

## Serious Game as a Way to Boost Self-Regulated Learning in Higher Education

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### ABSTRACT

Educational technology favors learning in the university context. In the same way, in the last decades, self-regulated learning has gained relevance in the scientific community because students controls, at their own pace, the way they learns best. Therefore, the present study analyzes educational praxis linked to serious game, in order to identify the self-regulation strategies that are enhanced. Design-Based Research was utilised to examine a group of 30 students of Sociology at the Technical University of Machala (UTMACH), in Ecuador. During the analysis of the data collected with a parametric t-test it was identified that out of the 10 self-regulation strategies analyzed, serious gaming primarily boosts three of them: goal-setting and planning; seeking information; and self-consequences.

### INTRODUCTION

At present, serious gaming is seen as a valuable alternative to promote learning; however, there still are unexplored aspects (e.g. self-regulation). There is no clear evidence of the contribution of this type of computational game in self-regulated learning. Therefore, the main objective of this research is to identify whether self-regulated learning is enhanced during an educational praxis using the "Seré Investigador" ("I will be an investigator") game (Samaniego, 2015).

### Connection between serious games with learning in higher education

A Serious Game (SG) is a type of computer software that favors learning. It has actually been a challenge for the designers of these educational games, in the last decades, to integrate entertainment with learning (Wouters, Van Oostendorp, Boonekamp and Van der Spek, 2011). This software has been used in the educational praxis of technical and scientific universities (Bellotti, Berta, De Gloria, Lavagnino, Antonaci, Dagnino, Ott, Romero, Usart, Mayer, 2014). During the educational praxis using a SG in higher education, the most relevant aspects that have been favored are: critical thinking and scientific reasoning (Halpern, Millis, Graesser, Butler, Forsyth, Cai, 2012); student engagement (Boyle, MacArthur, Connolly, Hainey, Manea, Kärki, and Van Rosmalen, 2014); and academic performance (Carr and Bossomaier, 2011; Hainey, Connolly, Stansfield, Boyle, 2011; Boada, Rodriguez-Benitez, Garcia-Gonzalez, Olivet, Carreras, & Sbert, 2015).

### The self-regulation of learning: an emerging conception in higher education

Self-regulated learning refers to the process by which students activate and maintain by themselves their motivation, cognition, and behaviors that are systematically aimed towards the attainment of their learning goals (Zimmerman & Schunk, 2011). This form of learning has been researched in the last decades as aptitude and as an event (Winne and Perry, 2000). Self-regulation has been evaluated as an aptitude using mainly the following instruments: the Motivated Strategies for Learning Questionnaire (MSLQ) developed by Pintrich, Smith, Garcia, & Mckeachie (1993); the Learning and Study Strategies Inventory (LASSI) designed by Weinstein, Schulte, & Palmer (1987); and the Self-Regulated Learning Interview Scale (SRLIS) developed by Zimmerman & Martinez-Pons (1986). Furthermore, according to Winne and Perry (2000), self-regulated learning has been measured as an event using protocols to measure thinking aloud (Think Aloud Measures) and methodologies that trace the path of student activities (Trace Methodologies).

### Serious game and self-regulated learning at UTMACH

In the present study the self-regulation strategies of the "Seré Investigador" serious game was adapted. The game was redesigned to support self-regulated learning. This research considered self-regulation as the student's aptitude and was structured based on the following question: does serious game boost self-regulation?

## PARADIGM AND RESEARCH METHODOLOGY

Due to the nature of the present study – research on technology-based learning – Design-Based Research (DBR) (Sandoval, 2004; Reeves, Herrington & Oliver, 2004; Hickey, Kruger, Frederick, Schafer & Zuiker, 2003) was used as the methodological approach. According to The Design-Based Research Collective (2003) guidelines, DBR is used because the data collected, analyzed and discussed allows designing and improving serious games.

Under this paradigm, one of the most used models of design-based research is presented by McKenney and Reeves (2012), which identifies three main phases that are implemented in an interactive and flexible way: analysis/exploration, design/construction, and evaluation/reflection. A representation of this generic model, which was used in the present study, is presented in Figure 1.

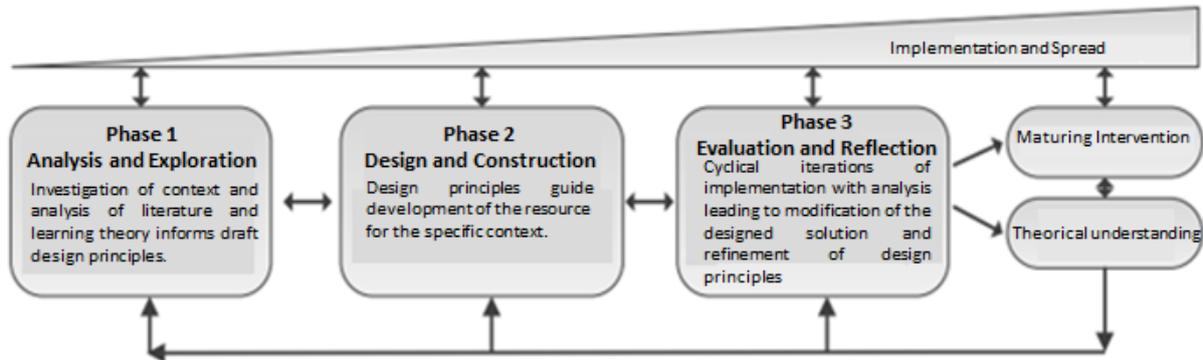


Figure 1. Design-Based Research Model by McKenney & Reeves (2012, page 77)

### Research methodology

#### Phase 1: Analysis and exploration.

Contributions from different learning theories on the field of self-regulation were reviewed. At this point it was of vital importance to examine the theoretical findings of Barry Zimmerman. In the review of these theories, Zimmerman (2001) identifies 7 perspectives: operant, phenomenological, socio-cognitive, volitional, Vygostkian, constructivist and information processing. From the analysis of these perspectives the socio-cognitive vision of self-regulation was chosen for our educational research.

In addition, the review of scientific literature established the cyclical model of socio-cognitive researchers Zimmerman and Moylan (2009) as a self-regulated learning model for educational intervention with serious games. This model consists of three phases: planning, execution and self-reflection. According to what was reviewed both in the theoretical and social cognitive perspective and in the self-regulated learning model, self-regulated learning strategies was identified, which were used to assess the self-regulation of students once they used a serious game.

Then, an analysis of the serious game components carried was out to see if the strategies mentioned in the previous paragraph easily adapted to both the design and the mechanics of the game.

#### Phase 2: Design and construction.

The serious game was designed with scenarios from each didactic unit and presented the player with a sequence of educational challenges very similar to the cycle of socio-cognitive self-regulation (planning, execution and self-reflection) of Zimmerman and Moylan (2009). The way the player moves through the different scenarios while self-regulating is displayed in Figure 2.

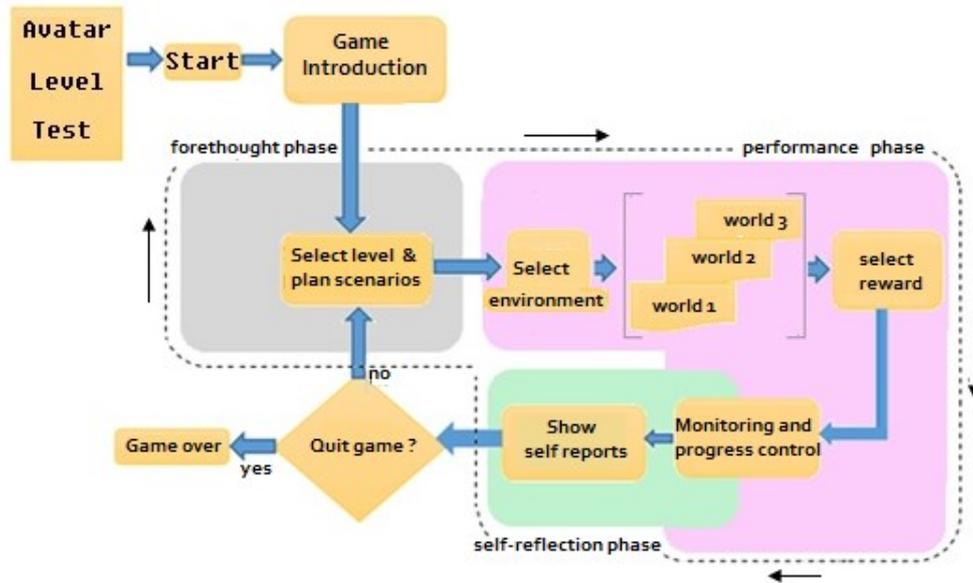


Figure 2. Sequence design of the game "Seré Investigador" and self-regulated learning

In the *forethought phase*, according to the legends each scenario had educational content and time to complete it, the player selected the scenarios according to the time he wanted to play and the learning outcomes he wanted to achieve.

In the *performance phase*, if the players want, they can first set up ambience and musical sounds, then during the game they can also configure the rewards they will receive if they succeed in the challenge presented by the game. In addition, while playing, the students may, if they wish at any time: choose clues and monitor the progress of what is played and learned. The clues play an important role in the visual environment of the game, as illustrated in Figure 3, since they are also self-regulation strategies adapted within the game (for example, information search is packaged in images of books).

In the *self-reflection* phase, as in the previous phase, one can monitor what has been played and learned; it is possible to analyze, if desired, self-reports prepared by means of the Trace Methodologies (automatic records of user actions within the serious game), and based on it, rethink new scenarios within the game, including new strategies.



Figure 3. Visual environment of the "Seré Investigador" serious game.

### Phase 3: Evaluation and reflection

The serious game evaluation was carried out during the first semester of 2016; specifically the initial iteration was performed during the first mid-semester, and the last iteration in the second mid-semester. In total, two iterations were carried to educationally test the game, one iteration for each mid-semester.

In each iteration, the students used the serious game during the educational praxis of the Métodos Cuantitativos de Investigación course. At the end of the first semester, the studied students were interviewed using the Entrevista de Autorregulación Basada en Juego Serio (EABJS), this measurement was used as a pre-test; likewise, at the end of the second mid-semester the post-test was applied, with the same instrument to see the empowerment of self-regulation strategies promoted by the serious game.

### Participants

In the evaluation process, 30 students enrolled in the course on Métodos Cuantitativos de Investigación participated in order to see if serious gaming promoted self-regulated learning strategies. The students belonged to the second semester of the UTMACH Sociology program.

### Instruments to collect information

The data collection instrument for the present study (EABJS) was designed from the Self-Regulated Learning Interview Schedule (SRLIS), developed by socio-cognitive researchers Zimmerman and Martinez-Pons (1986). For the final instrument, 10 categories of self-regulation strategies were kept: Self-evaluation, organizing and transforming, goal-setting and planning, seeking information, keeping records and monitoring, environmental structuring, self-consequences, rehearsing and memorizing, seeking social assistance, reviewing records.

### RESULTS

To ensure the reliability of the EABJS instrument, the Cronbach statistical test was applied. The instrument obtained a Cronbach's alpha of 0.961 (see Table 1).

**Table 1.** Cronbach's Coefficient Alpha of self-regulation strategies (EABJS)

Cronbach's alpha	Number of items
.961	10

Based on descriptive statistics (mean and standard deviation), differences were observed in pre-test and post-test measures on the use of self-regulation strategies.

**Table 2.** Mean and standard deviation pre and post test

	Pre-test	Post-test
self-regulation strategies	M(SD)	M(SD)
Self-evaluation	.68 (.589)	.76 (.554)
Organizing and transforming	.65 (.646)	.71 (.579)
Goal-setting and planning	.76 (.654)	.88 (.591)
Seeking information	.76 (.699)	.88 (.640)
Keeping records and monitoring	.76 (.781)	.79 (.687)
Environmental structuring	.50 (.615)	.59 (.609)
Self-consequences	.94 (.736)	1.03(.674)
Rehearsing and memorizing	.50 (.564)	.59 (.557)
Seeking social assistance	.47 (.615)	.56 (.613)
Reviewing records	.38 (.551)	.47 (.563)

According to the differences found in Table 2, the t-test for related samples was used for an intra-group analysis (Table 3) between the pre and post test means. All analyzes were performed using the SPSS v.22. Statistical software.

**Table 3. Intra-group t-test of EABJS**

self-regulation strategies	t	p
Self-evaluation	-1,989	,056
Organizing and transforming	-1,409	,169
<b>Goal-setting and planning</b>	-2,249	,032
<b>Seeking information</b>	-2,757	,010
Keeping records and monitoring	-1,795	,083
Environmental structuring	-1,439	,161
<b>Self-consequences</b>	-2,504	,018
Rehearsing and memorizing	-1,682	,103
Seeking social assistance	-1,882	,070
Reviewing records	-1,649	,110

The t-test for related samples was used to analyze statistically significant differences between the means of use of self-regulation strategies during the pre and post test. The above table does not show statistically significant differences in any of the strategies analyzed during the pre-test. However, in the post-test significant differences were observed in three variables: goal-setting and planning ( $t=-2.249$ ,  $p=.032$ ), seeking information ( $t=-2.757$ ,  $p=.010$ ), self-consequences ( $t = -2.504$ ,  $p=.018$ ).

**CONCLUSIONS**

This study is a self-regulated learning approach using a serious game. Although serious games usually have some self-regulation strategies within their components, it is advisable to adapt them to fit a certain self-regulated learning model.

The cyclical self-regulated learning model of socio-cognitive researchers Zimmerman and Moylan (2009) favors the sequence of the game as the student learns.

The frequency of use of some self-regulation strategies increases when using a serious game in educational praxis.

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