A Theoretical Framework of Self-Regulated Learning with Web-Based Technologies

Abstract: In the context of web-based technologies (WBT), a framework of self-regulated learning (SRL) is presented. SRL involves the cyclical actions of 1) task comprehension, 2) planning, 3) formation of strategies and 4) evaluating strategy effectiveness. A SRL with WBT framework is presented and suggests that SRL is a consequence of learner characteristics and supportive digital technologies to deliver learning strategies. Learner characteristics such as self-efficacy, experience, goal orientation, motivation, task-value beliefs and gender influence the use of SRL strategies and technology. WBTs facilitate the delivery of instructional strategies to support SRL by providing teachers and students with accurate, meaningful and accessible information. Such a paradigm proposes that an understanding of the ongoing reciprocal interactions between the elements of the digital environment and learner characteristics is needed to enhance SRL.

Self-regulation (SR) first appeared in educational literature in the 1960s and refers to the collective actions of individuals to achieve a desired goal (Chen, 2002). The term *self-regulated learning* (SRL) emerged in the 1980s and was specifically used to describe SR behaviours critical to achieving an academic or learning goal (Dinsmore, Alexander, & Loughlin, 2008). Instructional applications of SRL (theoretical and practical) reflect cognitive and metacognitive views of learning, including recognition of requirements, developing strategies and abilities to achieve these requirements, monitoring performance, rehearsal and retrieval of information (Roger Azevedo, Moos, Greene, Winters, & Cromley, 2008; Roll, Aleven, McLaren, & Koedinger, 2011; Sitzmann, Bell, Kraiger, & Kanar, 2009). Instructional applications of WBTs have proven particularly effective in promoting SRL (Barak, 2010; Denton, Madden, Roberts, & Rowe, 2008; Geddes, 2009). WBTs have been referred to by many names, such as technology enabled learning environments (TELE), computer-based training (CBT), learning management systems (LMS) and online learning environments (OLE). Each technology, while slightly different in application, serves the same fundamental purpose, that is, the delivery of learning strategies. This paper reviews contemporary theory and current empirical investigations of WBT to promote SRL. A theoretical framework of WBT and SRL is presented.

Self-Regulated Learning Theory

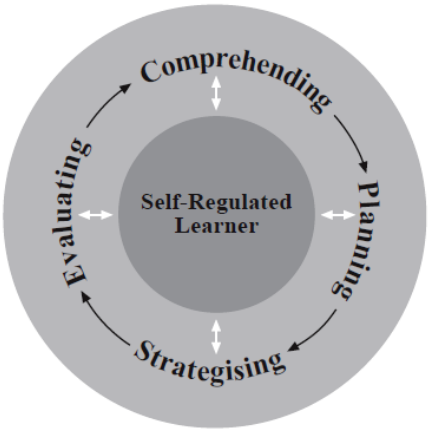
A fundamental concept associated with SRL is the primacy of *self*. Zimmerman (2002) proposed a three cyclical phase model of SRL which involves the concept of self in terms of 1) forethought, 2) performance and 3) reflection. The first phase, forethought, includes self-motivation and task-analysis processes such as goal setting and strategic planning. Self-motivation is influenced by a student's beliefs regarding the purpose of learning (i.e., the usefulness of the task) and perceptions of personal abilities to achieve those objectives. The second phase, performance, involves self-control and self-observation. Self-control refers to the use of specific strategies such as imagery, self-instruction, attention focusing and task strategies. Self-observation describes self-monitoring, time management and study habits. The third phase, self-reflection, includes self-judgement and self-reaction. Self-judgment involves self-evaluation or a comparison of self-observed performance against a standard (Miller, 2009; Shen, Lee, & Tsai, 2008) and causal attribution which is the gauge of success and failure (Hareli & Hess, 2008). Self-reaction can either be defensive or adaptive depending on an individual's performance evaluation. Defensive reactions include withdrawing or avoiding opportunities to learn (Moos & Azevedo, 2008); adaptive reactions include changing learning strategies or behaviours to increase the effectiveness of learning (Artino & Stephens, 2009).

Winne's (2005) Four Turning Points Model continued the work of Zimmerman (2002) by specifying learning behaviours which occur at each of the three cyclical phases. The Four Turning Points Model suggests critical processes or turning points which must occur during SRL. The model further proposes that learners must *understand the learning environment* (Turning Point 1). This turning point requires a learner to understand the factors affecting academic success such as time requirements, expectations and environmental influences. Winne suggested that *Goal setting* (Turning Point 2) can only proceed once Turning Point 1 is satisfied. Turning Point 2 requires a learner to identify the academic goal and begin developing strategies for achieving that goal. The *ability to apply learning strategies* (Turning Point 3) requires a learner to have or be able to obtain the necessary skills in order to implement learning strategies and can only occur once Turning Points 1 and 2 are satisfied. When all turning points are satisfied, the learner must also be motivated to spend the time and effort necessary to *apply the learning strategies* (Turning Point 4).

Zimmerman (2002) suggested that SRL can be developed in learners via instruction and modelling by parents, teachers, coaches and peers. Promoting SRL requires an understanding of the roles and relationships between each phase of SRL, the learning environment and individual student characteristics. Based on the SRL

theories of Zimmerman (2002) and Winne (2005), Figure 1 presents a summary of the essential cyclical processes of SRL. A learner's comphrension of academic requirements is the consequence of prior knowledge, experience and interaction with teachers and peers (Nicol, 2009; Schunk, 1985; Steffens, 2008). Planning requires devoting time to academic tasks and the formation of strategies to achieve learning objectives (Magno, 2010; Yang, 2006). As the student works towards the learning objective, self-monitoring facilitates personal understanding of current progress and the ongoing capacity to evaluate or adjust learning behaviour (Chiou & Wan, 2007; Kramarski & Mizrachi, 2006).

Figure 1. The Cyclical Processes of Self-Regulated Learning



Self-Regulated Learning with Web-Based Technologies

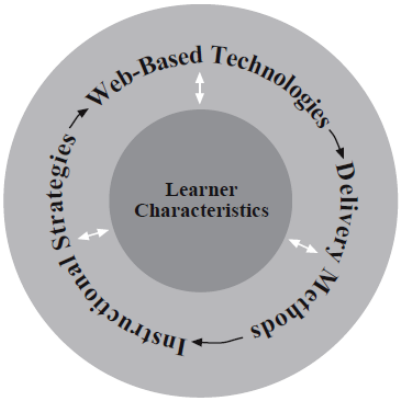
Winne (2006) argued that a fundamental objective of education is to enhance students' capacity for independent learning (i.e., SRL). Winne suggested that learning requires the use of tools (i.e., cognitive operations and physical devices) and materials (i.e., text, diagrams, video and audio). WBTs, essentially, provide these particular digital tools that are focused on facilitating SRL. For example, computer-based assessment (CBA) provides automated test marking and feedback, computer-based training (CBT) provides self-paced learning and learning management systems (LMS) such as Moodle support the delivery of instructional resources. However, Winne stated that tools and technologies can only support SRL if they have been designed and implemented to that purpose. Also, students and teachers must have the skills and motivation to use the digital technologies. In this regard, the design and delivery of online instruction requires additional consideration compared to traditional (face-to-face) learning environments.

Adeyinka and Mutula (2010) proposed the Content Management System Success Model which illustrates that LMS are capable of improving teaching and learning if the technical infrastructure, which includes hardware, software and support is available to users (staff and students). Further, the LMS has the potential to support SRL if it meets the learning requirements and provides motivation. Similarly, Pollard, Gupta and Satzinger (2010) suggested that contemporary approaches to systems development, including LMS, are extending user focus by adopting a *service-oriented* view which emphasises the importance of user (i.e., teachers and students) support. Tsai's (2009) Strategic E-learning Model identified that WBT, particularly online learning technologies, have four elements which differ from traditional (face-to-face) environments including 1) flexibility of time and space, 2) indirect social interactions, 3) abundance of information and 4) dynamic learning interfaces. Such characteristics render SRL more difficult in online, as opposed to traditional, learning environments. For example, the flexibility of time and space, while increasing access to learning opportunities simultaneously reduces direct social contact gained from classroom interaction (Hsu, Ching, Mathews, & Carr-Chellman, 2009). The availability and abundance of information provided via WBT (i.e., internet) also creates challenges such as non-linearity of information and information overload (Narciss, Proske, & Koerndle, 2007). Venkatesh, Morris, Davis and Davis's (2003) Theory of Acceptance and Use of Technology (UTAUT) illustrates that user acceptance of technology is influenced by four types of personal beliefs; 1) social beliefs include the expectations of peers towards using a particular technology, 2) performance beliefs relate to the views of the technology to improve learning, 3) effort beliefs are determined by the ease of use of the technology and 4) infrastructure beliefs refers to the level of support the user presumes will be available.

Based on these theories, models and methodologies of technology and learning (Adeyinka & Mutula, 2010; Pollard, Gupta, & Satzinger, 2010; Tsai, 2009; Venkatesh, Morris, Davis, & Davis, 2003), Figure 2 summarises the interrelations between digital technologies, delivery methods and instructional strategies to

support SRL. SRL is enhanced when instructional strategies and delivery methods are embedded into the design and use of the technology with a focus on enhancing student comprehension of the task, developing a plan and selecting strategies to complete the task and while evaluating the effectiveness of that plan on those strategies. For example, WBTs such as LMS (e.g., Moodle and BlackBoard) and other resources (e.g., Apples teaching apps) support the delivery of instruction by providing teachers and students with accurate, meaningful and accessible information. Further, Digital collaborative technologies (e.g., Elluminate, Prezis and discussion forums) facilitate the delivery of synchronous communication with teachers and peers. Computer-based training (CBT) and assessment technologies (e.g., SAM, Syngro and Gradebooks) deliver self-paced learning and immediate formative feedback to students.

Figure 2. Self-Regulated Learning with Web-Based Technologies



As mentioned previously, while WBT (i.e., online learning) creates new opportunities for learning it also creates challenges; the increased flexibility, indirect social interactions, abundance of information and the need to learn new WBT (if not addressed) may hinder SRL. It is therefore important the SRL phases, that is, comprehension, planning, strategizing and evaluating are addressed in the instructional strategies delivered through WBT. Trigano's (2006) study established that scaffolded guidance of SRL strategies (i.e., prompting) was critical to student's use of cognitive strategies. Research by Yang (2006) involving college students from Korea showed that the embedding of SRL strategies (i.e., rehearsal and progress monitoring) in their LMS increased student use of performance control (i.e., self-instruction and self-monitoring) and cognitive strategies. Green, Bolick and Robertson (2010) demonstrated that the incorporation of SRL (i.e., constant evaluations) in the design and delivery of WBT encouraged students to use planning strategies. Santhanam and colleagues (2008) sampled undergraduate business students and found that SRL increased when instructional strategies were used to create increased understanding of learning requirements (i.e., assessing feedback). Sitzmann and colleagues (2009) confirmed that students who were encouraged to use SRL strategies in the early stages of web-based learning had higher test scores than students who were not encouraged to use the strategies. Based on a sample of 128 secondary students, Azevedo and colleagues (2008) confirmed that students who were provided with scaffolded support showed significant differences in SRL strategies (i.e., planning, monitoring and strategies) and were able to gain more declarative knowledge than students not exposed to scaffolded support. Similarly, research by Kramarski and Michalsky (2010) showed that students who were encouraged to use SRL through metacognitive guidance outperformed students who were not provided such guidance. Shen, Lee and Tsai (2008) noted that scaffolded support of problem-based learning (PBL) scenarios improved student grades and SRL in WBT.

SRL often involve interactions with peers and teachers. A considerable volume of recent empirical research has established the utility of WBT to enhance collaboration and self-monitoring. For example, WBT such as groupware (e.g., E-mail, Google Documents, Elluminate and Prezi) may be used to facilitate communication and collaboration capacity of individuals and groups. Based on a sample of 86 middle school students from Israel, Kramarski and Mizarchi (2006) demonstrated that the use of an online discussion tool increased student interaction and use of SRL strategies. Nicole (2009) noted that students perceived online collaboration as beneficial. Lenne, Abel, Trigano and Leblanc (2008) reported that students collaborated in knowledge communities to store and disseminate resources. Steffens (2008) observed WBT offered a better collaboration experience than traditional learning environments. Denton and colleagues (2008) found that the use of CBA supported SRL by providing timely and relevant progress monitoring and feedback. CBA contributed to increased motivation; students exposed to CBA were significantly more satisfied than students who received only traditional marking and feedback (i.e., red pen annotation). Research presented by Miller (2009) and Ozkul (2001) indicated that a majority of students expressed satisfaction for the capabilities of CBA

in providing prompt grading and feedback. Data obtained by Kitsantas and Zimmerman (2007) attributed improved motor-skills to continual progress monitoring; greater improvement was observed when students regularly evaluated performance as compared to when these evaluations were done infrequently. Geddes' (2009) sample of 274 US business students confirmed that online gradebook monitoring positively impacted on academic achievement and was used more than any other feedback tool. Hsu and colleagues (2009) found that students perceived online calendaring and gradebook monitoring tools in WBLE as useful. Darabi, Mackal and Nelson (2004) established that software such as Electronic Performance Support Systems and Electronic Plan promoted SRL in students by providing direction and assisting in the identification of problems. Narciss, Proske and Koerndle (2007) demonstrated that computer learning tools such as *Study Desk* were useful in assisting SRL by providing note taking features and allowing students to seek further explanations.

As presented in Figure 2 and supported by the previously reviewed research, SRL is promoted with WBT via a range of delivery methods and instructional strategies. SRL, however, as claimed by Zimmerman (2002) and Winne (2005), is manifest in student behaviour or actions and, thus, controlled by student characteristics. In this regard, student characteristics influence SRL.

Student Characteristics and Self-Regulated Learning in Web-Based Environments

A variety of student characteristics influence learning, including self-efficacy, experience, goal orientation, motivation, task-value beliefs and gender (Schunk, 1985). Research by Geddes (2009) and Sungar and Tekkaya (2006) found that learners characterised by high self-efficacy demonstrated higher levels of SRL than those characterised by low self-efficacy. Geddes also documented that students with learning-goal and performance-goals were likely to use online monitoring tools to evaluate performance. A study conducted by Darabi and colleagues (2004) suggested that WBT such as training software improved student self-efficacy. Based on a sample of 136 college students, Choiu and Wan (2007) reported that self-efficacy was influenced by learning experiences, for example, self-efficacy increased when students were provided with consecutive positive learning experiences and decreased when they were provided with consecutive negative learning experiences.

Student previous experience and prior learning contribute to SRL and technology use. Williams and Hellman (2004) identified that the experiences of family (e.g., parents) related to SRL, that is, first generation tertiary students scored significantly lower compared to second generation tertiary student on comfort levels in using SRL for online learning. An investigation by Lee and Tsai (2011) noted that graduate students were more interested in collaboration, possessed greater SRL capabilities and demonstrated greater information searching capabilities than undergraduates. Artino and Stephens (2006) found that graduate students (i.e., with a greater level of experience) scored significantly higher than undergraduate students (i.e., with a lower level of experience) on SRL strategies and online technology experience and these were related to motivational engagement (i.e., critical thinking and task-value).

Student motivation and task-value perceptions relate to SRL in both digital environments and traditional environments. Edens' (2008) study of 120 undergraduate students demonstrated that course design was associated with task-value perceptions and motivation of high SRL students. Students characterised as high self-regulated learners demonstrated an increase in performance when learning tasks contributed to the final grade compared to when these tasks were not graded. Similarly, research by Moos and Azevedo (2006) reported that students characterised with adaptive motivation-emotional profiles exhibited significantly higher mean scores on all learning outcomes (i.e, elaboration, metacognition, satisfaction, continuing motivation and final course grade). Artino and Stephens' (2009) sample of 481 undergraduates from a US naval academy established that motivation related to academic success. Santhanam and colleagues (2008) suggested instructional strategies are needed to increase student motivation in a WBLE.

Sungur and Tekkaya (2006) reported that high levels of intrinsic goal orientation correlated with self-reported motivation and use of planning strategies and students with extrinsic goal orientated characteristics used metacognitive strategies and peer learning. Yukselturk and Bulut (2009) sample of 145 undergraduate and graduate students reported that gender was not related to motivational beliefs, SRL or achievement in online learning environments. Yukselturk and Bulut, however, suggested that test anxiety had explained the variance in female student achievement and self-efficacy and task-value explained the variance of male student achievement.

Research by Trigano (2006) and Lenne and colleagues (2008) reported that WBT promoted student motivation (i.e., increased interest value). Steffens (2006) discovered that WBT supported cognitive and motivational components of SRL. Edens (2008) showed that the use of student response systems and course design improved student motivation and preparation for class. Lee and Tsai (2011) noted students were more capable and interested in an online learning environment than in a traditional learning environment. Banyard and colleagues (2006) observed that students showed enthusiasm while using the Internet in class. Lazakidou

and Retalis (2010) sampled 24 primary school students and reported that self-efficacy in using computer technology increased with experience.

Thus, SRL is the consequence of wide range of student characteristics and environments with a variety WBTs and instructional strategies. Given the complexity of the interrelationship between student characteristics and digital technology and instruction strategies, a comprehensive theoretical framework is required. Such a paradigm would organise ongoing and reciprocal interactions between student characteristics and available and emerging WBTs and instructional strategies in the web-based environment.

Self-Regulated Learning with Web-Based Technologies: A Theoretical Framework

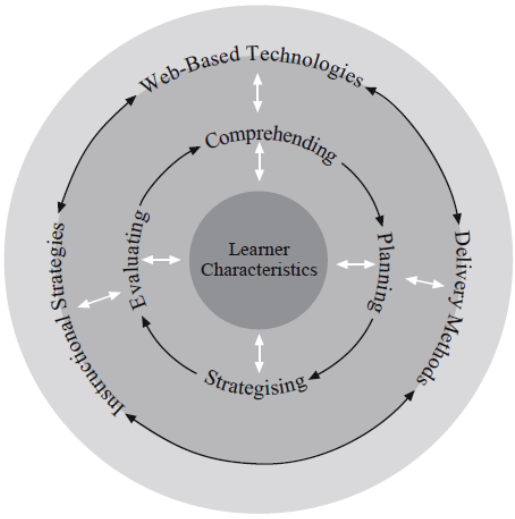
SRL involves the cyclical processes 1) comprehending, 2) planning, 2) strategies and 4) evaluating (Figure 1) based on Zimmerman (2002) and Winne (2005). Student comprehension of academic learning requirements emerge from prior knowledge, interactions with teachers and peers and other sources of information (e.g., unit outlines). Planning requires devoting time for academic requirements, assessing individual capability and forming strategies to achieve learning objectives. The formation of strategies involves a set of actions such as setting goals and improving ability (if lacking). As students work towards their goals they monitor progress and if necessary adjust or regulate learning behaviour.

Based on theories, models and methodologies of technology and learning (Adeyinka & Mutula, 2010; Pollard, et al., 2010; Tsai, 2009; Venkatesh, et al., 2003), figure 2 summaries the essential elements (instructional strategies, digital technology and delivery methods) critical to supporting SRL. Instructional strategies support SRL behaviour by facilitating comprehension of academic learning requirements, guiding the development of plans, promoting the formation of strategies and encouraging ongoing evaluation of efforts. WBT supports the delivery of these instructions and provides cues for SRL. WBT including LMS, CBA and CBT and other digital teaching applications support the delivery of instruction, facilitate collaboration and provide teachers and students with immediate and formative feedback.

The research has established that learner characteristics such as, although not limited to, self-efficacy, experience, goal orientation, motivation, task-value beliefs and gender influence the use of SRL and digital technologies (Chiou & Wan, 2007; Edens, 2008; Geddes, 2009; Lee & Tsai, 2011). For example, learners characterised by low self-efficacy, experience and motivation are less self-regulated with their learning than students with high characteristics in these areas. Students with low levels of experience and task-value beliefs of technology are less likely to use or accept it than students with experience and believe in the value of technology. In this regard, identifying and quantifying learner characteristics may contribute to customised student guidance of instructional strategies to support the use of SRL and WBTs. The ability of WBTs to collect and analyse student characteristics and SRL behaviour also give teachers and course designers a clearer picture and structure in developing instructional strategies.

Figure 3 presented a proposed framework of SRL with WBT and illustrates that SRL behaviour is a consequence of learner characteristics and digital learning environments. Such a paradigm proposes that an understanding of the ongoing reciprocal interactions between the elements of the web-based environments and learner characteristics is needed to enhance SRL behaviour.

Figure 3. A Comprehensive Model of Self-Regulated Learning with Web-Based Technologies



A framework for SRL with WBT highlights for teachers, students and course designers the central role of learner characteristics in contributing to use of SRL and digital technologies (e.g., self-efficacy, experience and motivation). In this regard, by identifying learner characteristics and quantifying these levels in students could provide a structure for customising student guidance of instructional strategies to support the use of SRL (comprehending, planning, strategising and evaluating) and digital technologies. The ability of digital technologies to collect and analyse student characteristics and SRL behaviour also give teachers and course designers a clearer picture and structure in developing instructional strategies.

Further Research

The comprehensive nature of the proposed theoretical model is simultaneously an asset and a liability. On the one hand, a comprehensive model is critical to understanding the complex nature of human learning in web-based environments. As supported by the previously reviewed research, a wide variety of learning characteristics give rise to SRL which in turn is influenced by pedagogical decision in the web-based environment. On the other hand comprehensive and complex models are difficult to empirically validate. Research based on the proposed comprehensive theoretical model would necessarily include the measurement of a wide variety of student characteristics and range of aspects of delivery, instruction and WBTs. Measuring a large numbers of complex variables assumed to have bi-directional influence is challenging. Further research is needed to understand the nature of the interrelated factors of WBT, SRL and learner characteristics.

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