Impact of Metacognitive Awareness on Learning in Technology Enhanced Learning Environments

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Abstract

With the advent of internet technologies and the closer integration of mobile and ubiquitous devices, learning and teaching has changed the way we view the learning process. Indisputably, there are many ways of using technology to support students' learning which enables them to manage the pace, time and place of their learning. Technology enhanced learning (TEL) can place students at the centre of the learning process, but this means that students need to take more responsibility for their learning. The literature refers to this as self-directed and self-regulated learning (Liu, Gomez, Khan and Yen, 2007; Nicol, 2006). Students can take more control over their learning and develop leadership of their own 'learning curve'. Self-directed learning includes management of the learning materials, monitoring learning progress and regulating cognitive learning styles. However, this requires students to develop metacognitive strategies so they can identify their own learning styles in the appropriate formal and informal learning situations. This paper aims to investigate the impact of students' metacognitive awareness on their learning outcomes within technology enhanced learning environments and concludes that the design of a TEL environment and the development of students' metacognitive skills have a direct bearing on learning performance.

Keywords

Technology enhanced learning, self-regulated learning, metacognition, learning strategies.

Introduction

The emergence of the internet and latest Information and Communication Technologies (ICT) have brought a whole new dimension to almost every aspect of society and in particular, to higher education. Learning and teaching in many disciplines now occurs within technology enhanced environments. ICT is used as a means for engaging in such activities as communication, socialisation, networking and researching but its unique affordances provide new approaches to the design of interactive learning environments. In such environments, there are many factors that can influence learning. A learning environment has a variety of elements including pedagogical approach, learning materials and activities as well as addressing students' learning needs. Motivation and students' learning styles are additional important factors that influence learning (Mulwa, Lawless, Sharp, Wade & Sanchez, 2010). In this paper the authors discuss how the design of a TEL environment and students' metacognitive skills can affect learning performance.

In most TEL environments students have the freedom to navigate through a wide range of resources, represented as text, graphics, animation, audio, and video, which are commonly presented in a non-linear way (Azevedo, Cromley, & Seibert, 2004; Mulwa et al, 2010). Learning in TEL environments

require students to regulate their learning by making decisions about what and how to learn, how much time to spend on the material, and determining whether the material has been understood or not (Azevedo et al, 2004). TEL allows students to take more control over their learning i.e. it provides a more heutagogic, as opposed to pedagogic/andragogic, model of learning and therefore works best for students who are motivated, self-directed, well organised and strategic. The current approaches used in TEL are less effective for those who require more support and direction for their learning (Flynn, Concannon & Bheachain, 2005). Corliss and Spitulnik (2008) state that "many students lack the self-regulated learning strategies needed to be successful in these types of learning activities".

Self-regulated learning is a form of metacognitive guided learning whereby students set learning goals for themselves, monitor their progress, regulate and control their cognition (Azevedo & Cromley, 2004). Self-regulation is the ability to develop knowledge, skills and attitudes that can be transferred from one learning environment to another as well as to a leisure and work environment (Boekaerts, 1999). Students who are aware of their learning strengths and weaknesses are self-regulated students (Benmimoun & Trigano, 2009). Self-regulated students can organise, manage and adapt their thoughts into skills that are required for learning (Shannon, 2008). They continuously monitor their progress towards a goal or outcome and redirect efforts when necessary (Shannon, 2008). Students need to be aware of their own thought processes and monitor the effectiveness of their learning strategies to develop an ability to self-regulate (Zimmerman, 2008). Furthermore, it is essential that students attain strategies such as identifying the main points in a given task, asking questions or dealing with a task from start to finish (Barak, 2010), and be motivated to use developed or newly acquired self-regulatory strategies effectively (Matuga, 2009).

Within TEL environments, students' achievement is influenced by the level and effectiveness of applied self-regulation techniques, or the ability to plan, monitor and evaluate their own behaviour and learning strategies (Matuga, 2009). A study by Azevedo et al. (2004) investigated whether undergraduate students could regulate their own learning about the circulatory system using a hypermedia environment. Results demonstrated that students who regulated their learning by using effective strategies, monitored their understanding, and adapted their time and effort, showed a significant improvement in their learning. By contrast, those who used less effective learning strategies limited their ability to manage their metacognitive monitoring activities and failed to show a significant improvement in their learning (Azevedo et al, 2004).

Azevedo & Cromley (2004) provide evidence to show that not all students have the ability to regulate and deploy certain key strategies during their learning. However, the presence of a tutor who assisted them in establishing goals and using effective strategies for regulating their learning, created a significant improvement in learning. Students who were given a list of goals to guide their learning were less effective at regulating their own learning (Azevedo & Cromley, 2004).

A study to measure students' self-regulation was carried out by Zimmerman (2008) who employed learning diaries, which were collected at the end of each week, to structure a series of questions regarding events during a study session. Students were asked to complete a questionnaire that included items about motivation and learning strategies at the outset and at the end of the study. The control group of students were asked to complete a pre-test and a post-test but did not receive self-regulatory training or use the diaries. Zimmerman (2008) reported that students who received self-regulatory training displayed significant improvements in intrinsic motivation, self-efficacy, effort, attention and self-motivation areas whereas those in the control group showed only increases in self-motivation.

Metacognition

The engine that drives self-regulated and self-directed learning is metacognition. Shannon (2008) suggests that students use metacognition to identify suitable learning strategies in the appropriate

learning situations. The term of metacognition was introduced by Flavell to describe people's own thinking processes and how they gain control over them. The concept of metacognition is the "knowledge and cognition about cognitive phenomena" (Flavell, 1976:906) It includes students' learning and awareness of their learning, how they control their strategy selection and change plans when needed (Phelps et al, 2002). Students who are aware of their motives, responsibilities, personal cognitive processes and have control over their learning strategies use metacognition (Phelps et al, 2002). Barak (2010) takes the concept further by suggesting that metacognition involves the use of strategies to control cognitive activities in order to meet a particular goal.

Phelps (2002) suggests that metacognitive awareness "empowers learners to become more independent in their approach to learning with, and about, computers in the future" (Phelps et al, 2002:481). Metacognitive skills of students may provide distinct advantages in contexts of rapid change, such as keeping up-to-date in the field of Information Technology where knowledge in using a particular piece of software is likely to become out-of-date over a short period of time (Phelps et al, 2002).

Students with strong metacognitive skills can foresee problems that may arise during a learning experience, and they are able to better allocate their cognitive resources for learning to cope. Furthermore, they are better able to monitor their learning experience and determine the information they understand or the information they need to investigate more (Vogel-Walcut & Fiore, 2010).

Metacognition in TEL environments

Zimmerman (2008) argues that TEL environments have the potential for improving learning, but they require skills including goal setting, monitoring, controlling cognition and motivation. Moreover, he argues that the improvement of high-tech learning environments can assist students in using self-regulated learning strategies (Zimmerman, 2008). Azevedo and colleagues have indicated that learning in a TEL environment requires self-regulatory skills to organise, navigate, and combine information into feasible mental models but, students experience particular difficulty in using metacognitive skills in TEL environments. They cannot appropriately plan, set goals and reflect on their progress (Azevedo et al, 2004). Several research studies have confirmed that students, who do not have the ability to regulate their learning in a TEL environment, learn little and the use of such environments for these types of students rarely provides them with a deep understanding of complicated subjects (Azevedo & Cromley, 2004). Commonly, regulating cognitive systems, organisation of, and access to, different representations of information and determination of an adequate instructional sequence, are seen as challenging for students (Azevedo & Cromley, 2004).

Vogel-Walcut & Fiore (2010) suggest that in order to facilitate students' overall retention and use of knowledge, a major goal of education must be to assist students in monitoring their learning. Metacognition has proven to be a particularly useful strategy for such settings that involves awareness and regulation of cognitive processes. Promoting the development of metacognitive skills encourages students to anticipate, monitor and reflect upon their own cognition and can lead to better engagement with learning materials. It can support students in developing their metacognitive skills in further learning or performance situations and in monitoring activity that takes place during critical performance events. Additionally, in the literature it's reported that despite the different characteristics of students, metacognitive support can improve learning (Vogel-Walcut & Fiore, 2010).

An understanding of learning styles, such as being aware of one's own learning processes and operating control over learning strategies, can be used to support or increase metacognitive awareness (Siadaty, 2007). Students can use different learning styles to select different learning pathway through materials, accessing and processing information that influence the quality of learning process (Ulieru, Draghicescu, Petrescu, & Stancescu, 2008). For instance, some students may

understand information better by watching or listening, others by reading, and others by doing and moving or through practical work in a hands-on environment (Cemal Nat, Dastbaz & Bacon, 2008).

Visual cues structure the design of the interaction in a TEL environment and have the potential to make a significant difference in the effectiveness of metacognitive development. Kirsh (2005) notes that the interface design of an environment which helps students to manage the resources provides tools, supports and advice. The success of a TEL environment "depends as much on the details of how tools, content and support are implemented and visually presented as on the simple fact of their presence" (Kirsh, 2005:01). For example, discussion forums and chat rooms will not be used if students do not notice them. Content will not be visited if the links which identify them are not well marked. Students need to actually notice the information first, and then to recognise that it is important (Kirsh, 2005).

Currently, the authors are running experiments in a formal learning design environment with undergraduate students to investigate their actions and evaluate their levels of metacognition related to their learning performance. The learning environment includes learner heuristics such as discussion forum, chat tools, mind-mapping and note-taking tools. It also provides additional metacognitive development activies. For example, students are asked to complete a pre-knowledge test, an information recall test and an information retention test during the experiment. While studying the subject within the TEL environment students have freedom to navigate through the learning materials which are presented in text, audio, image and video formats, and find a way of learning that suits them best.

Conclusion

In this paper we have discussed the factors that are required to help students gain the full benefits of learning within TEL environments. On the one hand, students need to use metacognitive strategies to manage their learning, particularly when they are given freedom to determine how they access and use a variety of on-line resources. On the other hand, TEL environments must include relevant metacognitive and support activities by considering students' differences in skills, preferences and metacognitive needs. Finding effective ways of learning depends on two key factors: the design of a TEL environment and students' metacognitive skills. Although, most students having difficulty in regulating their learning process and strategies, there are different learning activities (i.e. wiki, concept-mapping and discussion forums) that can be utilised to encourage skills development. Future work involves the discussion of students' behaviours within a formal learning design environment where students have full control of their learning.

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