignment of learning objects to match the gaps in students' knowledge which have been identified through the assessment of prior knowledge. The alignment of learning objects to match gaps in students' prior knowledge would be challenging and time consuming to any educator regardless of their technical competence. Time constraints can impact on educators' ability to engage with innovative teaching opportunities (Dagger, Wade, & Conlan, 2004).

A common problem in curriculum design in higher education is that students do not have the necessary prior knowledge and skills required for the more advanced courses (Hailikari, Katajavuori, & Lindblom-Ylanne, 2008, p. 1). Personalised e-learning would provide educators with the opportunity to identify the gaps in students' prior knowledge in order to address the gaps and any

misconceptions identified. Johnson-Glenberg (2010) proposed learning environments should be automatically adaptive, enabling both the student and the system to drive the learning experience.

FUTURE RESEARCH DIRECTIONS

Many research projects have been conducted over the past thirty years which were aimed at developing authoring tools or modules to bring closer to realisation personalised e-learning for all students. Still, many educators would not have any experience of using authoring tools for personalising e-learning. Personalisation of e-learning for all students is not easily achievable. As yet, no freely available online application will enable non-technical academic authors create personalised learning experiences for their students. Perhaps, if an authoring tool or module for creating personalised e-learning experiences based on prior knowledge was freely available online, more educators would engage with the process of personalising e-learning. Further research is required to realise a freely available authoring tool or module which can be used by non-technical authors as part of an existing Learning Management System. As previously mentioned academic authors would not only have to familiarise themselves with the functionality of an authoring tool or module for personalisation based on prior knowledge they would also have to consider the pedagogical impact on the students' learning experience.

CONCLUSION

A synthesis of the issues and problems which exist in relation to the personalisation of e-learning based on prior knowledge indicates that personalised e-learning based on prior knowledge is not easily achievable, and further research, development and discussion is required to bring this concept closer to realisation by many academics.

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KEY TERMS AND DEFINITIONS

Assessment of Prior Knowledge: In the context of this chapter assessment of prior learning (APL) and assessment of prior knowledge are synonymous, they both refer to the assessment of students' knowledge, skills and competences prior to engagement with a course of study.

Assessment of Prior Learning (APL): The assessment of students' knowledge, skills and competences prior to engagement with a course of study.

Educator: One who engages with the theory, practice and skill/art of teaching.

E-Learning: The use of information communications technology (ICT), hardware and software to facilitate online learning.

Higher Education: Providers of education which on successful completion lead to the conferral of: Higher Diplomas; Bachelor of Science, Bachelor of Arts, Post Graduate and Master Degrees; PhD, Doctorate and professional qualifications, across a range of disciplines.

Learning Management System: A LMS is used for the delivery of online learning. A LMS provides functionality for: organising and administering online courses; storage facilities for student information, course notes, presentations and Web links; and, communication facilities for Web conferencing, discussion boards, and online chat.

Personalised E-Learning: The purpose of personalised e-learning is to tailor learning content to the specific learning requirements of individual students.

Prior Knowledge: The amount of knowledge a student has accumulated on a specific domain prior to embarking on a course of study in that domain.