CHARACTERISTICS OF EFFECTIVE PEDAGOGICAL STRATEGIES FOR SELF-REGULATED LEARNING IN TECHNOLOGY-ENHANCED ENVIRONMENTS: TOWARDS IMPROVING LEARNING OUTCOME

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ABSTRACT

The purpose of this study is to investigate the primary features of self-regulated learning (SRL) treatments and strategies employed in technology-enhanced learning environments (TELEs) that could enhance learning outcome. A total of twenty related academic articles were identified and examined for key independent SRL variable features, SRL support strategies and SRL outcomes. The findings of the study are important in terms of advising TELE educators of the existing leading SRL treatment frameworks for consideration. The results showed some of the characteristics of learning outcomes influenced by self-regulation. The results show that SRL are sometimes taught during online courses, while in other courses, the SRL are embedded inside the TELE, giving students important and timely feedback as they evaluate themselves, and learn.

1. INTRODUCTION

In technology enhanced learning environments (TELEs), the absence of the instructor, and the increased responsibility demanded of learners to effectively engage in learning tasks, may present difficulties for learners, particularly those with low self-regulatory (SR) skills (Shen, et al 2007).

Interest in academic SR has increased considerably in recent years as investigators and practitioners attempt to understand how students become master of their own learning processes (Artino, et al 2013). Artino also concluded that effective self-regulated learning (SRL) may be critical in distance learning situations due to the high degree of student autonomy resulting from the instructor's physical absence.

A SRL perspective on students' learning and achievement is not only distinctive, but it has profound implications for the way teachers should interact with students while teaching, and the manner in which schools should be organized in relation to course deliveries (Zimmerman, 1990).

Demand for and the technological advancements in e-learning, more-so over the past decade, have seen more universities and colleges across the globe delivering more of their courses through these modes. It is even predicted that the global demand for higher education will expand from less than 100 million students in 2000 to over 250 million students in 2025 (Unesco, 2011). A growing momentum towards open educational approaches and resources, and advances in technology-enabled learning, have resulted in the emergence of a plethora of digital platforms and portals which offer easy access to educational resources and course materials from institutions across the globe, and have allowed individuals to undertake a vast range of courses online (European Commission, 2014). Both traditional higher education institutions and new types of providers have developed or are now developing a range of online offerings spanning full degree programs, continuing professional development and shorter type courses.

As universities and colleges move more and more towards flexible mode of course deliveries, as educators come to terms with the challenges of developing courses to be taught remotely and asynchronously, and as students battle with these new modes of delivery, a study was needed in the best practices by educators that foster effective SRL (McMahon, 2012). A body of literature investigating relationships between effective SRL and positive learning outcome has reported a mix of results. Zarei, et all (2012). Pintrich et all (1990)

In this proposed contribution, we'll attempt to answer the following research questions:

What are the key features in some of the pedagogical strategies or tools that effectively support learner SRL practices in TELEs?

Is there empirical evidence that those pedagogical strategies and tools do improve student learning outcome?

2. IMPORTANCE OF PEDAGOGICAL STRATEGIES IN SRL PRACTICE

Influencing learning and academic success, the research on the concept of self-regulation emerged in the mid-1980s to answer the question, "How can students manage their own learning processes?" (Bozpolat, 2016).

Interest in academic SR has increased considerably in recent years as investigators and practitioners attempt to understand how students become masters of their learning process (Artino, et al 2013).

In Azevedo et al (2015), it was shown that understanding the acquisition, retention, use and transfer of SRL skills, is key to enhancing comprehension in science learning online. Nejabati (2015) established a significant positive relationship between EFL (English as foreign language) learners' improved reading comprehension and a prior SRL treatment.

The findings in Artino et al (2013) suggest that faculty of online courses, should design their instruction and learning requirements in a manner that helps learners not only appreciate the value or importance of content or skills, but also supports and scaffolds their attempt to master them.

Cho (2004) explained that exposing students to practice or the use of SRL skills, is not enough to promote their self-regulated learning. They need continuous interactions with peers or with instructors about their progress. Interview results from the Cho study showed that many students were not able to fully understand the purpose of SRL, and why they were doing the activities. Cho showed that interactions with others will remind them to think continuously about their activities and progresses.

Marini (2014), studying the relationship among variables associated with SRL showed that intrinsic motivation had a statistically significant association with the use of cognitive and metacognitive learning strategies. These are some of the key variables that educators must appreciate in depth in order to better support student SRL practices.

3. WHAT IS SRL?

A wide body of literature supports the notion that high achievers reported more use of SRL strategies than lower achievers. Nejobi (2015) argues that SRL has deep implications for teacher-learner interaction during course delivery.

SRL was defined by Zimmerman (1990) as the degree to which learners are meta-cognitively, motivationally and behaviorally active participants in their own learning processes.

In terms of metacognitive processes, learners plan their steps, organize themselves to follow these steps, routinely monitor and compare actual steps to planned, and self-evaluating themselves at various points. Zimmerman described motivational process as learners reporting high self-efficacy, self-attributions and intrinsic task interest.

SR students have been described as confident, autonomous, inquisitive learners who employ meta-cognitive strategies to facilitate their learning (Alraggad, 2014). Since SR is not a personality trait, students can control their behavior in order to improve their academic learning and performance.

4. METHOD

Data collection
A total of 20 academic articles relating to SRL TELEs and SRL variables were identified and considered, from which 10 were selected.
Identification procedure
The primary procedure used was a search of appropriate electronic databases to identify relevant literature (Pickering et al, 2014)

Some of the key search terms included:
    "e-learning self-regulated learning"
    "design in self-regulated learning e-learning"
    "e-learning self-regulated learning treatment"
    "e-learning self-regulated learning strategies"
Some of the electronic database searched
    ACM Digital Library
    Google Scholar
The secondary identification procedure used was the reference list of some of the articles found (Pickering et al 2014).

Article Inclusion Selection Procedure

The following selection criteria was applied, in keeping with the recommendation in Pickering et al (2014):
- Peer reviewed
- Applied SRL strategy related with a quantitative analysis
- Reproducible post-SRL statistical analysis

Items selected from included articles

Five (5) items were selected as data from each article. These seem best to describe and report on their chosen SRL treatment:
1. The research questions
2. The independent SRL variables being studied
3. SRL support strategies/tools
4. Details of the experiment and study group
5. SRL outcome statistical results

Table 1 shows the papers studied

Table 1. Papers studied

Paper	RQs
1. Chen, Wang, Chen (2014)	Whether the proposed Digital Reading Annotation e-Learning System (DRAS) with SRL mechanisms, can promote reading comprehension annotation abilities in individual learners?
2. Hu, Driscoll (2013)	Whether a web-based SRL strategy training will positively influence (1) achievement measured with individual assignment scores and final grade for the course (2) learner motivation in terms of task-value, self-efficacy, goal-orientation and self-satisfaction, and (3) learners' self-reported use of strategies
3. Shen et al (2007)	What are the effects of web-based problem-based learning and SRL on the development of computing skills?
4. Lawanto et al (2013)	To what degree students' grade performance change after using EGN (enhanced guided notes)? To what degree students' SRL profiles change after using the EGN?
5. Al Khatib (2010)	What is the extent to which the following variables (intrinsic goal orientation, extrinsic goal orientation, task value, control beliefs, self-efficacy, and test anxiety), account for college students' course scores?
6. Lawanto et all (2014)	What was the students' task value? and to what degree did they exercise SRL while engaged in a web-intensive engineering course? While students were engaged in a web-intensive engineering course, were there significant correlations between: -task value and learning performance -SRL and learning performance -task value and SRL What was the relative importance of task value and SRL with regard to their impact on students' learning performance?
7. Chen C. (2002)	What SRL strategies are related to achievement in a lecture learning environment in an information systems course? Does prior computer experience and software used affect achievement? What SRL strategies are related to achievement in a computer hands-on learning environment of an IS course? Does prior computer experience and software used affect achievement?
8. Zara-ee, A (2007)	What is the relationship of test takers use of cognitive and metacognitive strategies with EFL (English as a foreign language) reading test performance?
9. Cigdem, H (2015)	Is there any significant correlation between student's success and learner self-regulation, perceived usefulness, perceived satisfaction, perceived self-efficacy, perceived anxiety, and interactivity in the online learning environment?
10. Chyung et al (2010)	What levels of intrinsic motivation and self-efficacy do students have in an introductory engineering class? What role do students' intrinsic goal orientation, self-efficacy and e-learning practice play in their learning?

5. FINDINGS

Research Question 1: **What are the key features in some of the pedagogical strategies or tools that effectively support learner SRL practices in TELEs?**

Table 2 summarizes the data collected. No significant pattern emerged in terms of approaches to SRL treatment strategies applied. Motivated Strategies for Learning Questionnaire (MSLQ) was the preferred questionnaire model in 5 of the 10 studies (#2, #5, #6, #7 and #10). MSLQ (Pintrich et al, 1991) is a self-report instrument designed to assess college students' motivational orientations and their use of different learning strategies for a college course. The MSLQ has been widely adopted in studying the impacts of students' motivational orientations and use of different learning strategies on their performances (Fang, 2014).

Five of these achieved the recommended Cronbach alpha reliability score range of 0.70 – 0.90 (Santos 1999). Two of the studies (2 & 6) were above the 0.90 mark which could suggest too many or redundant (Tavakol et all 2011) SRL items. The MSLQs used in studies #2 and #6 therefore appear to be both unreliable and ineffective pedagogical tools.

Only three of the studies (#5, #7 and #9), used a sample size of 100 or higher as suggested by Santos for the SRL questionnaires to be useful.

From table 3 which highlights the focus SRL variables of the studies, we can see that among the most included are self-efficacy (#5, #9 and #10), intrinsic goal orientation (#2, #5 and #10), learning time (#1, #6 and #7), and metacognitive SR (#5, #7 and #8), each appearing in three of the ten studies. This suggests any pedagogical strategy to support SRL practices by the learner, should include all four SRL components at the minimum.

Learning time was used in study #6 as part of the study's performance control strategy. It measured how students' allocate study time for online courses, how they schedule and observe study times, and how they distribute study times across days (MSLQ e.g. "I try to schedule the same time every day or week to study for my online courses, and I observe my schedule").

In study #1, learning time was used a SRL competence measure index, and a factor in a SRL status indicator to help remind and motivate the learner during the course. Used as a part of resource management strategies in study #7, learning time measured use of study time, sticking to a study schedule, keeping up regularly, tardiness in attending class, and time to review course material (MSLQ e.g. "I find it hard to stick to a study schedule", "I rarely find time to review my notes or readings before an exam").

Self-efficacy (SE) is defined as people's beliefs about their capabilities to produce designated levels of performance that exercise influence over events that affect their lives (Bandura, A. 1997). SE beliefs determine how people feel, think, motivate themselves and behave.

Self-efficacy (SE) in study #5 measured the extent to which students believed that were competent in terms in terms of task-related abilities and skills, and had a high likelihood of a successful academic performance (e.g. "I believe I will receive an excellent grade in this class").

Study #9 concluded that learners who were more satisfied with the online mode of blended learning, and found it is more interactive and useful, reported a higher level of self-regulation in online mode of the blended Computer Programming course. SE in study #9 measured students' confidence levels using a course portal, perceived satisfaction, perceived usefulness, and interactivity in the online learning environment.

In study #10, SE measured students' confidence levels in learning and performance at the end of an introductory engineering class (e.g. "I'm certain I can understand the most difficult material presented in the readings for this course.", " I'm confident I can understand the basic concepts taught in this course").

Intrinsic goal orientation (IGO) refers to the drive inherent in an activity itself, as when the student engages in an activity for its own sake, the enjoyment it provides, the learning it permits, or the feelings of accomplishment it evokes (Khatib, 2010).

IGO in study #5 was used to assess the degree to which learners perceived themselves to be engaged in academic tasks in order to meet a personal challenge, satisfy personal curiosity, and/or attain personal mastery over the elements of the task (e.g. "In a class like this, I prefer course material that arouses my curiosity, even if it is difficult to learn").

In study #10, IGO was used to measure how students perceive themselves to be participating in a task for reasons such as challenge, curiosity, and mastery (e.g. "In a class like this, I prefer course material that really challenges me so I can learn new things. ", "The most satisfying thing for me in this course is trying to understand the content as thoroughly as possible", "When I have the opportunity in this class, I choose course assignments that I can learn from even if they don't guarantee a good grade").

Table 2. Features of the SRL treatments applied

Paper	1	2	3	4	5	6	7	8	9	10
SRL embedded into the TELE	√									
n										
1 – 20		√								
21 – 39	√						√			
40 – 79			√		√					√
80 – 129				√						
130 – 149										
150 – 199							√			
≥ 200					√				√	
SRL q'nnaire										
MSLQ										
Pintrich, 1991		√			√	√	√			√
						√				
Butler, 2004				√						
Barnard, 2008				√						
Purpura, 1999								√		
Alpha coefficient										
0.50 – 0.59										
0.60 – 0.69										
0.70 – 0.79										
0.80 – 0.89		√		√	√	√				√
0.90									√	
0.91 – 0.99		√				√				
		√								
Likert scale										
1 – 4				√						
1 – 5		√				√		√		
1 – 6										
1 – 7					√	√			√	√
Item count										
1 – 20						√				√
						√				
21 – 39						√		√	√	
40 – 59					√		√			
60 – 100		√								
BEFORE COURSE										
Admin SQL q'nnaire				√	√			√	√	
DURING COURSE										
Admin SRL q'nnaire			√				√			
Taught SRL	√		√	√						
Allowed SRL practice	√		√	√						
AT END OF COURSE										
Admin SRL q'nnaire			√		√	√				√

Table 3. SRL variables used

SRL Variables	Paper									
	1	2	3	4	5	6	7	8	9	10
Cognitive strategies							√			
Concentrated learning	√									
Control beliefs					√					
Effort for learning courseware	√					√				
e-learning practice										√
Environment structuring						√	√			
Extrinsic goal orientation		√			√					
Goal seeking						√				
Help seeking						√	√			
Importance						√				
Interactively in the on-line learning environment									√	
Interest						√				
Intrinsic goal orientation		√			√					√
Learning time	√					√	√			
Metacognitive SR					√		√	√		
Monitoring Strategies				√						
Peer learning							√			
Perceived anxiety					√				√	
Perceived satisfaction									√	
Perceived usefulness									√	
Planning Strategies				√						
Prior computer experience							√			
Problem-based learning			√							
Reading rate	√									
Regulatory Strategies				√						
Reported Use of Strategies		√								
Self-efficacy						√			√	√
Self-evaluation					√					
Self-Satisfaction		√								
Software used							√			
SRL			√						√	
Task strategies						√				
Task Value		√			√					
Utility						√				

The findings by Pintrich et all (1990), that *meta-cognitive self-regulation* (mCSR) was the best predictor of academic performance on all the outcome measures, suggests that the use of self-regulating strategies, such as comprehension monitoring, goal setting, planning, and effort management and persistence, is essential for academic performance on different types of actual classroom tasks.

mCSR in study #5 was one of the predictors of college students' academic performance, and was used to assess the degree to which the students monitor and regulate their use of cognitive state (e.g. "when I become confused about something I'm reading for this class, I go back and try to figure it out").

mCSR is study #7 was used to measure how students handle challenging new topics while being delivered in class and studied, how students handle distractions or being confused, and how they use goals in studying.

Research Question 2: **Is there empirical evidence that those pedagogical strategies and tools do improve student learning outcome?**

Table 4. Summarised Statistical Overall Learning Outcome Results

| Study | n | Assessment | Mean Test Scores | | t | p | sig | r^2 |
			Control Group	Exprmnt Group				
1	32/32	Reading	45.31	60.63	-2.5840		0.0120	
			45.00	56.72	-2.4730		0.0160	
			47.34	62.19	-2.7020		0.0090	
		Annotation	14.34	34.53	-4.4020		0.0000	
			14.16	27.28	-3.0380		0.0040	
			16.41	27.94	-2.6400		0.1000	
2	13/8	Test	85.92	91.13		< 0.05		0.5100
		Paper	58.38	87.63		< 0.05		0.4800
		Final Exam	83.77	89.13		< 0.05		0.4800
3	52/54	MS-Word	58.21	63.11	2.0180	0.0460		
4	97	Exams 1/2			-7.9700	0.0000		
		Exams 2/3			-4.1300	0.0000		
		Exams 3/Final			5.0300	0.0000		
5	404	Final Exam				< 0.001		0.4050
6	57	Final Exam				0.0040		0.3710
7	197	Test				< 0.000		0.2290
8	30	Test					0.0340	0.3880
							0.5000	0.1280
9	267					< 0.005		
10	50	Test				0.0070		0.2400

Table 4 shows overall learning outcome performance statistically for each of the studies.

Study #1 shows significant better leaner performance in the mean test scores by the experiment group over the control group (Reading Test #1 – 45.31/60.63, #2 – 45.00/56.72 and Test #3 – 47.34/62.19 . Annotation scores at p = 0.0000 appears very significant. n is small at 32, but both groups were randomly assigned (Cohen et al 2005). These results suggest the results could be repeated using the same pedagogical strategies for another English-Language reading group. In this study, the SRL components were embedded in the TELe. The participants received regular SRL performance feedback during the course.

With n = 97 engineering students (selected by survey results, not at random), study #4 showed statistical very significant (p = 0.000) improved performances exam to exam (t = -7.79 and -4.13). The final exam (at t = 5.03) performance fell however.

In Study #5 40% of the test scores were predicted with a 95% confidence level and strong p below 0.001. n at 404 represented 100% coverage over five general education courses. Perhaps providing written procedural instructions and the purpose of the study to the participants contributed to the strong level of performances. In keeping with Cohen et at (2005) we could expect a repeat of these results over another large population using the same pedagogical strategies for the same courses.

Study #8 resulted with only 39% of the final exam scores explained by the cognitive strategies with low significance of 0.03, and 12% of the final exam scores explained by the meta-cognitive strategies with non-significance of 0.50. Study #8 used only the two SRL variables. Perhaps the inclusion of at least one more key variable would have strengthened the learner performance outcomes.

6. DISCUSSION

The findings of this study are important in terms of advising TELE educators on some of the existing leading SRL treatment frameworks for consideration. Previous studies on individual SRL treatment strategies to improve learning outcome, show how SRL treatments are applicable across many academic subject areas focusing on particular SRL variables and features.

Research also has shown that SRL skills need to be adopted in formal e-learning coursework as cognitive toolsets (Leacock et al 2006). This study provides educators with some of the key elements of established cognitive toolsets and stages in an e-learning course that could be applied.

Our analysis of ten studies showed some of the SRL treatment and strategy frameworks adapted by researchers in teaching cognitive skills in experiment. The features of the frameworks included the use and structure of SRL knowledge acquisition questionnaires, administering the questionnaires before, during and at the end of the courses, teaching SRL early in a course and allowing students to practice SRL during a course.

The data analysis in this study showed the sets of SRL variables considered crucial by researchers. From the statistical results provided, we later identified the four strongest variables.

Zumbrum et al (2011) found that learners who were taught SRL skills through monitoring and imitation, were more likely to elicit higher levels of academic self-efficacy (i.e. confidence). Code et al (2006) argued that intrinsic goal orientation provides students with a sense of control and resilience in the face of external challenges.

Based on the results of this study, and considering some of the strengths and weaknesses of the ten studies, we could recommend a pedagogical strategy to promote SRL practice among students in a TELe to include:

- Preparing a 21-39 item MSLQ questionnaire adapted from Pintrich (1991) to include subscales self-efficacy, intrinsic goal orientation, meta-cognitive self-regulation and time management at the minimum
- Administering the MSLQ at the beginning of course
- Preparing and delivering SRL workshops during the course based on the responses from the MSLQ
- Allowing the students to practice SRL during the course
- Administering the same questionnaire at the end of the course to assess the SRL behavioral changes

7. CONCLUSION

The main contribution of the present study was to investigate the primary features of the self-regulated learning treatments and strategies employed in TELEs that could enhance learning outcome. The results showed the characteristics in summary, of the SRL treatments and strategies that were investigated. The characteristics of and use of SRL knowledge questionnaires, how and when they are administered, where provided. The results showed that SRL are sometimes taught during a course, while another course embedded the SRL inside the TELE giving the students important feedback as they learn and evaluate themselves. The results also showed the focus SRL variables used in the studies, and how wide and indifferent there were. Some of the variables however where shown to be similar among the studies and formed the basis of consensus that the four variable identified are among the strongest that could best lead to improved learning outcome, if taught well to the students. The statistical results in provided in the studies confirmed the consensus, about which needs further analysis for future work.

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