Self-regulated learning using multimedia programs in dentistry postgraduate students: A multimethod approach

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Abstract

The purpose of this study was to study the effect of a multimedia computing program on the production of activities and self-regulated learning processes in 18 students of the Dentistry postdegree (Celaya, Mexico). A multi-method design (quasi-experimental, pretest-post-test and qualitative: Think aloud protocol) was used. Self-regulated activities were identified with the MSLQ questionnaire. Results of the MSLQ pretest/post-test questionnaire didn't show an intervention effect. In contrast, the qualitative methodology allowed the registration of a high frequency of self-regulated dimensions on the metacognitive area, on the making of inferences (cognitive area), and on the planning time and effort (behavioural area). Our data revealed the usefulness of a qualitative methodology for the understanding of the complex nature of the self-regulatory processes on learning environments based on computers.

Keywords: self-regulated learning, multimedia, multi-method design, metacognition, post-degree students.

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Introduction

The last decades, increased attention has been given to the Information and Communication Technologies (Its) and the influence on all aspects of our economic, social, political and cultural contexts. The implementation of the Its at the University required a careful follow up by all those who wish to go deeper on the characteristics of this new social and technological environment according to Saenz (2004).

As stated by Bartolomé (2004) or Kirkup and Kirkwood (2005), on Higher Education we are late assumers or simply reticent ones. Enormous technological potential must be ordered, systematized and applied on the new reality that we are living. Starting with the psycho-educational paradigms of learning based on the transmition of information and the generation of knowledge as the socio-cognitive theory and the information processing theory, a multimedia computing program was studied on students of the Dentistry Postdegree Program. The study was conducted under a multi-method perspective with a quantitative and qualitative boarding, procedure suggested by different authors (Desoete 2008, Van Hout Wolters 2000; Veenman, 2007).

New information and communication technologies in Education

On this century, facing the new circumstances and paradigms arose on the education field and ranging from the use of the ITs, its application and usefulness constitute a central theme for research since its reach and dimensions aren't well determined.

The virtual learning environment (VLV) was defined as the physical space where the new technologies such as satellite systems, the internet, and the multimedia and interactive television take place. The virtual learning environments are important because the human mediator is not available physically, although a human component is highly necessary in the learning process. Regian and Shebilske (1992) considered the virtual reality to be a superior environment to increase spatial abilities because the interface preserved the spatial characteristics of the simulated world and the motor actions of the student. The characteristics of virtual reality as an ideal learning environment had the following qualities:

- Great flexibility for the creation o virtual o artificial situations.
- The ability to offer a feeling of sense.
- The possibility of giving the user the control of the media and to be able to interact with objects and people.
- The possibility to obtain feedback from objects and people (Middleton, 1992).

Aguaded and Cabero (2004), stated that to the success of VLV depended on factors such as the instruction process and didactic strategies and attitudes that student's and teacher's have.. Otherwise, the same author (Cabero,2003) referred that the ITs located in the educational field is not

feasible to supply the didactic media known nor be the solution to all the problems that the relationship raised by the relationship teaching-learning phenomenon.

Nevgi et al. (2006) addressed the issue of motivational strategies for learning in students of the virtual university. The IQ form is a project of the University of Finland that involved the disciplines of information technology, computer sciences and education. The theoretical support of the project extended from the mediated learning theories, the distribution of cognition and theories of multiple intelligences by Gardner and the work of Pintrich.

Social cognitive theory of learning and self-regulation

The social cognitive learning theory is based the work of Miller and Dollard in 1941 who proposed a theory of social learning and imitation that rejected behaviourist theory prevailing in the psychological discourse at that time. Later the work of Bandura (2001), stated a series of considerations on three main components of the theory, equally, that interacted with each other and formed a triad of reciprocity:

- Staff with cognitive, affective and biological factors playing an important role.
- the behaviour and
- the so called environmental.

The theory mentioned contrasted sharply with the approaches of the theories of human functioning that overemphasized the environmental factors on behaviour and learning. At the core of social cognitive theory was the concept of self-efficiency defined as the personal judgments made by the subject about his capabilities to organize and execute actions required for different kinds of operations. This concept has been relevant in education studies involving constructs such as academic performance, success and failure attributes, determining goals, memory, and problem solving and teaching.

Another concept that underlies Bandura's theory (2001) is the one that refers to the capabilities available to man and that define him as such; being these symbolizing, planning alternative strategies, learning through watching someone else's experiences, self-regulated mechanisms, and the most distinctive capacity of human beings: self-reflection, with which the individual gives meaning to his experiences, explores his own knowledge and beliefs, engages in self-evaluation and as a result of the above changes his thinking and behaviour (Pajares, 2002).

Self-regulated learning model

Some self-learning models emphasized the integration of motivational and cognitive components of the learning process (Pintrich et al., 1993). Self-regulated learning requires awareness of reflection processes so that students are capable of evaluating their own actions and accomplishments. According to these authors, there are three broad categories of self-regulated learning:

- Cognitive strategies of learning. Weinstein and Mayer (1986) first mentioned the strategies of preparation, elaboration and organizational as important to the development of learning in the classroom.
- Preparation strategy referring to a technique where the items you wish to learn are mentioned aloud. Another one concerns the fact of emphasizing the lines of text on a passive and lacking in thought way. These strategies select important information for the student, enabling the working memory, but not necessarily cause a deep knowledge.
- Elaboration strategy includes the paraphrase of the text where the studied material is summarized creating analogies and making a connection and reorganization of ideas, explaining them in such a way that questions and answers about the topic are arose.
- Organizational strategies refer to the taking of notes or maps of the important ideas where the prose and structure of the text are identified, where as a result a deeper understanding than on the preparation techniques described above.

Metacognition

Flavell (1979) initially referred to metacognition as the knowledge that an individual has about his own cognition and to monitor and control that he has of the same knowledge (e.g., the student knows that is capable of reading fast, or that he has little capability of writing, etc). However Veenman et al. (2006) differentiated various aspects of metacognition, such metacognitive beliefs, metacognitive knowledge, feeling of knowing, learning judgment, metacognitive skills, higher order skills etc., revealing a lack of consistency and suggesting the need for further theoretical work to achieve a unified definition of metacognition. Metacognitive monitoring focuses on the progress of the cognitive process in which the person is engaged. One of this monitoring judgment is judgment of learning (JOL), which evaluate one's memory. However, there is a consensus on two general aspects of metacognition: knowledge about cognition and the self-regulation of cognition (Veenman, Kok, & Blot, 2005). Anderson and Krathwohl (2001) mentioned four categories of knowledge: factual, procedural, conceptual and metacognitive.

Moreover Suárez (2004) detailed the proximal development zones Vygotsky with respect to its implementation among subjects who were in

the process of learning and the benefited of using educational technology in network. He noted that, when learning the subject developed internal evolutionary processes that operated only in interaction and cooperation with other subjects. The zone of proximal development was defined as a category of analysis of the cooperative interaction among peers, which forced us to think that there was a theoretical basis of a significant interaction between peers (students), that was, based on social interaction by using the technologies as means of effective learning.

Since the use of instruments might influence the results, Van Hout (2000), Veenman (2006) and Desoete (2008) suggested using mixed methods to study metacognition.

Metacognitive and self-regulatory strategies of learning

Most models of metacognitive control or self-regulation strategies refer to the planning, monitoring and control of the students over their own cognitive and behavioural activities (Tobias, 2009; Serra & Metcalfe, 2009; Zimmerman, 2008). Of course not all academic learning follows these phases, since in many cases; students learn the academic material tacitly, implicitly or unintentionally, as suggested by the model (Pintrich et al, 1993)

Although it seems highly correlated empirically, can be discussed independently. The phases have been suggested in a heuristic to guide our thinking and may be considered as:

Phase 1. Planning of activities and formulation of goals. It has been investigated among students and it refers to the formulation of goals of study, skimming the text before reading, generating questions and doing an analysis of the problem. With these strategies, the understanding of the material is easier and the task is more efficient.

Phase 2. Monitoring processes of thought in terms of academic performance is a key activity in the regulatory activity. This activity takes place when students check their understanding on the previously self formulated purposes. An exercise that is often done is carefully monitor the reading of a text, making a series of questions through the reading and verifying if the material is really understood.

Phase 3. Resource management strategies, monitoring and control. Focuses on the strategies used by students to control, monitor and manage their studying environment. This item will include factors such as time and effort required to study; the environment that is achieved with other people including classmates and teachers through strategies of seeking assistance (Zimmerman, 2008). Such strategies help students to adapt and to change their way of studying making it correspond to their objectives and needs.

Phase 4. Reactions and reflections. This phase represents several kinds of reactions and reflections of him in relation to the activity or context.

There are publications where the various elements that make up our investigation such as the use of hypermedia and multimedia materials, intentionally designed for educational purposes. The use of structured questionnaires for the recording before and after educational interventions, using quasi-experimental study designs or multi-method, like those of Igo (Igo et al., 2008).

Boekaerts et al. (2000) used the term metacognitive knowledge presented to the student about the task, person and strategies. According to the work of Pintrich (1999) which refers to a scheme that relates motivation to self-regulated learning, this is defined as the strategies used by students to control and regulate their cognition (e.g., by using several strategies cognitive and metacognitive). A self-regulated student is aware of when he knows a fact or has a skill or when he doesn't. He views his achievements on a systematic manner and through the controlled process, so that he accepts as a big responsibility his goals. He, himself is the initiator of his learning process.

The self-learning has taken part in various learning theories in the behavioural theory regulation is through the external reinforcement. On cognitive theory self-regulation is handled as equivalent of metacognition and on social cognitive theory, self-regulation is a combination of self-observation, and self-reaction.

Teaching students to become more active learners, self-motivated is an issue that is continually mentioned in education. Authentic and meaningful classroom activities that are relevant and in real life generate knowledge processes on the student and conceptual changes. Although the motivational components are important it is equally important to include cognitive components on the learning models of universities (Pintrich, 2000).

Azevedo (2005) examined the relationship between epistemological beliefs, metacognition and student achievement in an hypermedia learning environment. Epistemological beliefs refer to beliefs about the nature of knowledge and of wisdom. Metacognition refers to the ability to reflect, understand and control the learning itself. This author recognizes that the dimensions of metacognition and epistemological beliefs have been little studied in relation to learning in a hypermedia context, and leaves the door open for further study where the kind of processes of deep knowledge are developed when there is a learning multimedia environment. Bendixen and Hartley (2003), examined the relationship between epistemological beliefs, metacognition and student achievement in a hypermedia learning environment. Stoney and Oliver (1999), described how the use of multimedia, taking into account the study of self-regulated learning, can achieve deep levels of thinking in the adult population. Refer also to the use of multimedia micro-world to explore and promote the use of self-regulated earning and in particular examines the degree to which elevated levels of

thought are achieved concluding suggestive ways in which these students could achieve these levels.

From another perspective, the work of Viniegra and Aguilar (1999), indicate that self-introspection is necessary, being aware of what happens in the process of developing the knowledge that, in the sense that we have been discussing has to do with student's self-conscious learning which they call, independent learning.

Macromedia Flash ® version 2004 education

Area (2002b) gives an example often given by teachers that apply multimedia materials such as Macromedia Flash ®. This program has a format of vector and interactive multimedia animations. There is a report based on constructivist theory that refers to two   learning theories developed on the twentieth century: behaviourism and cognitivism. His methodological approach seeks to demonstrate that students in rebuilding a web site using author tools such as Macromedia Flash ® are able to develop a learner-centred learning, meaningful and cooperative-type (Neo & Neo, 2001). The Macromedia Flash ® was chosen because the environment multimedia has features that help students to make a more effective management of information and to make mental models that facilitate learning (Mayer, 2003). Multimedia programs and multimedia learning environments have the potential to increase the amount and kind of information that are accessible to students, allowing an active participation and facilitating the use of higher mental processes. The learning environment based on the use of computers with multimedia programs can be compared within complex systems, which are composed of interconnected or interwoven parts whose links contain additional information and the hidden observer. As a result of interactions between elements, new properties emerge that can not be explained from the properties of the isolated elements. Thus, the process of making products in the learning environments based on technology is supported by the use of higher mental abilities (Mayer, 2001).

Present Study

We intended to study the use of information and communication technology (ITs) in particular the use of Macromedia ® Flash, in the development of strategies and self-regulated learning behaviours and their implications for the conceptual understanding of the thematic units of Epidemiology in the field of Dentistry Postgraduate students.

We stated the following research questions:

a) Can postgraduate students of dentistry based on the use of a multimedia program and   creating educational material, from the perspective of psycho educational paradigms of the transmission of knowledge (social cognitive theory and information processing theory), develop strategies and behaviours in self-regulated learning on the phases

described as: 1. anticipation/ planning/activation 2. monitoring, 3. using strategies, 4. difficulty of the activity and demand?

b) Can Dentistry postgraduate students improve their academic performance on the subject of Epidemiology using a multimedia program?

Method

Design

A multi-method design was used combining a quantitative methodology (quasi-experimental pre-test / post-test, single group) with a qualitative approach (Protocol analysis using the coding system of self-regulation behaviours of Azevedo and Guthrie (2004, See Table 1). Graduate Dentistry students made use of the use of the educational software: Macromedia Flash®, on the Epidemiology class, taken as independent variable was the educational intervention with ITs, defined as the educational modality that uses electronic media to promote self-regulated learning on students: use of Macromedia Flash ®. As dependent variable self-regulated learning was taken, defined as the aware recognition of the student of the processes (cognitive) and cognitive strategies, metacognitive of resource management and motivational processes.

Participants

The participants were 18 graduate students (12 females and 6 males) of the Dentistry Specialty on Orthodontics and Maxilar Orthopedy at the Universidad Latina de Mexico (Celaya, Guanajuato) in the 4th semester (August-December 2008 period). The mean age was 29.9 years (varying from 26-40 year). Participating students had not previously taken the Epidemiology course during their academic education.

Instruments

In line with Jöreskog, Sörbom & Valentine (2006), Ruohotie and Nokelainen (2000), and Nevgi (2003) the MSLQ (Pintrich et al., 1993) was used to assess motivational scales (expectations, task value and affection). The original questionnaire consisted of 81 items was reduced to 44 items based on the fact of Confirmatory factor analysis revealed the semantic meanings of items and helped to validate factorial structure of motivational strategies in learning. Kuder Richardson's 21 consistency test was performed (number of items =44) to yield acceptable values of .81.

The MSLQ tested two types of factors:

1. motivational factors that included components such as interest and value of the learning task (items 1, 4, 5, 10 and 17), components of usefulness of the studies (items 7, 14, 15, 21), components of self-efficiency (items 2, 8, 11 and 13), components of expectations of success (items 6, 9, 16, 18, 19, 22) and anxiety and nervousness due to the exam components (items 3, 12 and 20).

2. Cognitive-Factor was composed of the components: effort regulation (item 43), self-regulation learning components (items 32, 40, 42), components of persistence in the studies (items 27 and 33), metacognitive components of rehearse strategy (items 23, 31 and 35), metacognitive components of critical thinking (items 30 and 37), metacognitive components that focus to learning the essentials (items 24 and 34), metacognitive components of constructive learning (items 28 , 36, 44), metacognitive components of the use of keywords (item 41), metacognitive component of theory application (item 39) and metacognitive components on reflection on what was learned (items 25, 26, 29 and 38).

The total score was 44 (minimum 0 maximum 44), considering values of 1 (always), 0.75 (most times), 0.5 (sometimes), 0.25 (almost never or rarely), 0 (never) for each of the items, resulting in the sum the final score obtained by each student. Subsequently, for statistical purposes was taken to a ratio of 100%. On our questionnaire a Cronbach's reliability analysis was done of the cognitive and motivational factors obtaining values of .85 and .87 respectively.

Epidemiological Knowledge Test. Consisted of 41 items and basic concepts necessary for the understanding of the epidemiological studies as rates, proportions, prevalence, incidence, mortality rates, relative risk, odds ratios, as well as different kinds of experimental studies, of cases and controls, cohort studies, meta-analysis. Cronbach's value was .78.

Self regulation was coded according to the following coding system (see Appendix)

Procedure

The procedure was divided into 2 parts:

Part One. A course of 14 hours (2 hours a week) on the basic handling of the use of Macromedia's Flash ® software led by a faculty expert in the management of the program and was conducted during October and November 2008.

Participants received 12 weeks of simultaneous instruction during the Epidemiology course of the processes and cognitive strategies, metacognitive, resource management and motivational processes, as reported by Pintrich et al. (1993), Winne (2008) and Azevedo (2009):

1. Anticipation / planning / activation: implies a conditioned conduct to the state of the problem as well as hierarchization of goals and sub-goals that can be identified by the student who when become aware of relevant prior knowledge before conducting its activity and during it.

2. Monitoring. The student becomes aware that he does not known or understands everything deciding on alternatives to improve their understanding and he monitors it in relation to his targets, assessing the usefulness and / or appropriateness of what he is doing.

3. Using the strategy. The selection and use of various cognitive strategies for memory, learning, reasoning, problem solving and thinking, can include the selection of a new representation, coordination of multiple representations, search on the multimedia environment, summarizes what he has read, inspects or listens, makes inferences, asks questions, and elaborates what he just read, see or hear.

4. Difficulty on the activity and demand. The student seeks assistance from someone with experience concerning the recent knowledge on the subject or of the instructions received, indicates whether the activity is easy or difficult and if using the media environment is more difficult than using the book, chooses aspects of the multimedia environment to expand reading and viewing of information and has expectations that a certain kind of representation proves to be an appropriate for a given goal.

The students were told that they could use the strategies mentioned earlier in the educational intervention with Macromedia Flash ® version of education.

A pre- and post-test design was used with 24 hours before and 24 hours after the educational intervention an exam on "Concepts of Epidemiology" took place. The time required to prepare the test was decided by the students themselves (40 to 60 minutes). This instrument was considered to evaluate the academic performance. In addition the MSLQ was also used as pre- and post-test.

Part Two: Educational intervention. The educational intervention consisted on a 20 minutes activity, in line with Bannert and Mengelkamp (2007), where the activities of speech and the "Think aloud protocol (Ericsson & Simon, 1993) took place, on which students were asked to develop a multimedia material on their computers, called "Current Aspects of the Epidemiology of Oral Diseases in Mexico" and used as sources for the search documents that were available on the hard disk of computers from the computer room of Universidad Latina de México in Celaya called:

1. "Formulas of Epidemiology," which is in the PowerPoint ® format;

2. "Ph.D. Intervention material" (which has the summaries of articles "Sociobehavioural risk factors in dental caries-international perspectives." Petersen, P. and "Dental cavities and associated Factors in Mexican school children aged 6-13 years". A. Casanova-Rosado et al, both in Word format ®.

3. Epidemiology images "as a document in jpg format.

In the same way, portable recorders with cassettes were installed at each location for the sound recording of the student's verbalizations during the educational intervention. The teacher-researcher stayed with the students to answer doubts about the location of the equipment installed on the hard disk in order to streamline the process and the teacher who taught the course on Macromedia Flash ® tutored all of the time during the intervention the consultations on the use of the program. Students were

asked not to remain silent for more than thirty seconds during the activity. According to the methodology of the "Protocol analysis: verbal report as data (Ericsson & Simon, 1993). Students' verbalizations were registered using recorders Stern brand, made in China, and Sony made in Japan. For the analysis of recordings of the students' verbalization a transcription of each was done and then a comparison was made between the accuracy of the transcript of records with each recording register.

The analysis was made using the coding system of self-regulated behaviour proposed by Azevedo and Guthrie (2004; see Appendix). The coding was done before reading and re-reading by the author of various segments of the transcripts deciding on each case if each of the segments were selected in general, to each of the four self-regulation dimensions and in particular to each of the indicators identified. In total 360 minutes of recordings we analyzed. The transcript of the recordings of the material led to a document of 20,991 words in 45 pages with lines of one space (an average of 2.5 leaves per participant). The recordings obtained during the intervention with the Macromedia Flash ® multimedia material were transcribed and coded according to that described by Guthrie and Azevedo (2004; see Appendix).

Statistical analysis

On the quasi-experimental approach to manage data and perform the paired t test the statistical program Graph Pad Prism ® 5, was used, with which basic biostatistics and scientific charts can be performed. For the quantitative approach the frequency of emission of the students' verbalization was used.

Results

The average pre-test result on the Test of Epidemiology Concepts was 41.18 (SD = 10.59), whereas the post-test result was average 47.04 (SD =14.09). The data were normally distributed. The paired t test revealed a significant difference between pre- and post-test results (t = -2.36; $p < .05$).

The outcome of knowledge of concepts on Epidemiology showed a significant difference between the pre-test and post-test, demonstrating positive changes in terms of academic performance, which could be attributed to the effect of the intervention.

Also the data from the questionnaire on self-regulated learning strategies were normally distributed. The score obtained in the questionnaire of self-regulated learning strategies was lower in the post-test (69.88; SD = 3.94) versus 60.13 (SD = 6.61). The t-test revealed a significant difference (t = 4.80, $p < .0005$)

In addition, the results showed that using the multimedia program was not beneficial to develop self-regulatory strategies, since no much self-regulatory strategies were used by the students during the use of Macromedia ® Flash.

Qualitative methodology results

Here we report the results of the frequency with which they were used self-regulated learning strategies on each of the 4 dimensions described above (Table 1).

On the dimension Anticipation/Planning/Activation the indicator "sub-goals" was the most frequent. Here, possible operations, proposed or planned are offered on a exploratory manner in the documents provided, as well as the 'Activation of previous knowledge" dimension with which the process of selecting information is begun The students conducted a series of proposals intended to be made, which could be considered as part of the self-regulatory processes, which were verified on a new way in their academic life and had no reference to pre-existing states. The dimension of prior knowledge activation was the second most used strategy.

As long as processing of information advanced, we found that during the "monitoring" stage the most frequently used indicator is that of "content evaluation" where the student monitored the content of his reading and was made aware of what he did not know. It might be that this situation is related to the thematic depth and variety of texts offered, coupled with the difficulty of the task (management of multimedia) as well as the use of computers for purposes other than those used by students such as transcription of texts or internet use. This involved mental concentration activities in specific stimuli as in the case of the activity with the multimedia program and the texts offered in PDF and jpg images, it was selective and changeable. The use of several readings offered a challenge for students, since it contained a greater density and complexity of the ideas that if it had only been a source of information. Supporting what was said before; the indicator "assessment of learning" was also frequently used.

The 'use of strategy' dimension, under its various indicators provided a general overview of the use of epistemic resources which operate on a higher level, such as making inferences. This mental activity involved the use of mental functions such as abstraction where concepts involved in a defined problem are covered in a manner that allows drawing a logical cause and effect line. At this point it was demonstrated that the activities suggested in the multimedia program Flash, can be taken as the origin of the use of complex mental activities and that students were able to make and of which they give evidence, despite the difficulty and complexity of the proposed task. We must also consider that some of the students proved to be suitable subjects for such interventions to have certain language skills and practical conceptual domain of the expression being analyzed. The promotion of inferences during the use of the program and requested product was transformed into a creative process of high value in education.

Table 1. Frequency of indicators of verbalized self-regulated learning during the intervention with the Macromedia Flash ®

DIMENSION Forethought / Planning / Activation		DIMENSION Monitoring		DIMENSION Strategy use		DIMENSION Size and difficulty of the activity and demands	
INDICATOR	*f*	INDICATOR	*f*	INDICATOR	*f*	INDICATOR	*f*
Planning	17	Judgment of learning (JOL)	33	Selection a new informational source	1	Time and effort planning	35
Sub goals	50	Feeling of knowing (FOK)	2	Goal free search	10	Help-seeking behavior	21
Prior knowledge activation	25	Self-questioning	3	Summarization	6	Task difficulty	29
Recycle goal in working memory	7	Content evaluation	84	Copying information	5	Control of context	0
		Identify adequacy of information	12	Re-reading	2	Expectation of adequacy of information	3
				Inferences	20		
				Hypothesizing	2		
				Knowledge elaboration	1		

The fact that generating higher mental processes required high levels of attention, selection of information, memory and integration of knowledge, so this must be subject for further research in our educational environment. It should also be mentioned that the high frequency of conducting inference highly contrasted with the quantitative results reported by questionnaire self-regulated learning strategies discussed above, especially in the exploration of the items in the cognitive and metacognitive kind.

The dimension of "difficulty of the activity and demands" involved activities where the student related all the circumstances during the task performance, being mostly an intentional attempt to control his behaviour under factors such as time and difficulty of the task; that is, the learning environment in the use of technology led to a behavioural change in student. We must recognize that to fulfil the task assigned to the group, specific technical skills were required to handle the Flash program and in this sense not all students could be compared, some used it easily while other showed

that the activity represented an extreme difficulty or expressed their opposition to the assignment.

Discussion

The aim of this study was to look if an multimedia intervention on students in the Postgraduate Dentistry Program could improve their use of self-regulatory learning processes. Qualitative methodology, although challenging and complex in practice, carried in a manner appropriate allowed us to extract existing meaning in the contents of the material analyzed. Recent literature related to our work and study (Desoete, 2008; Igo et al., 2008) referred to the need and usefulness of combining mixed method designs, because only one quantitative approach are insufficient to explain the experimental conditions proposed and required the complementary of qualitative perspectives. Other authors such as Dresel and Haugwitz (2008), Graesser et al. (2008) and Manlove et al. (2008) have used computer programs including instructions for self-regulation, applied in populations of different educational levels, although none of the graduate like that of this work or in a population belonging to the health area. Their quantitative methodology provided different results and different conclusions, although the common denominator is the promotion of self-regulated learning, action sometimes achieved only partially. In our work, the computer program did not have a specific design for self-regulation and of common use on disciplinary areas different from educational activity, such as Graphic Design (Syllabus Acatlan FES, UNAM, 2009) in spite of this; we note the production of self-regulation on learners. This constituted an undeniable strength of this work and was consistent with the state of the art of research on self-regulation, particularly on the metacognitive processes that indicated the discrepancy that exists in the ways of conceptualizing the constructs, ways of operationalization and assessment methods (whether quantitative or qualitative) (Azevedo, 2007, 2009).

Supporting the above, let's only mention the different names found in the literature for the metacognition construct: metacognitive beliefs, metacognitive awareness, metacognitive experiences, feeling of knowing, learning judgment, theory of mind, metamemory, metacognitive skills, executive skills, higher order skills, metacomponents, monitoring understanding, heuristic strategies, (Veenman et al. 2006). Likewise, the proposal of this work has been based on cognitive acquisition (the development of processes and self-regulatory behaviours) and the review of practical behavioural elements from a reasoned and targeted use of information technology. It is also necessary to mention in order to have an objective overview of the results, the students refer to the difficulty of the task, because, being self-critical, not all had a positive experience with the use of the program. Until recently, in the field of education in dentistry when attempts are being made to integrate some of the theoretical elements of constructivism and meaningful learning such as concept maps, with

software such as PowerPoint ®, to improve the academic performance (Kinchin & Cabot, 2007).

Conclusion

Postgraduate students of dentistry based on the use of a multimedia program and creating educational material, developed strategies and behaviours in self-regulated learning on the phases described as: 1. anticipation/ planning/activation 2. monitoring, 3. using strategies, 4. difficulty of the activity and demand, that could be registered by qualitative method. However, the results showed that using the multimedia program was not beneficial to spontaneously use self-regulatory strategies, since no much self-regulatory strategies were used by the students during the use of Macromedia ® Flash.

An attempt to approach possible alternative assumptions that caused this outcome includes:

Abilities of students. Pieschl (2009) mentioned that it is necessary to identify the perceptions that students have about the skills they recognized on themselves. This is represented as metacognitive monitoring and the author identifies it as a necessary precondition for successful learning that is a relationship between an estimate of their capabilities and performance. Underestimate their self-efficiency could have a direct effect on motivation. In the corresponding items to the metacognitive components of constructive learning scores fell between the pre-test and post-test.

High degree of difficulty of the task. It should be noted that the completion of the task was the collection and use of various learning objects (in the form of text files, forms and images) based on Macromedia Flash ®, making this activity a high degree of complexity because required the use of various higher mental activities such as attention, memory, and organization of knowledge (Mayer 2003). This process of multimedia learning could not be registered using questionnaire forms.

Another possible issue is that the questionnaire would, despite its effectiveness, the necessary adjustments to be used in learning environments based on computers, although the theoretical design which is robust and it is undeniably interesting and important in educational research (Duncan & McKeachie, 2005).

Dentistry postgraduate students improved their academic performance on the subject of Epidemiology using a multimedia program. In Test of Epidemiology Concepts significant difference between pre- and post-test results was found which could be attributed to the effect of the intervention. In line with Desoete (2008) however this difference might also be the result of the teacher's participation (clarification of concepts and questions about the topics) and learning styles that students have used all along their academic life.

Based on the theoretical work we had the opportunity to study the phenomenon in two different ways, and in our case complementary: using the questionnaire of self-regulatory learning strategies of Pintrich et al., and the encodings of the records recorded for self-regulatory learning strategies proposed by Azevedo et al. Our proposal began a study on how to assess the production activities and self-regulatory processes.

However, we recognize that there are some limitations to the present study. First, one of the limitations is the small size of the sample. In addition the fact of trying to identify constructs of higher order cognition about cognition is methodologically a difficult task. Finally although a pre-test/post-test design with one single group has a high internal validity and is suitable for this sample, we could recommend a quasi-experimental design (non equivalent design group) for future research.

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References

Aguaded, J. & Cabero, J. (2004). Educar en red. Internet como recurso para la educación. Educating on the network. Internet as a resource for education. *Revista Pixel Bit*, (22),115-125.
<http://redalyc.uaemex.mx/redalyc/src/inicio/ArtPdfRed.jsp?iCve=36802211>
Accessed:13.04.09

Aguilar, E. & Viniegra, L. (2003). *Atando teoría y práctica en la labor docente. Tying theory and practice in teaching.* Ciudad de México, México: Paidós.

Anderson, L. & Krathwohl, D. (2001). *A taxonomy for learning, teaching and assessing: A revision of Bloom´s taxonomy of educational objectives.*New York, USA: Longman.

Area, M. (2002). Elaboración de material didáctico para la world wide web. Creating didactica material for the world wide web. *Web docente de tecnología educativa.* Universidad de la Laguna. <http://tecnologiaedu.us.es/bibliovir/pdf/dic_2.pdf> Accessed;10.03.09

Azevedo, R. (2005). Using hypermedia as a metacognitive tool for enhancing student learning? The role of self-regulated learning. *Educational Psychologist, 40,* 199-209.

Azevedo, R. (2007). Understanding the complex nature of self-regulatory processes in learning with computer-based learning environments: an introduction. *Metacognition and Learning, 2*, 57-65.

Azevedo, R. (2009). Theoretical, conceptual, methodological,and instructional issues in research on metacognition and self-regulated learning: A discussion. *Metacognition and Learning. 4,* 87–95.

Azevedo, R. & Guthrie, J. (2004). The role of self regulated learning in fostering student´s conceptual understanding of complex systems with hypermedia. *Journal of Educational Computing. Research 3,* 87-111.

Azevedo, R. & Witherspoon, A. (2009). Self-regulated use of hypermedia. In D.Hacker, J.Dunlosky & A.Graesser, (Eds.).*Handbook of metacognition in education,Chapter17, (753-760).* New York, USA: Routledge.

Bandura, A. (2001). Social cognitive theory: An agentive perspective. *Annual Review of Psychology. 52*, 1–26.

Bannert, M. & Mengelkamp, C. (2008). Assessment of metacognitive skills by means of instruction to think aloud and reflect when prompted. Does the verbalization method affect learning?, *Metacognition and Learning, 3,* 39-58.

Bartolomé, A. (2004). *Nuevas Tecnologias en el aula.New Technologies in the classroom* Barcelona, España: Grao.

Bendixen L & Hartley K. (2003). Succesful learning with hypermedia: The role of epistemological beliefs and metacognitive awarness. *Journal of Educational Computing Research, 28,* 15-30.

Boekaerts, M., Pintrich, P., & Zeidner, M. (2000). Self-regulation. An introductory overview. In:M. Boekaerts, P. Pintrich, y M. Zeidner. (Eds), *Handbook of Self-regulation.* Chapter 13 (423-428) San Diego,USA:Academic Press.

Cabero, J. (2003). Replanteando la Tecnología Educativa. Rethinking Educational technology.*Comunicar*, 21,(23-30). <http://www.uhu.es/comunicar/revista/nivel3/comunicar21.htm> Accessed: 04.02.09.

Desoete A. (2008). Multimethod assessment of metacognitive skills in elementary school children: how you test is what you get. *Metacognition and Learning, 3,* 189-206.

Dresel, M. & Haugwitz, M. (2008). A computer-based approach to fostering motivation and self-regulated learning. *Journal of Experimental Education, 77,* 3-20.

Duncan, T. & McKeachie, W. (2005). The making of the motivated strategies for learning questionnaire. *Educational Psychologist ,40,* 117-128.

Ericsson, K. & Simon, H. (1993). *Protocol analysis: verbal reports as data.* Cambridge, USA: MIT press.

Flavell, J. (1979). Metacognition and cognitive monitoring: A new area of cognitive-developmental inquiry. *American Psychologist, 3,* 906-911.

Graesser, A., Wiley, J., Goldman, S., O'Reilly, T., Jeon, M., & McDaniel, B. (2007). SEEK Web tutor: fostering a critical stance while exploring the causes of volcanic eruption. *Metacognition and Learning, 2 ,*89-105.

Igo, L., Kiewra, K., & Bruning, R. (2008). Individual differences and intervention flaws. *Journal of Mixed Methods Research, 2,* 149-168.

Jöreskog, K., Sörbom, D. & Wallentin, F. (2006). Latent variable scores and observational residuals. Finland. Upssala University. http://www.ssicentral.com/lisrel/techdocs/obsres.pdf Accessed: 07.05.07

Kinchin, I. & Cabot, L. (2007). Concept mapping principles in power point. *European Journal of Dental Education, 11,* 194-199.

Kirkup, G. & Kirkwood, A. (2005). Information and communications technologies (ICT) in higher education teaching – a tale of gradualism rather than a revolution. *Learning,Media & Technology*, 30(2), 185-199.

Manlove, S., Lazonder, A., & de Jong, T. (2007). Software scaffolds to promote regulation during scientific inquiry learning. *Metacognition and Learning, 2,* 141-155.

Mayer, R. (2001). *Multimedia learning.* Cambridge,U.K. :Cambridge University Press

Mayer, R. (2003). The promise of multimedia learning: Using the same instructional design methods across different media. *Learning and Instruction, 13,*125-139.

Middleton, T. (1992). Applications of virtual reality to learning. *Interactive Learning International, 8*, 253-257.

Neo, K. & Neo, M. (2001). A constructivist learning experience: Reconstructing a web site using web based multimedia authoring tools. Australian Journal of Educational Technology, 17, 330-350.

Nevgi, A. (2003). Motivational strategies of students in virtual university. Third international,Inter-disciplinary Evidence-Based Policies and Indicator Systems Conference. July 2001 (pp. 1-17). <http://www.cemcentre.org/Documents/CEM%20Extra/EBE/EBE2001/P203-219%20Anne%20Nevgi.pdf>. Accessed: 05.09.09.

Nevgi, A., Virtanen, P., & Niemi, H. (2006). Supporting students to develop collaborative learning skills in technology based environments. *British Journal Of Educational Technology, 37,* 937-947.

Oilo, D. (1998). "De lo tradicional a lo virtual: las nuevas tecnologías de la información". Debate temático. "From traditional to virtual: the new information technologies". Thematic debate. UNESCO París. Conferencia Mundial Sobre Educación Superior (pp. 1-18) < http://unesdoc.unesco.org/images/0011/001136/113604so.pdf>. Accessed: 04.03.09.

Pajares, F. (2002). Overview of social cognitive theory and of self-efficacy. Emory University. <http://www.emory.edu/EDUCATION/mfp/eff.html>. Accessed:19.01.09.

Pieschl, S. (2009). Metacognitive calibration—an extended conceptualization and potential applications. *Metacognition and Learning ,4,* 3–31.

Pintrich, P. (1999). The role of motivation in promoting and sustaining self-regulated learning. *International Journal of Educational Research, 2,* 459-470.

Pintrich, P. (2000). A framework for conceptualizing student motivation and self-regulated learning in the college classroom. In: P. Pintrich & P. Ruhotie (Eds). *Conative constructs and self-regulated learning*,Chapter II (pp. 31-51). Finland: Research centre for vocational education.

Pintrich, P., Smith, D., García T., & McKeachie, W. (1993). Reliability and predictive validity of the motivated strategies for learning questionnaire (MSLQ). *Educational and Psychological Measurement. 53,* 801-813.

Plan de estudios FES Acatlán, Diseño Gráfico. FES Acatlán, Graphic Design Curriculum. UNAM, (2009).< http://www.acatlan.unam.mx/licenciaturas/22/.>. Accessed: 12.12.08.

Regian, J. & Shebilske, W. (1992). Virtual reality an instructional medium for visual-spatial tasks. *Journal of Communication, 4*, 12-19.

Ruohotie, P. & Nokelainen, P. (2000). Modern modeling of student regulation and self regulated learning. In: P. Pintrich and P. Ruohotie. *Conative constructs and self-regulated learning*,Chapter VI (pp. 141-142). Finland: Research centre for vocational education.

Sáez, F. (2004). Más allá de internet. La red universal digital. X-economía y nuevo entorno tecno-social. Beyond the Internet. The universal digital network. X-economy and new techno-social environment. Madrid, España: Editorial Universitaria Ramón Areces.

Serra, M. & Metcalfe, J.(2009) Effective implementation of metacognition. In; D.Hacker, J. Dunlosky and A. Graesser (Eds.), Handbook of Metacognition in Education, Chapter 15 (pp. 652-654). New York.USA: Routledge.

Stoney, S. & Oliver, R. (1999). Exploring the nature of self-regulated learning with multimedia.In B. Collins & R. Oliver (Eds.). Proceedings of *World Conference on Educational Multimedia, Hypermedia and Telecommunications* (1),869-874.Chesapeake: USA.AACE.

Suárez, C. (2004). La zona de desarrollo próximo, categoría pedagógica para el análisis de la interacción en contextos de virtualidad. The zone of proximal development, educational category for the analysis of interaction in virtual settings. Revista Pixel Bit, (24), 5-10.

<http://redalyc.uaemex.mx/redalyc/src/inicio/ArtPdfRed.jsp?iCve=36802401>
Accessed: 22.06.08.

Tobías,S. & Everson,H.(2009). The importance of knowing what you know: a knowledge monitoring framework for studying metacognition in Education. Effective implementation of metacognition. In; D.Hacker, J. Dunlosky and A. Graesser. (Eds.), *Handbook of Metacognition in Education*, Chapter 7 (pp. 261-263). New York,USA:Routledge.

Van Hout, B. (2000). Assessing active self-directed learning. In P. Simons, J. van der Linden y T. Duffy (Eds.), *New learning,* (pp. 83-101). Germany: Kluwer Academic Publishers.

Veenman, M. (2007). The assessment and instruction of self-regulation in computer-based environments: a discussion. *Metacognition and Learning. 2*, 177-183.

Veenman, M., Kok, R., & Blöte, A. (2005). The relation between intellectual and metacognitive skills at the onset of metacognitive skills development. Instructional Science, 33,193-211.

Veenman, M., Van Hout, B., & Afflerbach, P. (2006). Metacognition and learning: conceptual and methodological considerations. *Metacognition and Learning, 1*, 3-14.

Viniegra, L. & Aguilar, E.(1999). Hacia otra concepción del currículo.Towards another conception of curriculum. Ciudad de México, México: Editorial Instituto Mexicano del Seguro Social.

Virtanen, P., Niemi, H., Nevgi, A., Raehalme, O., & Launonen, A. (2003). Towards strategic learning skills through self-assessment and tutoring in web-based environment. Conference on Educational Research, University of Hamburg, Germany. <http://www.leeds.ac.uk/educol/documents/00003227.htm> . Accessed:17.11.08.

Weinstein, C. & Mayer, R. (1986). The teaching of learning strategies. In: M. Wittrock (Ed.) *Handbook of research on teaching*, (pp. 315-327). New York USA; Mac Millan.

Winne, P. & Hadwin, A. (2008). The weave of motivation and self-regulated learning. In: D. Schunk & B. Zimmerman (Eds). *Motivation and self-regulated learning: Theory, research, and applications*, (pp. 297-314). New York. USA: Taylor & Francis.

Zimmerman, B. (2008). Investigating self-regulation and motivation: Historical background, methodological developments, and future prospects. *American Educational Research Journal,* 45,(1) 166–183.

Appendix

Classes, Descriptions and Examples of the Variables Used to Code Learners'
Self-Regulatory Behavior (Azevedo, Guhtrie, & Seibert, 2004).

Variable	Description
Forethought/Planning/Activation	
Planning	A plan involves coordinating the selection of operators. Its execution involves making behaviour conditional on the state of the problem and a hierarchy of goals and sub-goals
Sub-Goals	Consist either of operations that are possible, postponed, or intended, or of states that are expected to be obtained. Goals can be identified because they have no reference to already existing states.
Prior Knowledge activation	Learner searches memory for relevant prior knowledge either before they actually begin performing task or during task performance.
Recycle Goal in	Learner restates the goal in working memory (WM) Working Memory
Monitoring	
Judgment of Learning (JOL)	Learner becomes aware that they don't know or understand everything they read.
Feeling of Knowing (FOK)	Learner is aware of having read something in the past and having some understanding of it, but not being able to recall it on demand.
Self –Questioning	Learner re-reads to improve his/her understanding of the content.
Content evaluation	Learner monitors content relative to goals.
Identify Adequacy of Information	Learner assesses the usefulness and/or adequacy of the content they're reading, watching, etc
Strategy use	
Selecting a New informational source	The selection and use of various cognitive strategies for memory, learning, reasoning, problem solving, and thinking. May include selecting a new representation, coordinating multiple representation, etc.
Goal-free search	Learner searches hypermedia environment without specifying a specific plan or goal

Summarization	Learner summarizes what he/she has just read, inspected, or heard in the hypermedia environment.
Copying information	Copying an informational source such as text and/or diagram from the hypermedia environment
Re-reading	Learner re-reads or revisits a section of the hypermedia environment
Inferences	Learner makes inferences based on what he/she read, saw or heard in the hypermedia environment
Hypothesizing	Learner asks questions that go beyond what they have read, seen or heard
Knowledge elaboration	Learner elaborates what he/she has just read, seen, or heard with prior knowledge

Task Difficulty and Demands

Time and Effort Planning	Learner attempts to intentionally control his/her behaviour
Help-seeking Behaviour	Learner seeks assistance from experimenter regarding either their emerging understanding of the topic or their instructional behaviour.
Task Difficulty	Learner indicates one of the following: 1) the task is either easy or difficult, 2) using the hypermedia environment is more difficult than using a book.
Control of context	Learner uses features of the hypermedia environment to enhance the reading and viewing of information.
Expectation of Adequacy of Information	Learner expects a certain type of representation to prove adequate given the current goal.