The Challenges of e-Learning Initiatives in Supporting Students with Self-regulated Learning and Executive Function Difficulties.

Joanna K. Garner
and
Linda Bol

Old Dominion University
Norfolk, Virginia

Corresponding Author:
Joanna K. Garner, Ph.D.
Research Assistant Professor
The Center for Educational Partnerships
Old Dominion University
Norfolk, VA 23508
jgarner@odu.edu

Word Count: 7,362
In this paper we discuss students’ use of technology enhanced learning environments (TELE’s) or computer based learning environments (CBLE’s) in the context of self-regulation. We contend that success in courses taught through TELE/CBLE platforms requires effective self-management skills, and that this is the case for each of the three kinds of interaction described by Anderson (2003): student-content interaction, such as reading informational text or viewing multimedia presentations; student-teacher interaction, such as corresponding with a teacher or viewing feedback on an assignment; and student-student interaction, such as responding to a discussion thread or negotiating roles for a collaborative project. While a great deal of attention has been paid to self-regulated learning processes in student-content interaction, relatively little emphasis has been placed on understanding self-regulation during the other two types of interaction. Furthermore, very little of this research has been focused on individuals who have difficulties with self-regulation processes even though such difficulties are not uncommon.

Fundamental to learners’ engagement in all types of interactions are academically-relevant goals that the student wants to achieve. Setting goals and monitoring progress towards their achievement are hallmarks of effective self-regulation in any domain of life and these skills are important predictors of academic achievement (Boekaerts, Pintrich & Zeidner, 2000). There is widespread agreement that the ability to manage one’s affect, motivation, cognitions and behaviors in the service of learning goals – self-regulated learning – is even more critical in online learning environments than in traditional classrooms due to the lack of dynamic scaffolding and support that a physically present instructor typically provides (Azevedo, et al. 2008). However, many students find it difficult to manage their learning in TELE/CBLE settings (Greene & Azevedo, 2009). This paper is situated within the growing body of research on the topic of self-regulated learning in online learning environments but expands on it by considering that self-regulatory mechanisms can influence satisfaction with and success in any of the three types of interaction, not just interaction that directly changes students’ knowledge structures. It also explicitly considers the needs of students with self-regulatory difficulties.

**Self-Regulated Learning and Student-Content Interaction**

We cannot do justice to the complexity of models of self-regulated learning here. But we make reference to Zimmerman’s (2000) cyclical model of self-regulated learning (SRL) as a way to illustrate both the strengths and limitations of considering self-regulation in TELE/CBLE settings from the perspective of self-regulated learning only (see Figure 1). The model is most often invoked to explain a situation where the learner is working directly with text, study guides, hypermedia, and other forms of instructional material. Here, we review the aspects of the model dealing with metacognitive self-regulation, rather than the active management of motivation or affect.

The model divides a learning episode into three stages which are cyclical in their execution (Zimmerman, 2000). In the first stage of Forethought the task is analyzed. Learning goals are set, plans are formulated and strategies are selected. The second stage is called Performance or Volition. Here, the learning task is embarked on through self-instruction, and comprehension and progress are monitored throughout. Metacognitive strategies are used both to maximize the effectiveness of interactions with content and to manage the learning process itself. During the final stage called Self-Reflection
performance is judged and feedback is reviewed in order to improve future learning episodes. Thus, during a learning episode in an online course the student with effective self-regulated learning skills would be likely to articulate learning goals for themselves then analyze the task in terms of its requirements and in light of the resources at their disposal. They would identify appropriate strategies for interacting with the content then monitor their progress towards the goal as they used the strategies to comprehend, elaborate and integrate the information with prior knowledge. They would reflect upon both the progress made and the quality of the end result, and would seek feedback in order to adjust their behaviors during future learning episodes.

*Figure 1. Zimmerman’s (2000) Cyclical Model of Self-regulation (Abrami, et al., forthcoming)*

The theoretical constructs and processes inherent within this and other models of SRL have been successful in identifying factors that predict the level of success that students achieve during student-content interaction in face-to-face and TELE/CBLE settings (Green & Azevedo, 2009). However, the primary focus of SRL models is how learners manage their progress towards academic goals that center on concepts that need to be learned (Zimmerman, 2000). These models are most effective when used to understand student-content interaction and are notably silent when it comes to explaining the self-regulatory processes that do and must take place during interpersonal interactions with peers and instructors, even though these types of interactions also have important consequences in terms of overall academic achievement. This is why we believe it to be profitable for instructors and instructional
designers to think about self-regulation in both intrapersonal (student-content) and interpersonal (student-student, student-teacher) interactions, particularly in the context of distance and TELE/CBLE education. To accomplish this, a broader theoretical perspective is needed.

**Limitations of Self-Regulated Learning Theory as an Explanation of Self-Regulation During Interpersonal Forms of Interaction**

In seeking a theoretical perspective of self-regulation into which all three types of interaction could be accommodated, it is clear that models of SRL focus on student-content interaction but not on student-student or student-teacher interaction. SRL models may include ways in which these types of interaction are used by the student to inform current and future learning episodes, but not how the student uses self-regulatory skills to manage these types of interaction. Ultimately, we are concerned with ways to support students’ self-regulation processes during all three modes of electronically-mediated interaction because doing so should enhance student satisfaction and learning outcomes. We believe that a coherent theoretical framework in which to consider both types of self-regulation can be found by way of reference to the group of constructs known as executive functions. The framework is presented because executive functions are neurocognitive processes widely thought to give rise to domain-general self-regulatory processes which encompass both intrapersonal and interpersonal forms of interaction (Barkley, 2001; Lezak, 1995; McCloskey, Perkins, & Van Diviner, 2009). Self-regulated learning models do not easily yield hypotheses about how students engage in self-regulation in order to maximize the benefits of electronically mediated social interactions. Models of SRL also do not account for the specification of relationships between the social or interpersonal goals that students may have, and how these goals might influence the self-regulated learning process (Boekarts, 2002).

With increasing numbers of online courses incorporating opportunities for interactions with content and with other individuals (McLoughlin, 2002), the emphasis of attention on intrapersonal self-regulation to the exclusion of interpersonal self-regulation is problematic for several reasons. The first is that currently researchers do not have an easily accessible, unifying theoretical framework from which to derive hypotheses about how self-regulation takes place during all three types of interaction. As a result, research studies tend to examine the three types of interaction in largely independent ways. With only a few notable exceptions (Cho & Jonassen, 2009; Cho et al 2010; Yang, et al. 2006), we know of very few studies that have examined relationships between self-regulated learning skills and self-regulation processes in online social interaction. This is despite the recognition that online interactions extend well beyond the help seeking or peer learning behaviors that are included in models and assessments of self-regulated learning (Hofer, Yu & Pintrich, 1998; McKeachie, Pintrich, Smith, Garcia & McKeachie, 1991). It is also in spite of the need to better understand, support and scaffold peer-to-peer and instructor-peer relationships in online learning environments.

A second problem that arises from the lack of information about student self-regulation during interpersonal interaction in online courses is that it places limitations on our knowledge about ways in which variables such as domain knowledge, experience with online learning environments, and self-regulatory skill influence these types of interaction, including how students cross-regulate from one type of interaction to another in order to meet their goals. Because of this a third problem arises, which is that
our understanding of how to best support these types of interaction for particular types of learners, is limited. In web 2.0, commonly characterized as the social web (McLoughlin & Lee, 2010), learners have desires and expectations for using Personal Learning Environments (PLE’s) for online learning. In PLE’s, social interaction is an integral component to the learning process and social processes are used in order to construct knowledge. In such environments learners are “active agents…expected to create social relationships with peers and instructors, participate in group discussions, and initiate interactions in learning processes such as asking questions, posting messages, providing help, or seeking help.” (Cho & Jonassen, 2009, p.117-8).

CBLE platforms that offer opportunities for individualization and social interaction offer ways in which students’ academic and interpersonal self-management skills will become even more intertwined than ever. Before discussing ways in which this type of interaction might be scaffolded, and examples of platforms which attempt to do just this, we give an overview of executive functions as a framework for understanding intrapersonal and interpersonal self-regulatory processes as used in TELE/CBLE’s.

Executive Functions as a Framework for Understanding Self-regulation in Course-related Interaction

We have broadened our conceptual lens beyond theories of self-regulated learning and look towards the domain-general realm of self-regulation that is supported by executive functions. Executive functions have been defined as “the ability to maintain an appropriate problem solving set for attainment of a future goal” (Welsh & Pennington, 1988, p.201). Executive functions are thus a set of neurocognitive processes that allow for planning, goal setting, response inhibition, impulse control, attentional control, self-monitoring, and cognitive flexibility (Barkley, 2001; Denckla, 1996; Lezak, 1995; Spinella, 2005). Such control processes encompass “all domains and contexts” (Denckla & Reader, 1993, p.433). Executive functions have been much more widely studied in the clinical literature and by researchers in the fields of special and exceptional education. This is because there are specific consequences of deficits in executive functions which include difficulties with both intrapersonal and interpersonal self-regulation (Denckla, 2001; Spinella, 2005; Wilson, et al. 1996). Individuals with executive function difficulties struggle to control impulses and to plan before acting. They have difficulties managing the sequencing and execution of multi-step tasks, controlling attention and working memory, monitoring themselves with accuracy, and responding flexibly when given feedback that should result in changes to behaviors and strategies. These difficulties may interfere with learning behaviors and the peripheral social self-management processes that support them.

While executive function difficulties, coined executive dysfunction (Wilson et al., 1996), are more common in individuals who have undergone a degree of brain trauma, meaningful variation in executive function skill exists within the normal population (Garner, 2009, 2011). For example, in samples of normal college students, variability on executive function measures of planning, self-monitoring and emotional regulation contributed to self-regulated learning scores and academic achievement outcomes (Garner & Tocker, 2011). In younger students, executive functions pertaining to the control of working memory, strategic retrieval of information from long term memory, and cognitive
flexibility, have been related to academic task performance in reading and math for both unimpaired and learning-disabled populations (Gathercole & Pickering, 2000; Swanson & Sachse-Lee, 2001).

A key point is that even though individuals may vary in terms of strengths and weaknesses in particular areas supported by executive functions, and even though course contextual factors play a role in their use, executive functions nonetheless contribute to self-regulation in both intrapersonal and interpersonal domains (Barkley, 2001; Spinella, 2005). It is more typical to find scholarly perspectives on executive functions as broad capacities that serve more than intrapersonal self-regulation. More generally, they “perform the functions of monitoring and promoting the attainment of a person’s idiosyncratic goals,” whatever these may be (Matthews et al., 2000 p.171). Thus, executive function and self-regulatory skills can be directed towards the achievement of a goal that involves the metacognitive management of a learning episode using student-content interaction, or the self-management of a computer mediated student-student or student-teacher interaction in an online course.

As is the case with the self-regulated learning literature, there are multiple theoretical perspectives which speak to the composition and appropriate measurement of general self-regulatory mechanisms supported by executive functions. We cannot address them all here. However, the marked convergence between theories regarding the intra- and interpersonal facets of executive functions seems to offer a useful framework for thinking about how self-regulatory processes are prominent throughout each type of interaction (Barkley, 2001; McCloskey, Van Diviner & Perkins, 2009). Figure 2 incorporates elements of two theoretical perspectives to provide a framework for considering the relationships between executive functions and the three types of interaction.

*Figure 2. A Framework Integrating Intrapersonal and Interpersonal Self-Regulation.*

Our framework draws specifically from two perspectives on executive functions. McCloskey, Van Divner & Perkins et al (2009) synthesize research from neuropsychology, clinical and educational psychology to present a model in which executive functions serve self-regulatory functions in four arenas: intrapersonal, interpersonal, environmental, and symbol-related. The intrapersonal and interpersonal arenas are the most relevant for our discussion. According to McCloskey et al. when executive functions target the intrapersonal arena they pertain to “perceptions, feelings, thought, and actions in relation to her or himself” (p.57). Thus, goal-directed self-regulated learning through student-content interaction would
E-learning with Self-regulated Learning and Executive Function Difficulties

fall under intrapersonal applications of executive functions. When executive functions are turned towards
the regulation of these same capacities in other people, and regulate “the ability to interact
appropriately…the ability to find ways to balance the needs of the self with the needs of the community”
they fall under the interpersonal arena (McCloskey, Van Diviner & Perkins, 2009, p.57). The student who
is seeking to create and achieve learning goals within the social context of student-student interaction and
student-teacher interaction must use interpersonal applications of executive functions in order to maintain
successful and mutually beneficial relationships between themselves and others.

Barkley’s (2001) conceptualization of executive functions is widely known by scholars studying
attention deficit/hyperactivity disorder, but his discussion of the development of executive functions as a
process driven by evolution leaves no doubt that executive functions serve interpersonal as well as
intrapersonal goals. His model parses executive functions into cognitive processes such as response
inhibition, covert speech, and non-verbal working memory capacities that allow for the simulation of
action outcomes and the projection of those actions’ consequences. However, he claims that the
fundamental purpose of the processes in service of these goals is social in nature. Specifically, individuals
would not be able to create and maintain effective and mutually beneficial social relationships unless
impulses were controllable, thoughts were not always spoken, the capacity to consider future outcomes of
one’s actions was present, and strategic interpersonal behaviors were possible. Thus, intrapersonal self-
regulatory processes facilitate effective interpersonal behavior because one must be able to regulate
oneself in social interactions in order to maintain that relationship and reap its benefits. When applied to
student-student interactions, being able to effectively monitor and regulate how one interacts with one’s
fellow students ensures that others are likely to help when requested.

Especially in distance education courses, student-teacher interaction requires a combination of
interpersonal and intrapersonal interaction and requires the student to engage in effective self-monitoring.
Like student-student interaction, successful student-teacher interaction requires the student to co-construct
meaning and contribute towards a positive and productive relationship. Students know that if they are able
to engage in clear and congenial communication in such interactions, instructors are likely to provide
useful assistance when it is needed. Thus, interpersonal executive functions are required in order to
engage in self-presentation and communication management strategies that are needed in order to take the
perspective of interaction partner and that are likely to yield helpful responses from the instructor. In
addition, a great proportion of the content of student-teacher interaction concerns feedback and thus
requires the student to be able to alter their behavior in the future. Teachers provide comments, responses,
evaluations and assessments which prompt students to think about content in new ways and to improve
their performance on future assignments. Being able to respond to feedback, improve performance, and
not repeat errors, is a key component of executive functions (Stuss & Benson, 1994) and is also important
to SRL (Zimmerman, 2000). Failure to do this is seen as a sign of executive dysfunction (Wilson et al,
1996). Hence, co-creating, managing and benefitting from student-teacher interaction require both self-
management skills for social (and ultimately academic) gain as well as metacognitive management for
academic gain. Thus, we propose that student-teacher interaction requires both intra- and interpersonal
arenas of executive functioning.
When applied to intrapersonal interactions such as student-content interaction, there is evidence to suggest that executive functions account for variance in self-regulated learning skills (Garner, 2009). The relationship seems to be the strongest between general planning, goal setting, self-monitoring, time and effort management skills, and the metacognitive regulation component of self-regulated learning (Garner, 2009; Peterson, Lavelle & Guarino, 2006). When interacting with content, students with effective intrapersonal executive functions are able to plan their time, delay gratification, exert impulse control, focus their attention to the exclusion of distractions, and be flexible should they realize that their current actions remove them from their desired trajectory of learning. Each of these features is simultaneously a domain-general capacity when viewed from the perspective of executive functions (Diamond, 2002; Evans, 2005), and a specific component of effective self-regulated learning according to prominent theorists in this area (e.g. Zimmerman, 2001). Thus, students who can plan their learning episodes, set specific and adaptive learning goals, and who can monitor the effectiveness of their strategic efforts to reach those goals, are exercising self-regulated learning capacities that would not exist if executive functions were not also fully present.

Unique Demands on Self-regulation Processes Made By Online Learning Environments

Scaffolding is a term used to refer to the use of tools, strategies and guides that enable students to develop more sophisticated understandings than they would have been able to do independently. In the absence of scaffolding many students fail to effectively regulate their learning during student-content interaction with electronic and hypermedia-based learning materials (Azevedo & Hadwin, 2005) and what seems to be challenging is the degree of learner control that is required (Greene & Azevedo, 2009). The flow of information in e-learning environments is often non-linear and punctuated by decision points which yield information that may or may not be critical for a learner’s goals. The learner must decide what to look at, what not to look at, and how to merge multiple representations of ideas. While these features offer opportunities for instructional designers to create interesting and complex presentations of content which could serve to transform students’ knowledge about a topic, these same features present challenges to students who struggle to effectively execute autonomous learning episodes. In this environment, if students do not possess sophisticated SRL skills they tend not to engage in planning, goal setting, comprehension monitoring, effective strategy use, or reflection (Azevedo & Hadwin, 2005).

Deficits in Self-regulated Learning and Executive Functions

In this section we present an overview of ways in which poor self-regulated learning and executive function skills affect learning outcomes. Our review largely mirrors the fact that most of the research to date has focused on the direction of these capacities towards student-content interaction.

Self-regulated learning. In recent years, a comprehensive picture of the types of behaviors that students with deficient self-regulated learning skills engage in has been developed. From research on the self-regulated learning skills that contribute to reading comprehension, Pressley and colleagues (Colling Block & Pressley, 2002; Pressley & Afflerbach, 1995) have documented that while expert readers engage flexibly in a variety of cognitive and metacognitive strategies while reading, younger students and students with comprehension difficulties often fail to preview or set goals for their reading. Once reading or studying from text, these students also fail to detect comprehension errors and subsequently do not
appropriately diagnose or remediate them. Such students are not adept at reflecting strategically on the meaning of the text in relation to both their prior knowledge and the purpose for which they are reading, and continually struggle to identify key ideas in informational text (Dreher, 2002). When evaluating the products of their learning, their calibration judgments may be overconfident (Bol, Hacker, O’Shea, & Allen, 2005; Bol, Riggs, Hacker, Dickerson, & Nunnery, 2010). That is, they judge themselves to have better mastery of the content than they have actually acquired. Research on learning from hypermedia has shown that students who experience relatively little gain from studying online informational text are more likely to recycle their goal or subgoal in working memory instead of engaging in effective planning, time management and help-seeking behavior (Azevedo, Guthrie & Seibert, 2004). Metacognitive strategy research in writing has shown that novice and learning-disabled writers have difficulties with key points in the writing process in relation to self-regulation such as planning, monitoring during drafting, and revising with clear reference to a goal (Graham & Harris, 1996). However, in the case of reading comprehension and composition research, it seems that metacognitive strategy instruction can have long term benefits in terms of strategy utilization and transfer (Sawyer, Graham & Harris, 1992).

Executive functions. Research on the impact of executive function difficulties on achievement outcomes has historically been limited to students with special educational needs such as those with attention deficit/hyperactivity disorder (AD/HD) and learning disabilities. Students with AD/HD tend to have difficulties with impulse control, the maintenance of a goal and problem set in working memory, control over attentional focus and shifting, and regulation of arousal (Pennington, 1997; Zentall 2005). This means that in classroom settings they can require additional task structuring and prompting in order to maintain an optimal level of arousal and attend to content in the appropriate way (Zentall, 2005). Students with learning disabilities in both reading and math have been found to have difficulty with rapid shifting and sequencing on tasks that relate to their area of deficit, suggesting that they have difficulty with rapid retrieval and inhibition processes (van der Sluis, de Jong & van der Leij, 2004). In some cases, students with learning disabilities were found to underperform on tests of cognitive and strategic flexibility and information manipulation than students with AD/HD (Lazar & Frank, 1998). However, even in this realm, research has focused more on intrapersonal self-regulation on cognitive and neuropsychological tests requiring planning and problem solving, and not on interpersonal regulatory processes that may be affected in individuals with other learning and executive disorders.

Taken as a whole, these findings are meaningful since they call attention to the fact that perhaps more individuals may experience difficulties with self-regulated learning and executive functioning (and hence, self-regulation in TELE/CBLE settings) than was previously thought. Table 1 highlights some of the difficulties that individuals with self-regulated learning deficits or executive function deficits might experience when using TELE/CBLE platforms. These identified difficulties serve as examples and not an exhaustive list of all possible difficulties. They are categorized as a function of phase in the cyclical process of self-regulated learning (Zimmerman, 2000). In the next section, we examine ways in which these skills might be supported by way of instructional design, scaffolding and prompting in online learning environments.
Table 1. Problems Associated with Deficits in Self-regulated Learning and Executive Functions

<table>
<thead>
<tr>
<th>Difficulties relating to Self-regulated Learning</th>
<th>Difficulties common to SRL and EF</th>
<th>Difficulties relating to Executive Functions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Planning</strong></td>
<td>Failure to set a goal for learning (Barnard-Brak, Lan &amp; Paton, 2010)</td>
<td>Difficulty focusing and shifting attention (Mirsy, et al 1991)</td>
</tr>
<tr>
<td><strong>Monitoring</strong></td>
<td>Difficulties detecting breakdown in comprehension or writing processes (Pressley, Ghatala, Wolyshyn &amp; Pirie, 1990)</td>
<td>Difficulty controlling the contents of working memory (McCloskey, Van Diviner &amp; Perkins, 2009)</td>
</tr>
<tr>
<td><strong>Self-Reflection</strong></td>
<td>Failing to use strategies given the appropriate setting (Pressley &amp; Hilden, 2007)</td>
<td>Difficulty in maintaining behavior by way of volitional control (Kuhl, 1992; Zimmerman, 2000)</td>
</tr>
<tr>
<td></td>
<td>Poor calibration and attributions (Bol &amp; Hacker, 2001; Bol et al, 2005)</td>
<td>Difficulty incorporating feedback into future strategically-driven behavior</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Difficulty with behaviors that require social interaction and perspective taking or (Beauchamp &amp; Anderson, 2010; Spinella, 2005)</td>
</tr>
</tbody>
</table>

Fostering Effective Self-Regulation in Course-related Interactions

**Metacognitive scaffolding as a specific strategy for promoting SRL in student-content interaction.** Metacognitive scaffolding can be employed to enhance self-regulated learning as well as interpersonal interactions. Azevedo, Cromley and Seibert (2004) identified four kinds of scaffolding used in hypermedia environments to promote SRL outcomes: conceptual, metacognitive, procedural, and strategic. Of these, metacognitive scaffolds are the most relevant to the present discussion. Metacognitive scaffolds are those which help the learner manage their learning processes, such as those which facilitate goal setting, metacognitive monitoring of progress, judgments of learning, and self-reflection. One example of a vehicle for scaffolding the metacognitive processes that need to occur during self-regulated learning is an electronic portfolio, which can organize content and scaffold task completion. Specifically, electronic portfolios can “scaffold attempts at knowledge construction by supporting reflection, refinement, conferencing and the other processes of self-regulation” (Meyer, et al. 2010, p.85). ePEARL (Meyer, et al. 2010) is an example of such an electronic portfolio system. It contains features for creating,
storing and showcasing work products but perhaps the most intriguing features pertain to the ones that prompt the creation of goals at the beginning of a work cycle as well as the ability to view, share and integrate feedback into subsequent versions of a work product. After a year-long implementation study with elementary school students, Meyer et al. found that both student and teacher ratings of students’ metacognitive guidance of learning had increased. In particular, increases in self-reported satisfaction were noted in areas of intrapersonal regulation processes such as goal setting, being able to list strategies and being able to use feedback to improve work. Teachers reported that students were better at setting goals and articulating the demands of the task and integrating teacher and peer feedback into their work. From a SRL perspective, students increased their Forethought and Reflection behaviors. From an executive functions perspective, students became more accurate in their planning skills but importantly, increased in their flexible use of feedback. Likewise, the teachers also reported that students gave more constructive criticism to their peers. One tentative interpretation of this finding might be that students learned how to give better feedback, but it could be that the use of this learning tool prompted students to engage in more sophisticated interpersonal regulation and to be able to better empathize or take on the role of their peer in order to give them feedback. Such perspective taking is also characteristic of effective interpersonal executive functioning (McCloskey, Van Diviner & Perkins, 2009). More research is needed to see if and how this type of platform might benefit older students in distance education settings.

Boom, Paas, van Merrienboer (2007) conducted a study that led them to claim that “it is beneficial to present prompts to students that evoke them to reflect on their learning processes…A direct application of the results would be for developers of distance education courses to embed a reflection protocol in their courses,” (p.545). In their study, college students taking a psychology course were assigned to one of four conditions. Students in the control condition studied during their course without modification. Students in a second condition received nine reflective prompts, which were presented as web pages within their electronic workbooks. The subject of all reflective prompts was the learning process itself – task diagnosis, self-monitoring and adjustment of strategy use, motivation, and then evaluation. In a third and fourth condition, students wrote reflective statements in response to the prompts, which were then reviewed and elaborated on by a peer or a tutor respectively. Using the MSLQ and learning outcomes as dependent variables, posttest results found significant improvements in the task value and test anxiety aspects of SRL, for the feedback versus no feedback conditions. For learning outcomes, the tutor’s feedback resulted in superior performance than the peer feedback. This study is important because the majority of others have focused on scaffolding the metacognitive self-regulatory aspects of self-regulated learning, and not motivational aspects.

At a more local and specific level of support, there are other features that could be embedded within an online learning platform which might facilitate metacognitive monitoring. Winne (2004) presented several strategies to promote students’ calibration accuracy. Calibration refers to the degree to which a student’s judgment about their performance on a learning task correlates with or deviates from an external measure of that performance (Bol & Hacker, 2010; Winne, 2004). He argued for the use of temporal and task spacing in between learning and judgments of the quality of that learning, in part because of the delayed judgment of learning (JOL) effect showing that JOL’s are more accurate after a delay between learning and estimation (Thiede & Dunlosky, 1994). Students can find it hard to focus on the most important information prior to a test, and suggested that CBLE’s support this by tracking
highlighted text or using an algorithm to re-present important information to the student prior to a test (Winne, 2004). What is not clear, however, is how responsibility for using these strategies might be released to the learner in an online learning environment.

**Scaffolding interpersonal self-regulation: supporting the creation of meaningful social and cognitive presence in online learning environments.** Although not widely studied, there are several reasons why it is important to promote effective self-regulation during student-student and student-teacher interaction. One reason is because of its centrality to students in terms of course satisfaction (Wu & Hiltz, 2004). Perceptions of the quality of interaction with others play a substantial role in ratings of overall course quality. Quite simply, effective social interaction is valued by students taking distance education courses (Anderson, 2003). A second reason is that students who engage in effective social interactions in online courses are more likely to exhibit higher order critical thinking (Garrison, Anderson & Archer, 2000) and are more likely to use effortful cognitive and metacognitive strategies (Pekrun, Goetz, Titz, & Perry, 2002). Thus, there seems to be a connection between the social presence shared among students and faculty, the shared “ability to project oneself to others emotionally and socially” (Cho & Jonassen, 2010, p.299) and cognitive presence or “the extent to which participants…construct meaning through sustained communication” (Garrison, Anderson & Archer, 2004, p.1). A third reason concerns retention, since students who experience meaningful social interactions in online courses are less likely to drop the course (Visser, Plomp & Kuiper, 1999).

Students appear to already be applying self-regulatory skills towards their use and non-use of online interpersonal interaction in distance education settings (Sims & Bovard, 2004), but researchers have not applied a self-regulation framework to understand these decisions. Reasons why students do not seek out interaction should be investigated. They may reflect preferences that arise from individual weaknesses in interaction skills, a lack of familiarity with computer-mediated communication, a perception that the course is set up in such a way as to discourage interaction and collaboration, or a perception of the grading rubric that does not reward such interaction. Any or all of these could be interpreted as being an indication of deliberate interpersonal self-regulatory strategies to either compensate for or maximize learning experiences. Paran, Furnameaux & Sumner (2004) describe reasons why students in their study did not engage in more social interaction during an online course. Reasons were mostly unrelated to access to or familiarity with technology, but instead pertained to time management and conscious decisions that other students’ posts would not add value to their own knowledge base. These decisions are strategic and, if one assumes that interpersonal self-regulation is taking place, are to be expected because they allow the learner to engage in other activities which are more likely (in the learner’s mind) to serve their learning goals. Students know, for example, that “online discussion can be a fruitful source of insights into academic ideas, but it can also appear directionless, trivial and self-indulgent,” (Goodyear, 2002, p.51).

Moreover, qualitative naturalistic and descriptive research suggests that variations in scaffolding for student-student interactions do influence how students participate and ‘consume’ socially constructed information in online courses. The qualitative results of Ke (2010), who examined adult learners’ reactions to various aspects of online course interaction, seem to support the idea that learners have created subjective utility judgments for online discussions and other student-student interactions. Ke
grouped comments according to the purpose students assigned to these interactions, which were typically articulated from the perspective of an overall learning (rather than a social) goal. One purpose was to bring real life experiences to bear on the to-be-learned content. Students were aware in this case that interactions with other students may yield a perspective or example that they wouldn’t otherwise have generated for themselves. A second purpose related to metacognitive guidance of learning. Discussions served as externalizations of thought processes, which would help to frame and focus a learner’s thoughts. A third purpose was to ‘benchmark’ or compare their own knowledge or interpretation with another student’s interpretation. For example, the quality of a peer’s post could be used as a criterion against which the learner could judge their own comprehension or knowledge. Ke (2010) noted that “a major observation of these interviewing results was that the major benefits that participants discussed of online discussions did not involve a collaboratively cognitive inquiry or a wisdom that is collaboratively built.” (p.815). In other words, student-student interaction was being used to inform learning processes at the metacognitive rather than cognitive level.

In each of these cases, Ke (2010) found that the methods used for interaction were influenced by the ways in which the instructor facilitated and scaffolded the interaction. Thus, students evidently make reflective and conscious decisions about how, why, when and how much to interact with other students as part of their experiences in online courses. But they do so in the context of varying degrees of support from instructors, and the relationship between this support and students’ regulatory choices needs to be more clearly understood. In addition, if there are students who do have difficulty establishing and maintaining an appropriate social and cognitive presence in an online course, researchers should examine the underlying reasons. Whether they are unfamiliar with the technology, do not perceive the time and effort to be worthwhile, or have interpersonal difficulties that make computer-mediated communication unsatisfying, all impacts the ways in which they should be supported.

While little research has been done to assess the effect of explicitly manipulating scaffolding that should influence interpersonal self-regulation, pre-existing categories of strategies and features used to develop self-regulated learning can be applied to the problem of optimizing student-student interaction. In a concise review of types of and purposes for scaffolding, McLoughlin (2002) lists several types of learner support, including orientation, expert regulation, modeling, and metacognitive scaffolding. These were intended to prompt reflection by instructors and instructional designers as they seek to improve students’ self-regulated learning skills. We recast them here with a view to supporting student-student interaction.

In the category of orientation, students are given instructions about the instructor’s expectations for performance and are given an opportunity to review clear guidelines. In this case, students would be given clear instructions about the parameters for acceptable student-student interaction. Ideally, this would be followed up by expert modeling, whereby the instructor gives examples of the target learning outcomes. Even in the case of student-student interaction, examples of effective discussions, responses and collaborative efforts could be provided. Effective questions and constructive feedback could also be modeled. Additionally, the instructor and the learning environment should provide metacognitive scaffolding. Via synchronous or asynchronous media, technology permits the instructor to think out loud
about how and why he or she is engaging in the particular form of social interaction and how it relates to being successful in the course.

Support for at least some of the above strategies comes from a study by Mykota and Duncan (2007), which sought to describe those learner characteristics that predicted social interaction experiences as well as ways in which such experiences could be optimized. Like McLoughlin, they concluded that effective social interaction (and, within our framework, interpersonal regulation) could be facilitated by the instructor modelling appropriate means, styles and formats of interaction. Specifically, this could include participating actively in discussion threads, posting responses to students’ questions, maintaining a friendly tone, and encouraging the sharing of biographical information. Mykota and Duncan (2007) also called attention to the need for scaffolding for students who are new to the online learning environment. Thus, by modeling appropriate social interaction and by establishing appropriate forms of social presence, the instructor would essentially act as an external regulating agent on the social interaction among students. Students would of course need to recognize and internalize these standards and formats in order to continue effective interactions.

Additional evidence of the role of interpersonal regulatory processes comes from Greene and Land (2000). Although this study was conducted in a traditional classroom setting, students were gathering and utilizing electronic resources in order to answer open ended questions. Greene and Land noted that some groups were reluctant to give constructive feedback to one another, and that other groups struggled to construct a mutually agreed understanding of the assignment or content. We would interpret these findings as revealing an opportunity to support interpersonal self-regulation. The instructor could model providing feedback which could serve as a criterion for future comments from students. This would help students understand how to cast that feedback in ways that would be interpreted as being helpful and meaningful by others. From an instructional design perspective, it also may be beneficial to create electronic spaces for groups to record their co-constructed meaning of a project’s requirements or responsibilities, in a manner similar to Scardamalia et al.’s (1992) computer-supported intentional learning environment. Scardamalia and colleagues conceptualized giving groups of students access to a virtual, communal workspace in which ideas could be shared and manipulated in order to facilitate and record the meanings, plans and decisions for projects and tasks (McLoughlin, 2002).

Finally, a study by Yang et al (2006) investigated the relationship between a measure of self-regulated learning and perceptions of social interactions during an online course. By examining the relationships among cognitive, metacognitive and motivational aspects of self-regulated learning and a construct called “online social ability”, Yang et al sought to explain variance in peer-related variables such as perceived peer social presence, perceived instructor social presence, comfort with sharing personal information, and social navigation (measured using items which tapped into students’ awareness of the potential usefulness of working with and interacting with others). Yang and colleagues found that intrinsic goal orientation was significantly correlated with perceived peer social presence, while self-efficacy was associated with comfort with sharing personal information. Task value was important for explaining variance in social navigation, suggesting that students’ are making conscious decisions about how to use social interactions in order to achieve their learning goals, and that these decisions involve motivational and affective constructs. The results suggest that steps instructors can take to foster adaptive
motivational attitudes towards learning might also facilitate positive attitudes towards interpersonal interaction. However, whether interventions would yield improvements in actual interaction behaviors, and whether such interaction behaviors would be subject to effective self-regulatory processes that could be linked with self-regulated learning processes, are areas of speculation at this point in time.

Based on this preliminary review, Table 2 presents a summary list of the strategies that are likely to promote effective metacognitive self-regulation in intrapersonal and interpersonal forms of interaction.

**Table 2. Strategies to Support Metacognitive Self-Regulation in Online Learning Environments**

<table>
<thead>
<tr>
<th>Supporting intrapersonal self-regulation (student-content interaction)</th>
<th>Supporting interpersonal self-regulation (student-student, student-teacher interaction)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Use of an electronic portfolio to provide a place for students to set goals, work on draft work products, receive and reflect on feedback (Meyer et al. 2010)</td>
<td>Direct explanation of the use of interpersonal interaction as a strategy for achieving success in the course (McLoughlin, 2002)</td>
</tr>
<tr>
<td>Placement of prompts after studying so as to facilitate calibration accuracy (Winne, 2004)</td>
<td>Instructor establishes an appropriate social presence (Mykota &amp; Duncan, 2007)</td>
</tr>
<tr>
<td>Storage of highlighted or selected text sections, and prompted review of these sections (Winne, 2004)</td>
<td>Use of computer-mediated communication for instructor to model and thinks out loud about ways to interact that promote effective learning outcomes (McLoughlin, 2002; Mykota &amp; Duncan, 2007)</td>
</tr>
<tr>
<td>Prompting students to reflect on aspects of the learning process, and providing expert feedback on these reflections (Boom, Paas, &amp; van Merrienboer, 2007)</td>
<td>Provision of shared spaces for students to negotiate and record shared meanings for plans and decisions (Scardamalia et al. 1992)</td>
</tr>
</tbody>
</table>

When thinking about empirically derived ways to support learners with known deficits in self-regulated learning and executive functions, an important limitation must be noted. Much of the research described here, with the exception of studies which have focused on specific samples of individuals with specific difficulties, has been conducted without screening for or identifying individuals with these types of difficulties. This is the case for the majority of the research which has investigated online learning. Therefore, while conclusions can be drawn regarding ways in which support can be provided, the effectiveness of this support for particular groups of individuals who may have self-regulated learning or executive function difficulties cannot be unequivocally predicted. While the implications of the research that we present here are logically derived, further research is needed to understand how the needs of particular groups of learners may manifest themselves in the context of online learning and how these individual difference variables may interact with various attempts at scaffolding.
E-learning with Self-regulated Learning and Executive Function Difficulties

Conclusion

In writing this paper we sought to raise awareness of the breadth of self-regulatory processes that are necessary in order for students to get the most out of online learning experiences, and to draw attention to the difficulties that students may encounter if they are not able to effectively engage in these processes. We also sought to point out specific examples of ways in which intrapersonal and interpersonal self-regulatory processes could be supported.

A great deal of research has been devoted to understanding how students use SRL skills during online learning episodes, and we have referred to some of this research in order to draw general conclusions about how these processes can be supported and promoted. In contrast, very little attention has been paid to ways in which students regulate peer-to-peer and student-instructor interactions even though these types of interactions are becoming more and more integral to the online learning experience. To date, although we can list problems that students may have in managing intrapersonal and interpersonal interactions, we cannot draw decisive conclusions or make concrete suggestions about how interpersonal self-regulation should be promoted or supported during computer mediated communication. Clearly, research needs to delve deeper than students’ perceptions of on-line learning and students’ satisfaction with interpersonal interaction in order to understand how students are more or less successful in regulating their cognition, affect, motivation and behavior as directed towards online social interactions that ultimately serve learning goals. For all three types of interaction researchers also need to attend to ways of differentiating the support needs that students may have depending on the sophistication of their SRL skills and executive function capacities.

Having more detailed knowledge about regulatory processes within and across types of interactions will help instructional designers better understand where and how to provide opportunities for interpersonal interaction when designing online learning materials, as well as appreciating the ways in which students may differ in the level of support that they require. This in turn should enable interpersonal interactions in online learning environments to become more effective and reach their potential to provide opportunities for genuine dialogue that will facilitate learning (Muirhead, 2000).

Eventually, we hope that researchers will establish detailed theoretical and empirical connections between each of these issues. We hope that more will be learned about how students effectively employ interpersonal self-regulation in online learning environments, and how specific behaviors or attributes of these interactions promote achievement, adaptive motivation and learner satisfaction. This knowledge should then inform ways in which self-regulation can be supported through each type of interaction, and how such support might be tailored or adapted for learners with SRL and executive function difficulties.
E-learning with Self-regulated Learning and Executive Function Difficulties

References


E-learning with Self-regulated Learning and Executive Function Difficulties


E-learning with Self-regulated Learning and Executive Function Difficulties


E-learning with Self-regulated Learning and Executive Function Difficulties


McLoughlin, C., (2002). Learner support in distance and networked learning environments: ten dimensions for successful design. *Distance Education* 23, 149-162.


E-learning with Self-regulated Learning and Executive Function Difficulties


E-learning with Self-regulated Learning and Executive Function Difficulties


