<table>
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<tbody>
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Self-Regulation, Mediators, and E-Learning:
A Field Experiment in Rural Belize

Completed Research Paper

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Abstract

Can lessons from IS research be applied on a small scale in rural environments to help a country develop? Students in rural schools in Belize often lack access to well-trained subject experts, score lower on national exams, and enroll in secondary schools at a lower rate than urban students. Utilizing mobile Internet technologies, students living without electricity can now access educational resources similar to urban students. How best to utilize these resources to improve students’ learning outcomes remains to be solved. This article first describes and compares a theory originating in the developed world (self-regulated learning) with one originating in the developing world (minimally invasive education). Second, it presents a framework combining constructs from both theories. Finally, it focuses on learning outcomes as measured by students’ cognitive ability, self-efficacy and motivation and compares a self-organized learning environment with one enhanced by self-regulated strategies, through a quasi-experimental design.

Keywords: Self-regulated learning, e-learning, developing countries, motivation, self-organized mediated environment, minimally invasive education, mobile technology

Introduction

In developed countries, researchers have conducted extensive studies to establish pedagogical theories to best implement computer technologies and Internet resources to improve educational outcomes. A prominent theory that has gained much attention is the theory of self-regulated learning (SRL) (Tsai et al. 2013) that not only improves learning outcomes but focuses on increasing students’ self-efficacy and motivation among users (Schunk et al. 1999; Alavi et al. 2001; Azevedo et al. 2008; Wan et al. 2012).

However, researchers in developing countries have focused on utilizing these technologies to solve a distinct set of issues that are not as prevalent in developed countries; that is, the lack of access to subject matter and subject experts. In solving these issues, researchers have introduced a novel pedagogical theory, minimally invasive education (MIE), to best utilize technology in education that significantly improve learning outcomes (Mitra et al. 2005). These studies also show that a friendly mediator with no knowledge of the subject could improve the performance of rural children.

In this article, we describe and compare a theory originating in the developed world (SRL) and one originating in the developing world (MIE), and draw from them a conceptual framework to best combine constructs of both to create an environment that not only improves learning outcomes but builds users’ motivation and self-efficacy. We then report results of our study, conducted in a remote rural school in Belize, to compare relationships identified in our framework. We focus our study on improving students’ math skills, although the conceptual framework can be used to improve a wider set of skills. Utilizing a quasi-experimental design, we first test Mitra’s MIE theory by replicating a self-organized mediated
environment (SOME) modified by utilizing tablets and wireless Internet access to conduct the study in a remote school, with no access to electricity. We then create an environment that combines concepts of both theories; a SOME with explicit SRL strategies included in the environment (SOME+SRL). Both environments are compared measuring academic ability, self-efficacy, and motivation before and after the course. We focus on math because rural students in the region being studied score the lowest in this subject on national tests. This is according to the study by the Inter-American Development Bank “Challenges and Opportunities in the Belize Education Sector” (2013), which also states that teachers working in these regions test the lowest in math showing the lack of subject experts.

Our conceptual framework combines two theories found in the literature and the results of our study are supported in prior studies. Although the theory of MIE has been studied in developing countries with subjects that have no prior experience with technology, the same is not true about studies of SRL. The main contribution of this study is in evaluating the application of the theory of SRL in a new context; subjects from a rural area in a developing country that have minimal experience with computers. The question may be posed: “Will novice users of technology respond to SRL strategies in an e-learning environment in a similar manner to users that are familiar with technology?” Our findings suggest that they do. These results could be useful to both researchers and educators interested in investigating ways to increase the effectiveness of e-learning environments in developing countries that lack access to subject experts.

This article is organized as follows. First we present a background of Belize regarding the educational realities currently faced, followed by a review of the literature. We then focus on the framework of combining constructs from two theories and develop the research model and hypotheses. The research design is then detailed. Data analysis and results are then presented and the discussion, limitations and conclusions follow.

**Country Educational Background**

The Inter-American Development Bank conducted an extensive study of the Belize educational sector (2013) and summarized:

Belize is paying a lot for education but getting little. More youth are outside the school system than in it and many fail to make the transition to the workforce. More and more youth drop out of school and become involved in gang activities. Action is needed if Belize is not to lose a whole generation of youth.

The report shows the secondary school enrollment rate at 45%. Moreover, while five in ten students living in urban areas were enrolled in secondary schools, only three in ten residing in rural areas were attending school. Since most Belizeans living in rural areas are of Mayan decent, the attendance of Mayan children (Yucatec, Mopan, and Ketchi) is lower than children from other ethnic groups.

Gaining acceptance into secondary school in Belize is not a certainty as parents must overcome financial obstacles and students must pass the national Primary School Exam (PSE). According to the report fewer than half (44 percent) of the students who took the PSE in 2011 obtained an overall grade at or above the satisfactory level. The results were even worse for students living in rural areas, where only 37 percent scored at the satisfactory level, compared with 52 percent in urban areas. This shows a correlation between students’ scores on the PSE and secondary school attendance. While the challenges are great, the recommendation of the study is to focus on increased efficiency, quality and equity.

**Literature Review**

In the past, researchers in education and human psychology disciplines have studied the influences of cognitive theory and self-regulation on learning outcomes (Zimmerman 1989; Bandura 1991; Pintrich et al. 1993; Azevedo et al. 2008; Winne 1995). In recent years, the IS literature has studied the influence of these theories when applied to technology enhanced learning environments (Tsai et al. 2013).
Cognitive Theory and Self-Regulation

Social cognitive theory emphasizes the interaction of personal, behavioral, and environmental factors (Zimmerman 1989). Self-regulation is a sub-function of social cognitive theory that is critical to the application of the theory. In self-regulated learning, students manage their own learning processes by monitoring and adjusting their behaviors to achieve learning goals they have set for themselves (Bandura 1991). In order for students to self-regulate their learning they must be metacognitively, motivationally, and behaviorally active in their learning (Zimmerman 1989). Self-efficacy affects self-regulation when students evaluate their progress; perceived progress enhances self-efficacy and motivation, which enhance learning (Schunk et al. 1999).

Self-Regulation in E-Learning Environments

Early experiments evaluating the effects of SRL conditions introduced into e-learning environments focused on self-evaluation, students were given single and multiple opportunities to self-evaluate when using an e-learning system (Schunk et al. 1999). The learning outcomes of these e-learning environments were then compared to environments where no self-evaluation was available. The results of these studies showed that providing students with opportunities for self-evaluation enhanced their self-efficacy.

A more recent approach has been to include SRL strategies in traditional e-learning environments in the form of pre-training scripts, external evaluations, and feedback scripts during training. These have also increased learning outcomes (Santhanam et al. 2008). This approach has been extended by incorporating externally-facilitated self-regulated learning, in the form of human tutors that facilitate students’ self-regulation, to the e-learning environment. This has shown to further enhance learning outcomes when compared to self-regulated learning environments that do not include human tutors (Azevedo et al. 2008).

Experiments conducted in a business organization setting where training is provided via an e-learning environment have also given insight to online training providers. These studies show the difference in personal versus social learning strategies suggesting that learners adopt different self-regulated learning strategies resulting in different e-learning outcomes (Wan, et al. 2012).

A review of SRL studies in selected journals from 2003 to 2012 (Tsai et al. 2013) show that 46 papers on SRL in e-learning environments have been published. Of these, only 4.3% of the studies focused on elementary students and none of the studies were conducted with subjects that had no prior experience with computers. The current literature does not provide evidence that novice users can use an e-learning environment while incorporating SRL strategies to improve their learning outcomes.

These studies originated in the developed world where researchers conceptualize strategies to overcome the inherent nature of e-learning environments that require students to take control of the learning process. In the developing world, a distinct set of issues has lead to research on self-organized learning environments.

Minimally Invasive Education

Minimally Invasive Education (MIE) is a pedagogic theory originating from experiments that were carried out in 1999 where a computer with an Internet connection was installed in a slum of New Delhi, India, and children were allowed to use the computer without supervision (Mitra et al. 2005). In less than a month, the children had learned how to browse, create documents, paint pictures and play games. The observation that children could learn basic computer skills on their own when they come into contact with the technology led the researchers to define MIE theory and conduct further research on its implications. Experiments with self-organized learning environments (SOLEs) found that children, following the principles of MIE could improve their English pronunciation on their own (Mitra et. al. 2003), and improve their mathematics and science scores in school (Inamdar et al. 2005). In developing countries where geographical, economic, social and political factors combined with the unavailability of properly trained teachers, leads to poor quality of public schools, the implementation of SOLEs has been shown as a viable solution (Mitra et al. 2008).

In an attempt to find a limit to MIEs, an experiment was carried out to teach 10-14 year old students in a remote Indian village to learn basic molecular biology utilizing a SOLE (Mitra et al. 2010). Although the
learning outcomes were comparable with the test scores of children at local state schools, the outcomes were lower than those of students at private urban schools. When the SOLEs were supported by mediators with no knowledge of the subject, the learning outcomes were equal to their peers in the privileged private urban school. Mitra (2010) describes mediators as: “parents, grandparents or other adults in remote areas. Such mediators are not likely to be trained to teach, nor are they likely to have any specific subject knowledge.” This experiment showed that a SOLE with a mediator present, a self-organized mediated environment (SOME), further improved learning outcomes. In developing countries where rural children do not have access to the same educational resources as privileged urban students, SOMEs can be an effective solution in overcoming the inequalities.

**Research Model and Hypotheses**

**Framework Combining Constructs**

While SRL strategies have been utilized for over a decade to improve e-learning environments in developed countries, and self-organized environments have been implemented in developing countries to overcome the issues of lack of qualified teachers, the literature is lacking a combining of constructs from both regions. We believe that, in the same way that SRL strategies have been introduced into traditional e-learning environments, so can they be combined with self-organized learning environments to further improve learning outcomes. They may be better suited for this, as SOMEs tend to require more self-regulation than traditional e-learning environments. A conceptual framework, based on Piccoli’s model (2001), to combine constructs of SRL and SOMEs is shown in Figure 1.

![Figure 1. Research Framework Combining Constructs](image)

**Development of Hypothesis**

We utilized existing web-based communication technologies to design an e-learning environment where students learn in groups, with minimal intervention, by using Internet resources to answer broad questions about concepts that prepare them for the Primary School Exam (PSE) based on the government
The use of mobile Internet connected devices, in this case computer tablets, allowed us to maintain connectivity and interaction with the instructor and among students, thus being able to create self-organized mediated environments (SOME) proposed by Mitra (2001). Utilizing these same technologies, a second environment was created by combining a SOME with explicit self-regulated strategies suggested by Schunk (1999), Alavi (2001), and Wan (2012). These environments allowed us to focus on the constructs of self-efficacy, motivation, and academic ability. Drawing on this framework, we developed testable hypotheses that compare the two e-learning environments on these three measurements of learning outcomes. Learning outcomes are measured in terms of students’ scores on a PSE achievement test. Self-efficacy and motivation are measured with validated surveys.

Minimally Invasive Education theory (MIE) (Mitra et al. 2005) provides the foundation for the design of both the e-learning environments. MIE is a theory of instructional design that provides a solution for situations where there is an absence of subject experts. Open-ended questions are provided for students who use Internet resources to answer the question then the answers are presented to collocated mediators and remote instructors. Explicit SRL strategies in the form of scripts included in traditional e-learning environments have been used to improve outcomes (Schunk et al. 1999; Alavi et al. 2001; Wan et al. 2012). By combining these environments, we thus hypothesize:

**H1: Students in the SOME+SRL e-learning environment achieve higher test scores than their counterparts in the SOME only e-learning environment.**

To analyze why one learning environment achieves better learning outcomes than another, physiological learning processes need to be measured. We therefore include the measurements of self-efficacy and motivation of students in both environments. We measure students’ self-efficacy pretreatment and post treatment to evaluate if the distinct learning environments affect students self-efficacy differently. By having collocated mediators follow SRL strategy scripts to encourage students during the classes, we hypothesize:

**H2: Students in the SOME+SRL e-learning learning environments will report higher levels of computer self-efficacy than their counterparts in the SOME only e-learning environment.**

Students who use internal factors for motivation have been shown to stay focused on tasks longer, give up less often, and thus achieve higher learning outcomes than students who use external factors for motivation (Bandura 1989). We measure students’ motivation pretreatment and post treatment to evaluate if the distinct learning environments affect students motivation differently. SRL strategies scripts followed by the mediators will reinforce students’ beliefs that they are solely responsible for their learning. They can only learn the subject based on their own motivation and efforts. We therefore hypothesize:

**H3: Students in the SOME+SRL virtual learning environments will report higher levels of internal motivation than their counterparts in the SOME only virtual learning environments.**

**Research Design**

We conducted a field experiment adopting a two group pre-treatment, post-treatment measurement design, varying the e-learning environment (SOME, SOME+SRL).

The course was a voluntary two week after-school math program focusing on geometry. The students took part in ten, one hour classes. The stated purpose of the course was to prepare students for the math section of the Primary School Exam (PSE). The course was offered to 7th and 8th grade students at a rural primary school. The course contained objectives from the Belize Primary School Math Curriculum with an emphasis on answering questions similar to the ones on past PSE.

A total of 43 primary school students participated in the experiment. Subjects had no knowledge that the course was an experiment; they participated in order to prepare for the PSE. Additionally, students were not informed that the two sections were to be presented with differences in course content and instruction. Completion records are shown in Table 1.
The subjects were students between the ages of 11 and 14 who study in a rural school in the Cayo District of Belize. The subjects included both males and females of similar socioeconomic status. The subjects are bilingual in English and Spanish; they speak Spanish at home with their parents and study in English, and are considered native English speakers by the school system of Belize. They are representative of the traditional primary level school students in rural areas of the country. The students’ parents reside in rural areas due to their profession as agricultural workers. The typical parents of the participants do not have formal education above the level of primary school. The typical subject will not have the opportunity to attend secondary school. This environment mirrors the environment of the 60% of Belizeans that live in rural areas.

A preliminary survey was completed before the course began to measure demographics. We administered the pre-treatment assessment test of multiple choice questions from past PSEs. Pre-treatment surveys to measure self-efficacy and motivation were also administered. A series of t-tests were run to ensure that there was no significant difference between the treatment and control group on the above dimensions.

**Procedure and Learning Environments**

The subjects were randomly assigned to either an SOME+SRL e-learning environment or a SOME e-learning environment. Two mediators, that are not subject experts, were selected to facilitate the groups and were collocated with the students. One mediator facilitated the SOME group and one mediator facilitated the SOME+SRL group. The SOME+SRL mediator participated in a one hour class that described SRL with instructions on how to encourage students to use SRL strategies. Each section was equipped with seven android tablets connected to a Wi-Fi network that connects to the Internet via a 4G wireless connection. This mobile solution facilitated the implementation of the e-learning environment in a remote school that did not have access to electricity. Students worked in groups of three sharing a tablet. (The SOME had one group of four students). There were two instructors who were subject experts. These online instructors were located remotely. The e-learning system allowed for synchronous communication with the instructor via chat, video chat, and interactive documents.

**Experimental Manipulation**

Both the SOME+SRL and SOME only courses have been designed in accordance with Mitra’s Minimally Invasive Education (MIE) theory. Students work in groups without the help of instructors to come up with answers. Students have been instructed to use khanacademy.com to answer these questions. A broad question is asked at the beginning of the class. The students then watch videos and work out examples in groups with minimal intervention. This is in line with MIE theory where students, when asked the right questions, take the initiative to search for the best answers. At the end of the class each group of students presented their answers to the online instructor. Additionally students and the online instructor interacted whenever the students had questions during the class in a synchronous fashion.

In general, students can be described as self-regulated to the degree that they are metacognitively, motivationally, and behaviorally active participants in their own learning process (Zimmerman 1989). Santhanam et. al. (2008) propose that learning outcomes will be enhanced if instruction includes interventions that instruct learners to follow self-regulatory learning strategies that encourage learners to believe that they can learn through e-learning training, enhance their motivation to learn, and formulate appropriate goals for the course. Therefore, the SOME+SRL course included a onetime intervention defining SRL. This component of explicit self-regulation strategies was presented by the mediator on the...
first day of class. It included a short video on SRL and a ten minute presentation on academic goal setting, self recording, self evaluation, and adaptation.

Additionally, daily interventions were introduced to the SOME+SRL group. First, the mediator followed a script to verbally encourage the use of these strategies during the session by asking the students if they were using the SRL strategies.

Secondly, to build students’ self-efficacy, the mediator followed a script to verbally encourage the students throughout the course. Positive comments included: “Excellent effort and progress!” “You are making good progress toward the goal of learning geometry.” “Good job!” These comments were derived from Santhanam et al. (2008)’s study. However, instead of being presented to students via the online system, they were given verbally to the students by the mediator in a similar method as Azevedo (2008).

Thirdly, daily interventions to increase students’ motivation were incorporated in the SOME+SRL group. To increase students’ motivation, the mediator followed a script to encourage the students with the following statements and questions: “These days, all students should go to high school.” “A high school education is necessary for you to live a good life.” “Which high schools are you interested in attending?” “Have you applied to high school yet?” “You must pass the math PSE to gain entrance to high school.” These interventions were an attempt to build students internal motivation. Students with internal motivation tend to persevere in tasks to a greater extent than externally motivated students (Bandura 1989).

These interventions left the SOME+SRL students with less time for the math content to be presented and worked on. This was intentionally part of the experiment. We compared the results of both the treatment and control groups to see if having less time to spend on the math content affected the post treatment learning outcomes. In order to clarify the distinction between the SOME+SRL and SOME only e-learning environments used in our study, we contrasted them on the dimensions introduced in Table 2.

<table>
<thead>
<tr>
<th>SOME</th>
<th>SOME+SRL</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Content</strong></td>
<td>Broad question on Geometry</td>
</tr>
<tr>
<td>Students utilize Khan Academy to find answers</td>
<td>Students utilize Khan Academy to find answers</td>
</tr>
<tr>
<td>Does not include explicit content on SRL strategies</td>
<td>Contains video and lesson on SRL strategies</td>
</tr>
<tr>
<td>-Students verbally answer questions about their use of SRL strategies</td>
<td></td>
</tr>
<tr>
<td><strong>Instruction</strong></td>
<td>Mediators do not encourage students to utilize SRL strategies</td>
</tr>
<tr>
<td><strong>Time</strong></td>
<td>Entire class time is utilized to learn Geometry</td>
</tr>
</tbody>
</table>

Table 2. Contrast of SOME and SOME+SRL

We explicitly addressed the potential for researcher bias. The primary investigator did not participate as the online instructor or as a mediator, but observed the mediators and the online class activities. In this way, we were be able to observe both the offline interaction of students with each other and the collocated mediators and also the online interaction of students with each other and the online instructor. The online instructor and the mediators were not informed of the research details (hypothesis, dependent variables, instruments) prior to the completion of the course.
Experiments on learner control have varied greatly in the amount of time used as the unit of analysis. Studies introducing SRL strategies in a single session have been conducted by Santhanam (2008), Gravill (2008), Schunk (1999) and Avevedo (2008). Studies have been conducted over one semester (Alavi 1994). However, studies by Mitra (2002, 2005, 2010) were conducted over a period of nine months or more. Our experiment length of ten hours is between the single unit experiments and the semester length experiments.

Participants’ interaction represents an important characteristic of a learning environment. Thus, we monitored students interaction both online and offline. The main researcher observed each session, taking notes to later categorize the offline interaction. The online interaction was logged by the e-learning system and was analyzed after the experiment was complete. A summary of these interactions are presented in the discussions of the experiment.

**Variables and Measures**

Zimmerman (1989) identified four dimensions of SRL: motives, methods, performance outcomes, and social-environmental resources. In this study, we focus on two of these dimensions: motives and performance outcomes.

To evaluate performance outcomes, we measured students’ achievement. Grades on the declarative knowledge pre-treatment test and post-treatment test were used to measure achievement. This test was comprised of math questions, specifically geometry questions, selected from past PSEs. The PSE is developed by the Ministry of Education of Belize. Each year a new set of questions are produced for the exam, they are similar to questions of past exams and are based on standards set forward by the math curriculum for primary school students. The test had 40 questions and was scored from 0 to 40.

Psychological learning processes include cognitive and information processing activities, interests, memory, and students motives (Alavi et al. 2001). We measure only the motives dimensions in our study. To evaluate motives we utilized instruments to measured both students’ self-efficacy and students’ motivation.

The Academic Self-Regulation Questionnaire (SRQ-A) was utilized to measure students’ motivation. It asks 32 questions about what motivates students to complete various school related tasks. Validation of this scale is presented in Ryan and Connell study (1989). In this version, “Always” is scored 4; “Most of the Time” is scored 3; “Sometimes” is scored 2; and “Never” is scored 1. The responses to each item are on a 4-point scale rather than a 7-point to make it easier for children to complete. The scale was developed for students in late elementary and middle school. (The comparable SRQ for adults is referred to as the Learning Self-Regulation Questionnaire). There are four subscales to the questionnaire: external regulation, introjected regulation, identified regulation, and intrinsic motivation. The Relative Autonomy Index (RAI) is formed using the following formula to combine the subscale scores: 2 X Intrinsic + Identified - Introjected - 2 X External. The RAI score can range from -9 to 9. A high negative score indicates that the child is externally motivated and a high positive score indicates that the child is internally motivated. Internally motivated children perform better in school than externally motivated children. Therefore, a student with a high positive score on the SRQ-A questionnaire is regarded as highly motivated and a student with a high negative score is regarded as lowly motivated. The students’ states of motivation were measured on the first day of the course and on the final day of the course.

Students’ states of self-efficacy were measured on the first day of the course and on the final day of the course using 7 questions from the Motivated Strategies for Learning Questionnaire (MSLQ) (Pintrich et al., 1993). The scale was modified to a 4-point scale to make it easier for the students to answer and to match the SRQ-A questionnaire that measured motivation.

**Data Analysis and Results**

The primary purpose of our study was to measure the effects of SRL on the learning outcome of academic achievement. The academic achievement tests given to the students had 40 questions; students were given 1 point for each correct answer on the test making the range of test scores 0 to 40. T-tests were run comparing pretest and posttest academic achievement results for both learning environments. Mean and standard deviations of achievement, t-test significance and p-values are reported in Table 3.
Table 3. Means and Standard Deviations, Learning Outcomes

<table>
<thead>
<tr>
<th>Achievement</th>
<th>SOME+SRL Mean (SD)</th>
<th>SOME Mean (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pretest</td>
<td>14.45 (5.52)</td>
<td>15.25 (5.54)</td>
</tr>
<tr>
<td>Posttest</td>
<td>19.35 (5.14)</td>
<td>17.50 (5.22)</td>
</tr>
<tr>
<td>T-test (P-value)</td>
<td>7.60 p&lt;.001</td>
<td>2.40 .027</td>
</tr>
</tbody>
</table>

Our results show that both learning environments significantly increased learning outcomes. The SOME+SRL environment students showed a significant effect for achievement, $t(19) = 7.60, p < .001$, with students receiving higher scores on the posttest than on the pretest. The SOME students also showed a significant effect for posttest achievement, $t(19) = 2.40, p < .05$. The results show that the SOME+SRL group's difference in sample means ($p<.001$) was higher than the SOME group's ($p<0.5$) supporting the first hypothesis that the students in the SOME+SRL environment would achieve higher test scores than the students in SOME environment.

Since our results show a statistically significant main effect of the learning environment we performed additional analysis. One-way analysis of covariance (ANCOVA) was performed on achievement scores with the pretest scores used as a covariant. Table 4 contains the test of between-subjects effects which shows the effect size for both the pretest score and the learning environment.

<table>
<thead>
<tr>
<th>Dependant Variable: Post Test</th>
<th>Type III Sum of Squares</th>
<th>Df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
<th>Partial Eta Squared</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corrected Model</td>
<td>711.433</td>
<td>2</td>
<td>355.71</td>
<td>30.871</td>
<td>.000</td>
<td>.625</td>
</tr>
<tr>
<td>Intercept</td>
<td>234.288</td>
<td>1</td>
<td>234.288</td>
<td>20.333</td>
<td>.000</td>
<td>.355</td>
</tr>
<tr>
<td>Pre Test</td>
<td>677.208</td>
<td>1</td>
<td>677.208</td>
<td>58.771</td>
<td>.000</td>
<td>.614</td>
</tr>
<tr>
<td>Learning Environment</td>
<td>60.211</td>
<td>1</td>
<td>60.211</td>
<td>5.225</td>
<td>.028</td>
<td>.124</td>
</tr>
<tr>
<td>Error</td>
<td>426.342</td>
<td>37</td>
<td>11.523</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>14717.000</td>
<td>40</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corrected Total</td>
<td>1137.775</td>
<td>39</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 4. Test of Between-Subjects Effects

ANCOVA was performed after confirming requirement of homogeneity of within-cell regressions ($F(1,38)=0.59;p>0.05$). Our results indicated that prior to the beginning of the study no significant differences existed in achievement scores between the two instructional approaches ($F(1,37)=0.21;p>0.05$). On the post-test, we found significant differences between the instructions ($F(1,37)=5.23;p<0.05$). The high effect size for the pretest (ES=0.61) is common in education research. Effect size for the learning environment indicated that at the end of the study the SOME+SRL students outperformed the SOME students in achievement scores (ES=0.12).

While effect size of the learning environment may be considered low, studies on educational interventions in the developing world emphasize the cost of intervention as related to the effect size of the intervention (Iqbal Dhaliwal et al. 2013). In our study, the effect size of 0.12 would be considered acceptable when
compared to the cost of implementation, which was low; one hour of SRL training for the mediator and inclusion of SRL lessons in the course content.

The second purpose of our study was to measure the learning outcomes of student motivation and self-efficacy. The instrument’s range for measuring self-efficacy was from 1 to 4; 1 indicating high self-efficacy and 4 indicating low self-efficacy. Table 5 presents the means scores and standard deviations of self-efficacy, and list significance in pre and posttest measurements.

<table>
<thead>
<tr>
<th></th>
<th>SOME+SRL Mean (SD)</th>
<th>SOME Mean (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Self-Efficacy</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pretest</td>
<td>1.79 (0.39)</td>
<td>1.71 (0.52)</td>
</tr>
<tr>
<td>Posttest</td>
<td>1.58 (0.34)</td>
<td>1.68 (0.36)</td>
</tr>
<tr>
<td>T-test</td>
<td>2.44 .018</td>
<td>0.20 .847</td>
</tr>
</tbody>
</table>

Table 5. Mean and Standard Deviations, Psychological Learning Processes (Self-Efficacy)

Our results show that the SOME+SRL learning environment significantly increased students self-efficacy, \( t(19) = 2.44, p < .05 \). The SOME students’ self-efficacy also increased, however the increase was not significant \( t(19) = 0.20, p > .05 \). The results show the SOME+SRL difference in sample means (p<.05) was higher than the SOME group’s (p>.05) supporting the second hypothesis that the students in the SOME+SRL environment would report higher self-efficacy than the students in SOME environment.

Table 6 presents the means scores and standard deviations of motivation, and list significance in pre and posttest measurements. The instrument’s range was from -9 to 9; -9 indicating a lowly motivated student and 9 indicating a highly motivated student.

<table>
<thead>
<tr>
<th></th>
<th>SOME+SRL Mean (SD)</th>
<th>SOME Mean (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motivation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pretest</td>
<td>-0.41 (1.14)</td>
<td>0.29 (1.13)</td>
</tr>
<tr>
<td>Posttest</td>
<td>-0.32 (0.48)</td>
<td>0.14 (1.29)</td>
</tr>
<tr>
<td>T-test</td>
<td>0.24 .818</td>
<td>0.96 .395</td>
</tr>
</tbody>
</table>

Table 6. Mean and Standard Deviations, Psychological Learning Processes (Motivation)

The pretest measurements of motivation indicate that the students in the SOME group were more motivated (0.14) than the SOME+SRL group (-0.32). However, both scores are close to 0. A score of 0 indicates that students are neither highly motivated nor lowly motivated. Posttest results show that although both learning environments increased students’ motivation the results were not significant. The SOME+SRL environment students showed an insignificant increase in motivation, \( t(19) = 0.24, p > .05 \). The SOME students also showed an insignificant increase in motivation, \( t(19) = 0.96, p > .05 \). This shows that the students were still neither highly nor lowly motivated at the end of the course.

The instrument used, the SRQ-A, measures students’ motivation in regards to why they do their school work. Although the students were motivated enough to complete the voluntary course (all students in both groups completed the course), neither learning environment significantly changed the students’ motivation in regards to why they do their school work.
Due to the insignificance of the results, our third hypothesis, that the students in the SOME+SRL environment would report higher motivation than the students in the SOME environment, was not supported.

Discussion, Limitations, and Conclusion

Discussion

E-learning environments have been shown to, at worst, be as effective as traditional learning environments (Russell 1999). In cases where there are no traditional learning environments to be utilized as an alternative, these findings can be viewed as positive. Studies by Mitra (2005, 2010) have shown that SOMEs can be implemented, where traditional learning environments are not feasible, to improve learning outcomes. Our study replicating Mitra’s SOMEs utilizing mobile technology, has shown similar outcomes. The improvement of the SOME group achievements were statistically significant (p<0.05). Additionally, our findings show that SOMEs can be improved by having mediators emphasizing self-regulated learning strategies. The SOME+SRL group showed higher achievement results (p<0.001) than the SOME group. Our study has shown that when SRL strategies are introduced in e-learning environments in the developing world, with novice users of technology, the results are consistent with prior research conducted with experienced users in the developed world (Schunk et al. 1999; Azevedo et al. 2008; Wan et al. 2012).

Both the SOME and the SOME+SRL fostered increased computer self-efficacy. This is consistent with previous studies (Gravill et al. 2008) where learning environments that have high degrees of learner control show improved self-efficacy of students. Although both groups of learners increased their self-efficacy, only the treatment groups increase was significant (p<0.05). This is consistent with studies that have introduced SRL strategies to e-learning environments (Schunk et al. 1999). Our findings show that SRL strategies also improve self-efficacy with novice users. It shows that SOMEs can be enhanced by adding SRL strategies to further improve self-efficacy.

To measure motivation, we utilized the SRQ-A survey which measures a student's motivation as being either internal or external. A positive SRQ-A score shows internal motivation and is viewed to be more desirable in students. In our study, the pretest given to both groups of students showed that the SOME+SRL group tended to be externally motivated (-0.41) while the SOME group tended to be more internally motivated (0.29). Compared to the pretest survey the posttest showed that treatment group did tend to move towards a positive score in the posttest, however, the improvement was not statistically significant. A reason could be that two weeks were not enough time for a person to move from external to internal motivation. To evaluate if a learning environment could changing a student from being externally motivated to intrinsically motivated, studies would have to be conducted over a longer period.

Although students’ motivation did not improve on the SRQ-A, many observations regarding motivation were observed during the experiment. When students were asked why they participated in the after school math program, the majority answered that they wanted to use the technology, that is, tablets connected to the Internet. Further questioning of the students found that less than half of them would have participated in the class if it were taught in a traditional environment without the use of technology. The use of technology as a learning tool seemed to be a motivational factor. The measure of the influence of technology on motivation could be an interest for further research.

Observations by the main researcher on interaction between the remote instructor and the students found that the instructors provided little in terms of actual helpful math instruction. However, students stated that they looked forward to showing their answers to the remote instructor. Showing their work to a subject expert seemed to motivate the students more than just showing the work to the mediator.

Although students’ motivation as measured by the SRQ-A survey did not show improvement, observations were made that in indicated technology was a motivation factor in attracting students to enroll and complete the voluntary after school math course.
**Limitations**

The study was conducted within a limited timeframe of two weeks. Measurements of self-efficacy and motivation moved in a positive direction, although not always significantly. Future studies, with extended timeframes, measuring motivation and self-efficacy outcomes could show if these measurements would continue to move in a positive direction to a significant level.

Due to the small size and remoteness of schools in the district where our study was conducted, the number of students participating in the study was low (n=43). This small sample size makes the generalizability of our findings to the population of rural schools a subject of debate. Replication of the study with a larger number of student participants could validate our outcomes.

Since students in rural areas of Belize scored the lowest in math on the primary school exam, this subject was chosen as the focus of our study. To test the generalizability of our findings to other subject areas future research could be conducted.

Our study was conducted after school on a daily basis. The treatment group and the control group took part in the experiment at different times. However, these students spent all day together during the regular class day. Although they were told not to discuss their after school math class, students could have spoken about the differences in the classes leading to diffusion of treatment. Future research could be conducted where students assigned to the treatment and control groups attend separate schools thus avoiding possible contamination.

**Conclusions and Implications**

Self-organized mediated environments (SOME) have shown that with the use of technology students in rural areas can learn a diverse area of content without the presence of subject experts. In this article, we combined concepts from minimally invasive learning theory and self-regulated learning theory to improve the overall effectiveness of a SOME as measured by academic achievement, student self-efficacy, and motivation. Our study provides results of interest to rural communities in developing countries that are faced with the issue of not being able to provided well trained subject experts for students and are looking to utilize technology to overcome this problem. We found that with a minimal amount of time and effort, having mediators utilize an SRL script, e-learning environments can increase learning outcomes of achievement scores and students’ self-efficacy.

Our study focused on improving a SOME by adding SRL strategies to increase students’ self-efficacy and motivation. Since students did not show a significant improvement in motivation, additional research on improving motivation should be conducted. The study of technology as a motivating factor is of interest as students stated that the main reason for taking part in the math class was because it was being taught with tablets connected to the Internet.

Since the subjects of the study were novice users of technology instruments could have been developed to measure the stress level of the students. Future studies could include such measurements.

Remote communities with access to technology but not subject experts, and that are interested in implementing e-learning systems, should consider training mediators to encourage self-regulated learning strategies to improve learning outcomes and build students self-efficacy. The correct combination of technology and psychological learning process enhancements can allow for less developed communities to leapfrog the linear incremental development pattern to level the educational playing field between developed and developing countries.

Our results attest to the potential of adapting concepts from IS theories studied in the developed world to help in deploying technology in less developed countries.
A self-organized mediated environment modified by utilizing mobile technologies and enhanced with explicit self-regulated learning strategies (rural school, Belize)
References


