The Effect of Teaching Metacognitive Learning Skills on the Performance of Online Learners Demonstrating Different Levels of Self-regulated Learning

Claude Martel

A thesis

in

The Department

of

Education

Presented in Partial Fulfillment of the Requirements

for the Degree of Doctor of Philosophy (Educational Technology) at

Concordia University

Montreal, Quebec, Canada

July 2008

Your file Votre référence
ISBN: 978-0-494-63440-0
Our file Notre référence
ISBN: 978-0-494-63440-0

ABSTRACT

The Effect of Teaching Metacognitive Learning Skills on the Performance of Online Learners Demonstrating Different Levels of Self-regulated Learning.

Claude Martel, Ph.D.
Concordia University, 2008

In this study participants were exposed to different approaches on how to apply metacognitive strategies within an online instructional context. Eighty-five participants were randomly assigned to one of three treatment groups. A self-regulated learning inventory was administered to determine the influence of this factor within the experiment.

This study used a posttest only control group design with three levels of the instructional independent variable. All groups received an instructional package on how to apply metacognitive skills in an instructional context. One group, the control group had no additional experimental intervention and went straight through the instructional material and posttests. This group provided the baseline data for comparison with the other treatments. The two other groups, the meta-cognitive strategy conditions, were prompted at key moments of the experiment and asked to apply the metacognitive strategies they had learned. Participation in these activities was optional for the second group and mandatory for the third.

Results obtained did not provide strong support for the first of the experimental hypotheses. No significant correlation was found between the self-regulated learning inventory used and the performance measures.

The experimental data showed that participants exposed to mandatory metacognitive activities obtained significantly better results than those exposed only to the instructional package on how to apply metacognitive skills. Analysis provides some preliminary support for the use of mandatory embedded metacognitive activities with an online instructional context.

Additional information was also gathered and discussed on the benefits and challenges of running an online experiment.

ACKNOWLEDGEMENTS

To Nathalie, Florence and Arnaud (my family)

for their constant patience, support and love.

To Dr. Robert Bernard for his guidance, insight

and patience.

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CHAPTER 1

INTRODUCTION

The debate over the efficacy of computer assisted instruction has been continuous for nearly four decades. From its origins in "programmed instruction", "teaching machines" (Saettler, 1990) and the current evolution towards web-based instruction, promoters of learning technologies predicted a massive transformation in the field of training and education. On the other side of the debate, Traditionalists, considered that computer assisted instruction was just a passing fad.

However, with the commercialization of the Internet in the mid-1990s, the use of online learning has been steadily growing. In its 2007 State of the Industry Report (Paradise, 2007) the American Society for Training & Development determined that technology-based learning methods now account for 30% of all learning hours provided, a noteworthy jump from 11.5% in 2001. This growth cannot only be attributed to the inherent cost savings of online delivery, but the advantages offered by "anytime, anywhere" learning that does not require centralized resources, travel or fixed time commitments found in traditional classroom-based approaches. The promise of online learning can also be attributed to the interactive, hypertextual, collaborative and rich-media capabilities of the Internet that has experienced an unprecedented and universal expansion around the globe.

Many researchers in the field of education were fascinated with the potential but also concerned with the shortcomings of this alternate mode of delivering instruction (Clark, 2000). To some, it became a flexible and powerful tool to deliver instruction

(Land & Hannafin, 1997) with the potential of standardizing and improving the instructional outcomes (Jonassen, Howland, Moore & Marra, 2003). To many, it also became a tool to democratize learning, as it could make instruction widely available independent of the geography or the requirement of physical infrastructure (Bransford et. al., 2000).

On the critical side, some researchers were doubtful that technology alone could actually improve learning (Clark & Sugrue, 1995). Many others maintained that the medium of delivery had little or no impact on instructional outcomes. Other factors such as instructional strategies that were in fact independent of the mode of delivery might have a much larger overall effect than the medium itself (Clark, 1983).

Other researchers made the case that the evolution towards online instruction might actually make it less accessible, creating a cleavage, or what is known as the "digital divide" between more affluent technological societies and others (Attewell, 2001; Pearson, 2002).

In conjunction with the exponential growth in online instruction, a recent meta-analysis (Bernard, Abrami, Lou, Borokhovsk, Wade, Wozney, Wallet, Fiset & Huang, 2004) demonstrated that performance results obtained from distance learning were not greatly different from the result obtained from classroom instruction. One of the major challenges cited in this analysis was the lack of applied empirical research in the literature that could provide guidance on how to design and deliver instruction better adapted to advantage the characteristics of the medium.

While the adaptive potential of online learning has been recognized from the start, the biggest challenge is perhaps the identification of appropriate cognitive instructional models that can adapt better to the context of the learner. Early research on topics like learner control did not provide any significant results that could be used in this direction (Niemiec, Sikorski & Walberg, 1996). Another significant challenge lies in the development of an instructional design model sufficiently distinct from the declarative-procedural ISD model that is most commonly used in the development of online instruction. A more comprehensive instructional approach that includes the learner as an active participant in the learning process, such as those identified by Hodges, (2008) may provide opportunities for enhanced and more effective learning in online contexts.

Picking up on previously researched conceptual domains, such as learner self-regulation and beliefs about the learning process in non-traditional environments, there is a parallel with asynchronous web-based e-learning that has been little explored. While there has been considerable research on online learning from a media or presentation perspective, the theoretical underpinnings that govern the design of online instruction from a cognitive or meta-cognitive perspective are typically ill- defined.

Recent studies on metacognition and self-regulated learning in traditional learning environments have provided impressive significant and replicable results. Robbins et al. (2004) conducted a meta-analysis of 109 studies and found that metacognition and self-regulated learning indicators were the strongest predictor of cumulative grade point average (GPA) and came in second as a predictor of retention among college level students. Tools and inventories derived from these studies have also provided strong predictive correlations with general performance measures (Lindner, Harris & Gordon, 1996; Hammann & Stevens, 1998; Pintrich, 2000).

Distance education is usually defined as a field of education that focuses on the pedagogy, technology, and instructional systems design that aim to deliver education to students who are not physically "on site". For the purpose of this experiment, we will concentrate on a much narrower definition of what is usually called distance education. To facilitate the production and the administration of the instructional material, we only used autonomous asynchronous E-learning. The amount of material and the length of the instructional delivery will also be much shorter than many of the classical distance learning course. The total instructional experience will consist of about 2 to 3 hours spread over 2 weeks.

Asynchronous E-learning is perhaps the ideal environment in which to formally study self-regulation. In this pattern, learners are largely on their own in an environment that by default encourages the learner to regulate the flow of information and activities (self-paced).

Because of the autonomous nature of most online learning, it became natural to investigate the potential of metacognitive activities and Self-Regulated Learning (SRL) inventories and how they could be used to design more effective online instruction. If we could identify learners that are less autonomous, we might then be able to adapt the instructional activities provided to compensate for this lack of autonomy.

The Debate Over the Effectiveness of Online Learning

Early comparative research using online and traditional modes of instruction provided episodic or local effects of the efficacy of one mode of instruction over another, but no generalizable prevalence that would clearly demarcate an advantage of any mode could be obtained. Because of inconclusive initial results obtained from media comparison studies, Clark (1983, 1994) suggested that more effort should be made to identify the operant instructional factors that would provide significant results. Clark's went further and proposes that media research needs to stop emphasizing descriptive research and focus on prescriptive research designs and questions. He also expands the discussion to online and multimedia instruction and suggests that we need to be careful about the assumption often supported about this means of instruction. He proposes that we should check more carefully research evidence for the presumed benefits as research can sometimes provide counterintuitive evidence that does not support what looks like probable assumptions (Clark & Feldon, 2005).

Many researchers attempted to compare some of the key features of various modes to try to understand where the key factor might be identified (e.g., feedback, practice, learner control, media…). Cobb (1997) contributed a compelling argument to the debate by arguing that under certain circumstances, the innate characteristics of certain types of media may support enhanced cognitive engagement of the learner, thus making instruction more stimulating regardless of the content.

As the research evolved over the last decade, online learning approaches and applications have also progressed and have become increasingly sophisticated (Taylor, 1995). These solutions can be placed in a continuum with increasing flexibility, interactivity, ease of delivery, and access (Taylor, 2004).

A multitude of hybrid approaches are also now appearing. For example, "blended learning" and synchronous modes of instruction such as "webinars" include many of the key features of both classroom and online instruction. Yet all approaches to online instruction do not fully address the fundamental issue, which is, "Can online learning provide equivalent or better results than other traditional classroom means?"

A recent meta-analysis of empirical research compared the online to classroom mode of instructional delivery and brought a novel perspective to the debate (Bernard et al., 2004). The results of this meta-analysis showed that there was no significant difference between these two different delivery methods. This resulted in a movement away from superficial media effect and modal comparison studies and helped to shift the analytical focus towards more fundamental instructional design and cognitive strategies.

Learner retention

The emergence of online and other computer assisted solutions also brought into sharp focus the issue of learner retention (Morgan & Tam, 1999). The relative ease in which the instructional experience could be discontinued, and the difficulty that some learners have in these learning environments are issues that needs to be addressed. Preliminary experiments in this area (Bocchi, Eastman & Swift, 2004) demonstrated that providing some kind of collaboration and engagement (group work or discussions, remote tutoring or some kind of hybrid or blended delivery) could greatly mitigate the perception of isolation that was found to have a major impact on the attrition rates of online learners.

From the instructional design perspective, other preliminary research (Moore & Thompson, 1993) suggests that by increasing the level of interactivity with the learning environment, learners might experience a lessening of the perception of isolation that is often reported in online and distance education.

Expanding the debate

Shuell (1993) proposed that current experimental approaches and instructional practices should be revised. He suggested that we look more closely at the interaction of the teaching and learning aspects of instruction as they are both active and intimately linked ingredient in this progress. This triggered not only a reconsideration of many instructional practices but also demanded that experimental approaches should be revised in order to better understand the complex processes active in these modes of instruction. This had the effect of reigniting interest in researching the fundamental characteristics of individual differences and metacognition. In the last two decades, there has been an emergence of new tools that combine both the teaching and the learning perspectives (Reigeluth, 1999).

One of the main issues in adopting this new holistic approach was identifying key factors that could significantly represent the learner in the teaching/learning equation. Early attempts to identify such key factors were not very successful. Potentially promising research on learner control has provided little if any significant experimental effect on learners (Niemiec, Sikorski & Walberg, 1996). Research and inquiries on learning styles have also failed to provide any clear or significant results (Clark & Feldon, 2005). On the other hand, research in the area of metacognition and cognitive skills has provided interesting insight into how people process and ultimately learn new information (Butler & Winne, 1995).

The idea that learners may or may not use metacognitive strategies to enhance the learning experience provides a basis on which to better understand why some learners respond differently in identical instructional contexts. However, the current literature does not disclose any models and tools that might provide a clear enough strategy for effective instructional prescriptive guidelines. In addition, the rapid proliferation and use of online instructional material has made it essential that more researchers examine the different metacognitive factors that might contribute to the effectiveness of this mode of instruction.

The present study attempts to complement some of the existing research on the use of metacognition and of self-regulation in an online environment. It is proposed that specific types of instructional and metacognitive strategies can and will provide significant results for certain types of learners.

Problem statements

In this study, how self-regulatory learning models and SRL inventories can play an active role in the online instruction was investigated. A first element was to investigate if it was possible to determine the level of self regulation used by learners through the administration of a SRL inventory. The information obtained was then cross-validated to determine if this measure is a good predictor of overall learner performance in the post-tests of the experiment. This result is particularly useful as it is used later in the experiment to investigate the impact of embedded SRL strategies on the different levels provided by the SRL inventory results.

To insure that prior metacognitive abilities would not significantly interfere with the experiment, a Self-Regulated Learning Inventory (Lindner & Harris, 1992; Lindner, Harris & Gordon, 1996) was used as a covariate. One of the premises of self-regulated learning inventories is that they can explain a large amount of the variance in instructional situations independently of the treatments offered. Previous research has also shown that there is a significant correlation between Grade Point Average (GPA) and self-regulated learning measures (Lindner, Harris & Gordon, 1996). This might also implicate self-regulated learning as a good predictor of more specific instructional performance outcomes.

Therefore the first hypothesis:

> *There will be a consistent significant correlation between the self-regulated learning measure used in this experiment and the performance measure obtained following the different instructional treatments.*

It was also interesting to examine the impact of using embedded metacognitive strategies in online instruction. One of the key questions was to investigate if embedded SRL supporting activities had a similar impact on learners displaying different levels as determined by the SRL inventories.

Research has shown that metacognitively active learners are usually more effective learners (Swanson, 1990), but as Garner (1990) suggested, some learners may also resist using recently acquired metacognitive skills. To determine how much these factors may affect results, it was decided that two treatment groups would be exposed to metacognitive activities embedded in the instructional treatment. One group would be exposed to optional metacognitive activities where participants would have the choice of performing these activities. The other group would also be exposed to embedded metacognitive activities but will be mandatory.

The second hypothesis is as follows:

Participants who are exposed to metacognitive activities embedded in the instructional material will obtain significantly better results than groups that are not exposed to these embedded support activities.

Since the use of SRL seems to be episodic in many cases (Azevedo, Guthrie & Seibert, 2004), a final aspect of this study was to determine the effect of making these embedded SRL strategies optional or mandatory. Here the impact of suggesting versus forcing these activities on the participant, and whether this intervention would have a positive or negative effect were investigated.

The third hypothesis is as follows:

Participants exposed to mandatory embedded metacognitive activities will obtain significantly better results then those exposed to the optional embedded metacognitive activities.

CHAPTER 2

REVIEW OF THE LITERATURE

Definition of Metacognition in the Academic Literature

The term "metacognition" appeared around 1975 in the work of developmental psychologist John Flavell of Stanford University. The term "metacognition" refers to higher order thinking processes involving an active and (usually) conscious control over the processes engaged in learning. This definition suggests that the management and regulation of learning processes is an active executive function (Flavell, 1979). From this definition, metacognition involves a variety of activities like goal-directed processing of information, the determination of action to be taken and the implementation and monitoring of learning activities.

Entwistle (1988) also proposed that there is a circular relationship between motivational factors and the use of strategic effort and performance. He suggested that there should be an overall "game plan" that could help students translate knowledge skills into strategies, thus rendering learning more effective. Haller, Child & Walberg (1988) supported this premise by demonstrating the importance of metacognitive mediation in the development of reading skills. Their meta-analysis found an impressive overall effect size of 0.71, even if research in the area of metacognition does not always provide such clear results. Garner (1990) suggested that the application of metacognitive skills is not always as straightforward as might be expected. He observed that many learners did not use metacognitive skills even when trained to use them.

To clarify these observations, some researchers attempted to identify the significant variables that influence learning and use of metacognitive skills. In the past, many experiments attempting to explain individual differences were mainly focused on one facet or one category of attitudes. Research in the field of education now supports the idea that complex integrated processes and attitudes play a crucial role on how a learner interacts with instruction (Snow, 1987). This has also been supported by studies that demonstrate that metacognition is a complex process that is closely associated with academic success and intelligence (Borkowski, Carr & Pressley, 1987; Sternberg, 1986).

Cognitive and Metacognitive strategies

By definition, metacognition is often composed of knowledge and strategy components. However this requires defining and differentiating clearly between what is *cognitive* from what is *metacognitive*. Even Flavell (1979) acknowledged that discerning metacognition from basic cognition is not always straightforward. He proposed that the key distinction appear in how information is used. For example, a learner might use a variety of cognitive learning strategies in everyday tasks. Yet, when confronted with a novel situation, the learner might revert automatically to a preferred strategy whether or not it is adapted to the context. This suggests that the process of selecting the most appropriate strategy could be instinctive or automatic. On the other hand, if the goal is the application of metagognitive strategies then the learner would need to develop a conscious reasoning of the task at hand in light of the cognitive strategies available to him. Metacognition implies that there is a conscious and deliberate choice being made about a learning strategy and how it might better address the particularities of a given context.

Brown (1980) helped to differentiate between cognitive and metacognitive processes. He suggested that the main function of cognition is to resolve problems and to bring cognitive enterprises to a good end. The primary purpose of metacognition is to regulate a person's cognitive processes in solving a problem or executing a task. Metacognition involves executive insight such as recognizing what is not understood, consciously increasing concentration to block distractions and deliberately using prior experience to increase retention and understanding, among other things (Brown, 1987).

In essence, metacognition is a reflection and evaluation of the thinking process and not simply providing declarative knowledge production as evidence of learning. Metacognition clearly involves more executive components such as setting goals, selecting strategies and monitoring their effectiveness in the accomplishment of learning tasks. By definition metacognitive strategies surround the learning activity and are often triggered by the success or the failure of a learner's selected or habitual strategies (Roberts & Erdos, 1993).

One of the key challenges with metacognitive strategies is that they are often used sporadically. Sometimes these strategies are initiated at the start of a given learning task but sometimes they are initiated only when established or habitual cognitive strategies fail (Roberts & Erdos, 1993). The unsystematic use of metacognitive strategies can also be a determining factor as there appears to be an important difference between the knowledge of metacognitive strategies and their systematic application.

Metacognitive regulation and the concept of Self-Regulated Learning (SRL)

Several models of self-regulated learning have been developed, the majority originating in Bandura's socio-cognitive theory of human functioning (Bandura, 1986). A basic assumption of Bandura's theory is that people are active, self-determined and self-regulating entities, rather than reactive and shaped by their environment.

Metacognitive experience involves the use of metacognitive strategies. This requires a definite level of monitoring and regulation (Brown, 1987). More precisely, metacognition is the ability to control the cognitive processes. Sternberg (1986) refers to these executive metacognitive processes as key components of his theory of intelligence. He refers to the capacity to self-monitor and adapt as crucial to figure out what to do in novel or evolving situations.

Corno and Mandinach (1983) were the first to identify the concept of self-regulated learning (SRL), as a central factor explaining part of the variance brought by the learner to the learning experience. They described SRL as a multifaceted construct that would account for learner participation in the learning/teaching process.

In general terms, self-regulated learning can be defined as a series of volitional situations that are characterized by a recursive flow of information monitored by the learner. By monitoring these learning processes, learners can evaluate and review the type of engagement and strategies believed to be the most valuable or efficient in the attainment of goals (Butler & Winne, 1995). This definition is also reinforced by Brooks (1997) who proposes self-regulated learning as active and goal directed, resulting from effective regulation of behaviour, motivation and cognition.

Rooted in the theoretical and experimental literature of information processing and metacognition, researchers rapidly began to identify metacognitive variables that made learners more effective (Butler & Winne, 1995). The concept of self-regulated learning provides a working framework that could be used to explain and integrate some of the complexity that learners represent in the teaching/learning equation.

Early research in this area demonstrated that self-regulated learners were in general very successful (Pintrich & De Groot, 1990; Zimmerman & Pons, 1986). From these results, many researchers started to develop self-regulation models and tools (Biggs, 1993; Butler & Winne, 1995) and instruments (Lindner & Harris, 1992; Pintrich, 1991; Schraw & Dennison, 1994; Zimmerman, 1992) that could be used to identify the strengths and weaknesses of a given metacognitive approach. Since SRL is about the choice and use of learning strategies, there is a strong assumption that it will significantly influence learning performance. A potential implication of SRL models and instruments is their use to identify students that are more or less cognitively active while learning. This becomes an important issue for online instruction as enhanced cognitive activity could not only contribute to learning performance, but might also be a factor in the attrition rate of online instruction (Rovai, 2003).

Preliminary research suggests that SRL models and instruments could be useful tools to teach and reinforce metacognitive skills. There has been some success in teaching learners to be more metacognitively active (Jacobs & Paris, 1987) and to engage them in better strategic behaviours when involved in a learning tasks. Even if preliminary results are encouraging, there is still little evidence that learners will easily transfer these behaviours to real-life situations (Salomon & Globerson, 1987).

Winne (1997) provided a working model that suggests learners develop self-regulatory learning processes through experience, bootstrapping previous self-regulatory processes to newer ones. So as learners are exposed to newer and richer learning situations, they develop more intricate and more sophisticated self-regulatory learning schemes. Research in this area indicates that the timing and adroit articulation of large sets of interacting factors is required to successfully teach students the use and application of self-regulatory learning processes (Pressley & McCormick, 1995; Winne, 1995).

Winne also proposed that there are three major factors that promote or prevent the development of these self-regulatory learning processes (Winne, 1997). They are:

- The availability of sufficient and appropriate feedback
- The ability of the learner to remember how learning was enacted, so that metacognitive choices were actually connected to an obtained outcome.
- The ability of the learner to reason and monitor the factors that may affect their learning performance.

The ideal process would stimulate learners to systematically activate strategies that enhance learning. These stimulations would take the form of volitional strategies, as well as cognitively based and regulatory strategies (Garcia, 1995). Garcia & Pintrich (1994) identified three key highly correlated strategies that learners can use: planning, monitoring and regulation.

- *Goal formation.* Typically in this strategy, the learner identifies the instructional task to be accomplished and proximal goals to help perform better academically (Boekaerts, 1997).

- *Monitoring strategies.* These are closely linked to regulatory strategies as one can trigger the other (Garcia & Pintrich, 1994). Monitoring can include strategies like self-testing, monitoring attention and motivation, as well as monitoring comprehension during a learning activity. The coordinate effect of these factors allow learners to effectively take control over the learning experience and thus improve their engagement by monitoring the effect of their past and current learning strategies.

- *Regulation.* Regulation is the capacity of a learner to adapt effort and strategies according to the monitoring of results in order to achieve the performance goal (as set by the learner).

Self-regulation and online learning

Because of the relatively autonomous nature of asynchronous online instruction and the wide range of presentable information, learners are often required to develop a higher level of autonomy and self-regulation than externally driven or traditional classroom instruction. Despite the growth and prevalence of online learning, there is a limited amount of research on how self-regulated learning (SRL) can be used to understand some of the forces in action in these environments (Azevedo, 2005). SRL models provide a comprehensive framework to examine how learners adapt to a less externally-directed instructional environment typically found in online learning.

Several researchers have already started to investigate the key role of cognitive, motivational and behavioral regulation (Azevedo, Cromley, Thomas, Seibert & Tron, 2003; Hadwin & Winne, 2001). Recent investigations on this topic also show that learners often have difficulty learning online because they often fail to engage self-regulation (Azevedo & Cromley, 2004).

Winne (2001) also proposed the necessity to investigate the complexity of the learning task at hand, as learners may require to reflect and modify their perception of the instructional content in order to be more effective learners. Studies on the subject indicate that a learner's inability to self-regulate often leads to lower level of understanding when studying complex topics online (Greene & Land, 2000; Land & Hannafin, 1997).

The role of scaffolding in facilitating learners' self-regulation has become an important issue, thus bridging the gap between internally driven and externally regulated aspects of learning (Azevedo, Cromley & Seibert, 2004). A few years earlier, Greene & Land (2000) had already started to compare different types of scaffolding strategies (web resources, procedural guidelines, student-student interaction, and instructor-student interaction) that learners use while learning online. McManus (2000) also provided some insight on how different embedded strategies could benefit learners in online environments. Azevedo, Guthrie & Seibert (2004) demonstrated that students differ significantly in their ability to self-regulate when engaged in learning online. A second level of investigation in this area is inquiring how adaptive these tools must become in order to help learners deal with complex content and learning environments (Azevedo, Cromley, Thomas, Seibert & Tron, 2003).

The complexity of online and other nonlinear environments has created additional challenges for learners (Azevedo, 2002) but also open many possibilities. The results obtained with the use SRL models in online learning environments are promising, yet research in this area is still preliminary. SRL has provided a flexible theoretical framework to help better comprehend the variety of reactions when individuals learn online (Azevedo, 2005).

This illustrates the apparent complexity first described in Shuell (1993) who proposed that both sides of the learning and teaching equation need to be analyzed. The analysis of SRL in online environments might be a suitable strategy to study some of the important elements that contribute to this apparent complexity.

Performance Predictors and the Measurement of Self-regulation Skills

The search for a reliable predictor of instructional performance is not new. Early research on individual differences and learning styles had raised many expectations yet the results obtained were far from convincing. Concepts like field dependence-independence, Myers-Briggs profiling or learner control never provided the predictive results promised (Borges & Savickas, 2002; Niemiec, Sikorski & Walberg, 1996). However the research on metacognition and SRL has been much more effective in providing consistent prediction of both short-term performance and long term achievement (Duncan & McKeachie, 2005).

From the present state of the literature, it is assumed that the development of metacognitive self-regulatory skills is neither simple nor rapid to develop. Developing fully autonomous self-regulation is at best a long term and complex process that is probably beyond the scope of most standard experimental settings. Furthermore, Zimmerman, Bonner & Kovach (1996) also proposed that self-regulation is not an automatic response and is only triggered when learners understand the benefits of self-regulation.

This variability in behaviour raises a multitude of questions about the ability to effectively measure, support or incite individuals to use SRL strategies. However if it is possible to identify learners with less effective metacognitive approaches, it could be possible to strategically provide interventions that would incite the use of SRL techniques (Pintrich, 2000).

Many of the early tools focused on only one variable of one facet to predict results. SRL inventories usually encompass multiple scales as indicators of cognitive regulation and provide measures of the monitoring and control activities for cognition (Pintrich, 1991). SRL inventories usually take a more inclusive perspective on learning to include not only cognitive, but also motivational, affective and social factors (Pintrich, 2000).

There are several self-regulatory learning inventories in the literature that have gained experimental maturity (Lindner, Harris & Gordon, 1996; Pintrich, 1991). These tools could provide an important contribution, as they could be used to identify learners that require more or less support from the instructional setting.

Recently, more sophisticated tools and measures that go beyond self-reporting and learner's perception about SRL (Perry & Winne, 2006) have emerged. By using fine-grained traces learners' actual activities while studying can be recorded. This approach allows the differentiation between learner perception of study habits and actual learning preferences while performing learning tasks.

Training and Developing Self-regulating Skills

Even if it is possible to develop tools to identify whether learners can demonstrate higher levels of self-regulating ability, there are still a few fundamental questions that need to be addressed. For example, is it possible to rapidly train learners to use SRL techniques? If yes, should the type of instructional intervention change with different types of self-regulated learners?

Despite the demonstrated advantage of using SRL in learning contexts, research has indicated that learners have difficulties demonstrating the use of SRL while learning simple and complex tasks (Mevarech & Kramarski, 1997). Learners often do not realize consciously that they should regulate their learning process. They usually employ successful habits established in past experiences and rarely consider alternatives. In addition, learners often require additional support in order to reflect and regulate their ideas (Azevedo & Cromley, 2004; Kramarski & Mevarech, 2003).

Many authors have not only argued for, but demonstrated experimentally that students' can be trained to apply aspects of self-regulation and consequently improve their learning performance (Azevedo & Cromley, 2004; Kramarski & Gutman, 2006; Zimmerman, Bonner & Kovach, 1996; Perry & Winne, 2006). Azevedo & Cromley,

(2004) also showed that learners exposed to relatively simple SRL training could gain a deeper understanding of complex subject matters.

Such results have considerable implications for the design of online learning environments as well online content. Embedding SRL supporting activities may offer substantial benefits to learners.

CHAPTER 3

METHOD

Sample

The experimental sample of this experiment was composed of 129 participants enrolled in undergraduate and graduate studies at Concordia University in Montreal. To recruit participants, 13 presentations were made over a 2 month period to a variety of in-course students in the departments of Educational and Communication Studies. Recruitment continued until the target of 25 participants per treatment was reached. The participants that had started the experiment before when this target was reached were retained in the sample of the study.

The participants' ages ranged from 19 to 37 years old, 39 were male and 90 were female. They were all full time registered students at the time of the study. Sixty-six were undergraduate students and 63 were in a graduate program.

Each participant was randomly assigned to one of three experimental conditions in this study. Participants that did not complete all of the mandatory activities in either of the two trials of the experiment were eliminated from the sample. One participant was also eliminated from the sample due to insufficient working knowledge of English necessary to comprehend the experiment's instructions as well as the learning content.

Design and data analysis

This study implemented a post-test only control group design with three levels of the independent variable, Self-Regulation Training. The results of the Self-Regulated Learning Inventory (SRLI) (Lindner & Harris, 1992; Lindner, Harris & Gordon, 1996) were used as a covariate on all three treatment groups. The treatment was administered in two trials to determine if the experimental treatment would vary over time. ANCOVA methodology was used to evaluate the results obtained in this experiment. In the result section, the reasons and rationale for the transformation of the experiment to a more straight forward Analysis of Variance (ANOVA) will be discussed.

Table 1: Experimental design

	Instructional Metacognitive Group	Optional Metacognitive Activity Group	Mandatory Metacognitive Activity Group
Immediate Posttest (Trial 1)	n=44	n=42	n=43
Immediate Posttest (Trial 2)	n=28	n=28	n=29

In the first trial of the experiment, the Self-Regulated Learning Inventory (SRLI) measure was administered first. The participants were then asked to complete the instructional treatment and performance measurement. In this first trial, learning content was presented as five modules.

The second trial was delivered with a delay ranging between 7 to 12 days. Participants were requested to complete five additional modules. The same experimental treatment and performance measurement were used for each trial.

Selecting the content delivery and management platform for the experiment

Running the online experiment presented many technical and administrative challenges. The goal was to make the process as transparent and seamless as possible for participants, and to automate as much as possible the tracking and tabulation of participant data for the experimenters. For this experiment, this required seamless assignment to one of the three treatment groups with the planned variations of the instructional content running concurrently. Results of each treatment group required highly specific and detailed tracking and tabulation. Finding the appropriate content delivery and administrative features in a Learning Management System (LMS) would clearly impact the success or failure of the experiment.

The following criteria were established and used for the selection of the LMS:

The requirement of supporting a variety of end-user computing platforms

Because the experiment was conducted over the public Internet, there was very little control over the configuration of participants' personal computers that would be used to access the learning content. The LMS therefore needed to support multiple operating systems (Microsoft Windows, Mac OS), be compatible with multiple web browser platforms (Internet Explorer, Firefox and Safari) and finally low network resource requirements as it could be expected participants would not all have high bandwidth (high speed) Internet access.

The requirement of fine-grained user tracking, statistics and tabulation of results

In the design of this experiment, it was imperative that the results obtained by participants would be kept and stored for subsequent analysis. Most commercial (and non-commercial, or open source) LMS have this functionality but this experiment required much more finer-grained detail. For example, for many of the metacognitive activities, we needed the capacity to automatically flag narrative responses to confirm that specific learning tasks were actually accomplished.

Because of the high drop out rate anticipated during the planning stages of the experiment, it was essential to monitor and track the progression of participants. For example, reporting features were needed to track the number of participants completing each trial of the experiment to verify that the minimum of 25 participants per treatment group was attained.

The requirement of managing variations in learning content

Since the purpose of the experiment was to compare the effect of different treatments of the same learning content, the use and management of reusable learning objects (RLO) would facilitate the advance preparation of the content which meant elements that were similar in all three versions could be reused. Subsequently the elements that were unique to each treatment could be added without difficulty.

The requirement of automated communication (e-mail notification)

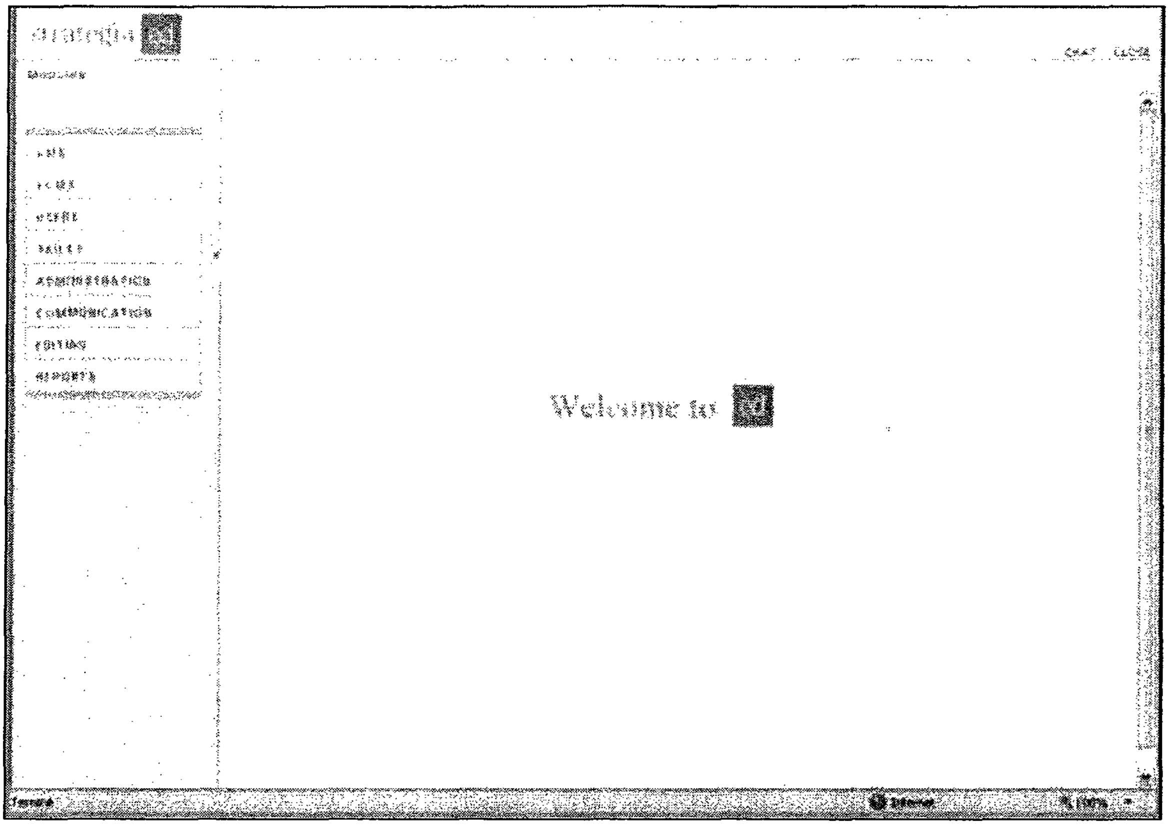
Since participants could start the experiment as soon as they were recruited, it became important to automate as much as possible the communication between researcher and participant. The ability to automatically send pre-formatted e-mails as part of various learner and course administration processes would greatly reduce the communication burden on the experimenters. For example, e-mail messages prompting participants at pre-determined events, such as:

- An introductory message with instructions and login information (URL, user name and password).
- A reminder message for participants who had not logged in (every three days repeated three times)
- A message inviting successful trial 1 participants to continue with the second trial exactly six days after completion, with instructions and login information
- A reminder message for trial two participants who had not logged in (every three days repeated three times)
- A thank you message, including a reminder about the confidentiality of the process and additional information regarding the experiment.

The cost to use and operate the solution

Because this experiment was performed within a very limited budget (C$ 2,000), it was also essential that the acquisition and implementation costs be as reasonable as possible. This included the cost of hosting the experiment on a public Internet server as well as Help Desk services for the duration of the experiment (about three months).

Figure 1: Sample Welcome Screen of the Strategia Ed LCMS



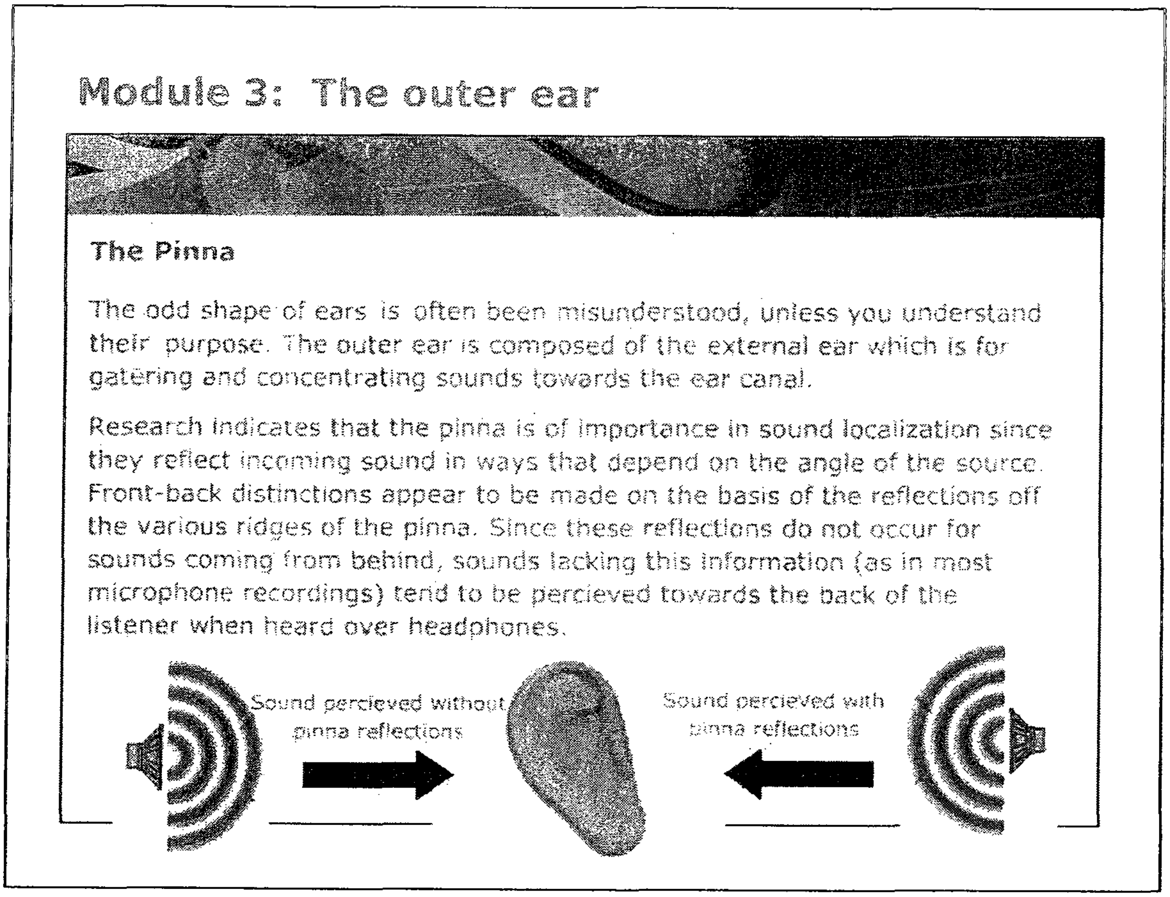
After reviewing all the solutions available, Strategia Communications Inc. of Longueuil, accepted to take part in the experiment and provided their Ed LMS platform at a significantly reduced cost. The Ed platform fulfilled all the requirements necessary for the experiment.

Instructional Content Developed for the Experiment

The development and use of instructional content for an experiment is always challenging. Duchastel proposed that the selection of the subject matter to be used in an experiment should be greatly considered (Duchastel, 1980). The subject matter should be of interest to the participants yet not be too familiar so that prior knowledge would not be a significant factor. The structure and inner workings of the human auditory system was selected for the instructional content because it matched the interest of the sample population and therefore enhanced the ecological validity of the experiment. Since the human auditory system was not typically studied in the departments from which the sample was taken, it was novel enough to require a significant level of effort from the participants. Interviews done after the end of the experiment with several participants confirmed that the material was in a domain of interest yet novel to the participants.

The chosen instructional content was equivalent to two 1-hour online courses. It was developed in English using available material in the Concordia university library, from journals and from content available on the Internet. All the texts were original and adapted to better accommodate screen viewing for online delivery of the content. Each text was composed of a maximum of 175 words (less than 1,000 characters including spaces) to maximize readability. Illustrations were juxtaposed with the text on virtually all presentation screens to enhance comprehension.

Figure 2: Sample Content Screen



Five instructional modules were developed for each trial of the experiment, each covering a slightly different topic with the subject matter. In the first trial of the experiment the following topics were covered:

Module 1: Overview of our Modern Soundscape

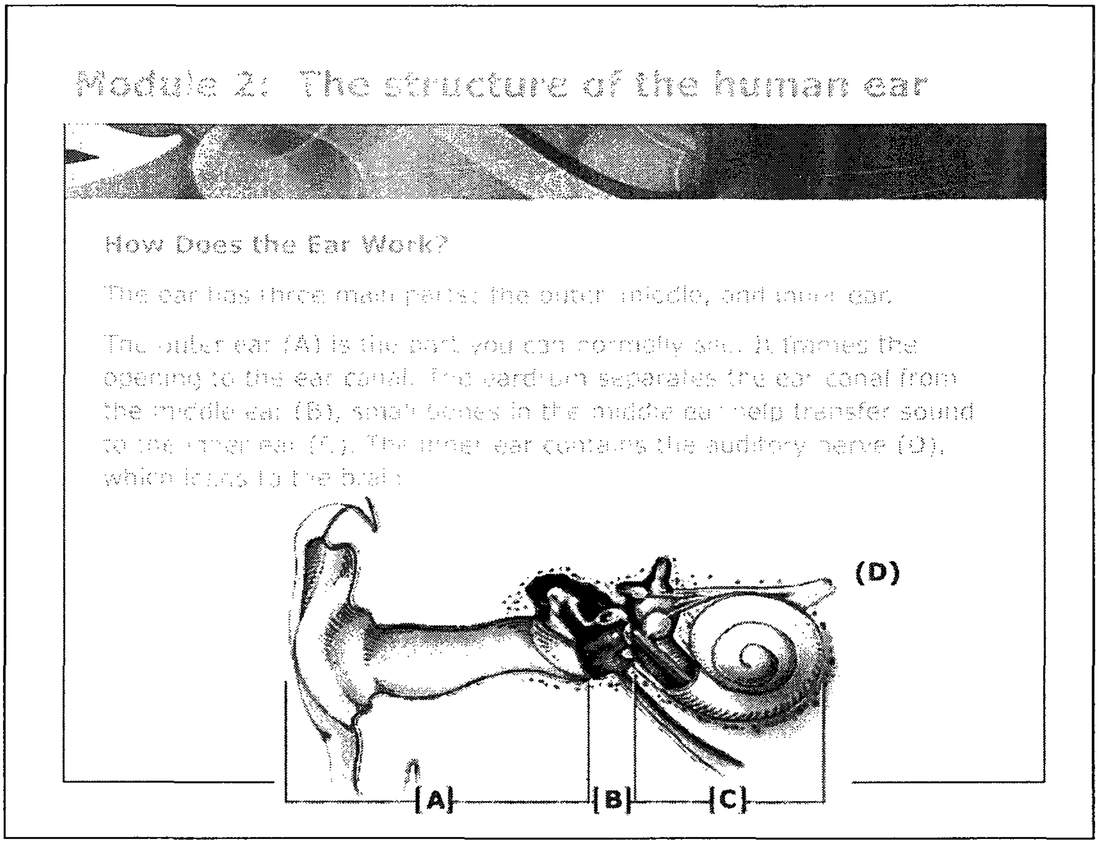
Module 2: The Structure of the Ear

Module 3: The Outer Ear

Module 4: The Middle Ear

Module 5: The Inner Ear

Figure 3: Typical Module Introductory Screen



In the second trial, a bridge module provided a review of the material covered in the first trial of the experiment. The remaining four modules provided additional information about structure and inner workings of the human auditory system. The modules delivered in the second trial of the experiment were:

Module 6: Review of previous Material (covered in the first trial)

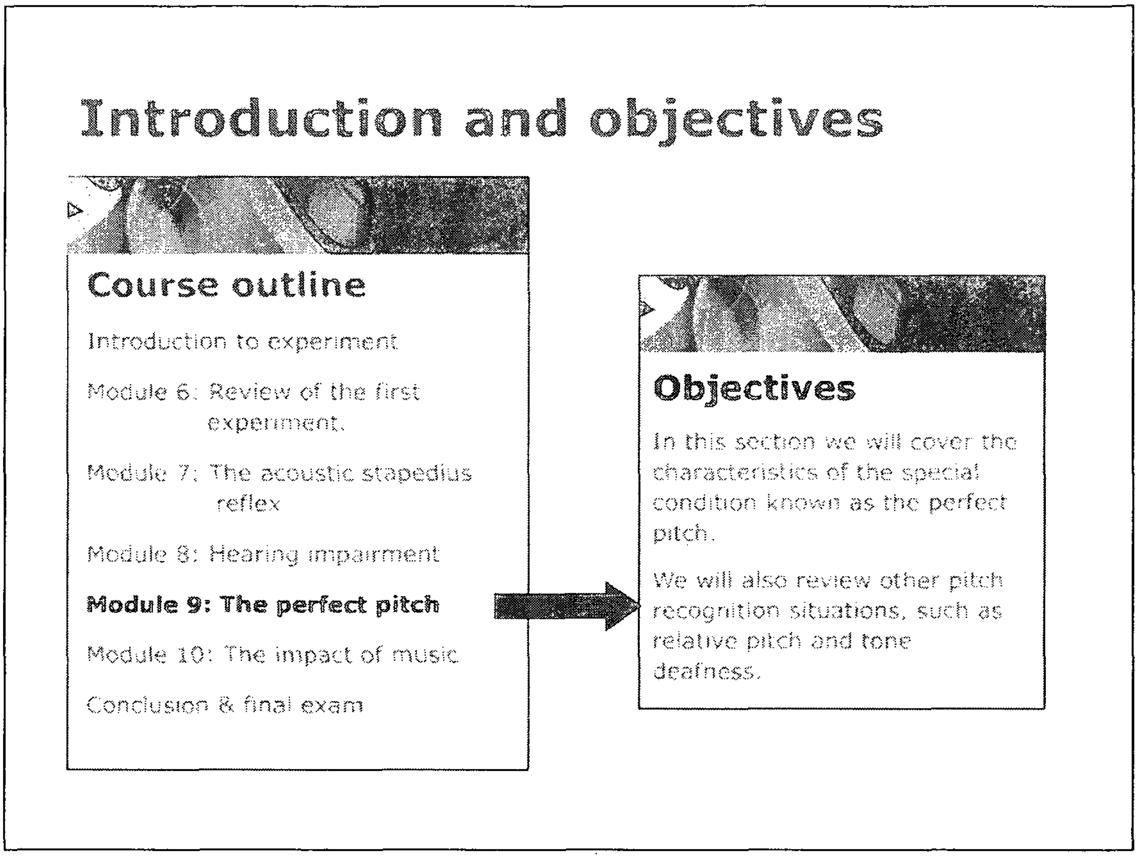
Module 7: The Acoustic Stapedius Reflex

Module 8: Hearing Impairment

Module 9: The Perfect Pitch

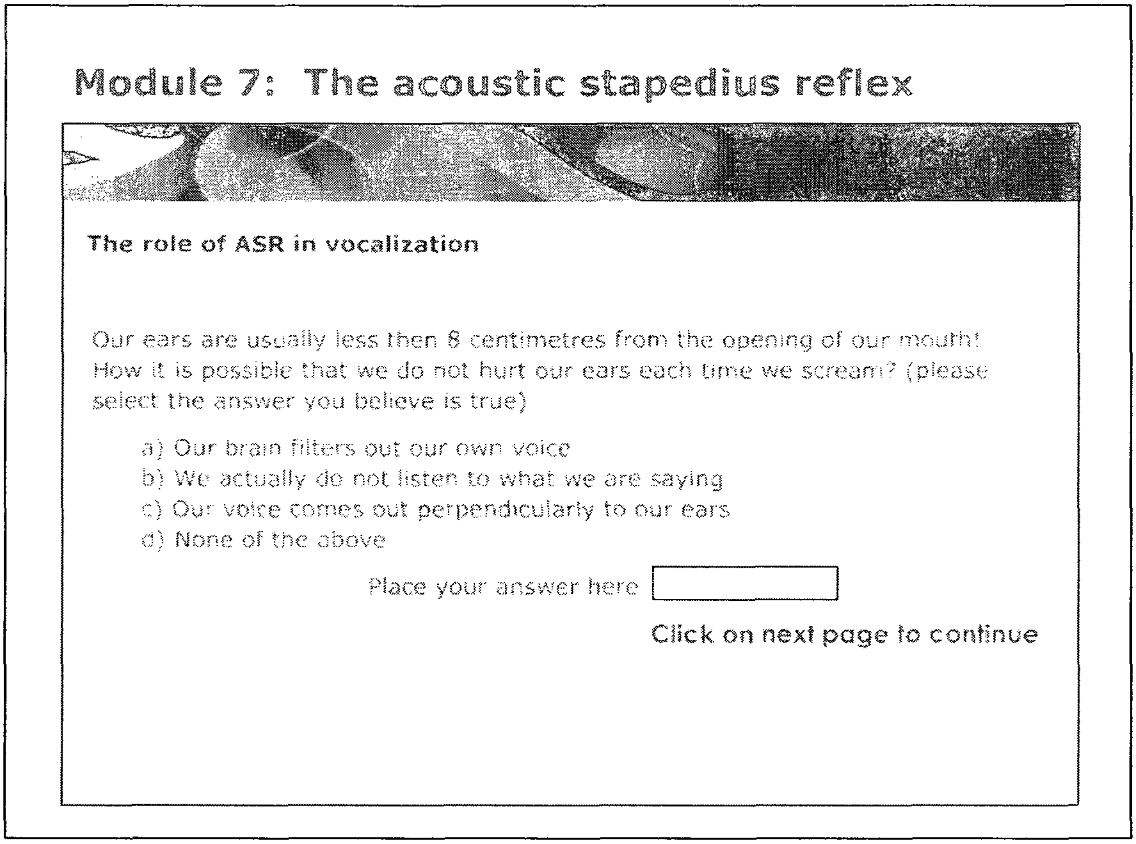
Module 10: The Impact of Music

Figure 4: Sample Table of Contents with Objectives Screen



All ten modules were composed of a title screen, a screen providing the table of contents and the instructional objectives of the module, and 10 to 12 screens of instructional content. In each module, 2 or 3 interactive questions were embedded in the instructional material (see examples of these pages in appendix A). In the instructional development process 6 to 7 post-test questions were developed for each of the modules.

Figure 5: Sample Post-test Question Screen



A paper version of the instructional content and post-test questionnaires was pilot tested with 4 potential participants from the sample population (2 participants from Communication Studies and 2 from the Educational Technology department). These participants were also asked to identify any ambiguities and errors while they were going through the modules.

As a result of the pilot testing, five pages were rewritten due to uncertainty generated about the material. Three questions were dropped from the 2 post-test questionnaires as they were found to be too ambiguous. The overall average result on the posttest was 71%. The results obtained in this pilot study increased our confidence that the material and post-test questionnaires would offer enough discrimination for the experiment (neither too hard, nor too easy).

Following the pilot test revisions, a final version of the instructional material was then produced to be used for online delivery. All the material was developed using Macromedia Flash (version 6). The material was then uploaded and integrated into the Strategia Ed Learning Management System (LMS).

Because the experiment was held online, it was not possible to standardize the computer or the browser used by the participants. A final round of technical compatibility testing was performed to insure that the material developed and the experiment would run on the multiple operating systems and the variety of web browsers that would be used by the target population. These tests were performed without any significant problems. The only technical issue identified was the incompatibility of the LMS software with certain settings of typical commercial firewalls. To compensate, we decided to include a notice in the package that would permit participants to reconfigure their firewall if needed.

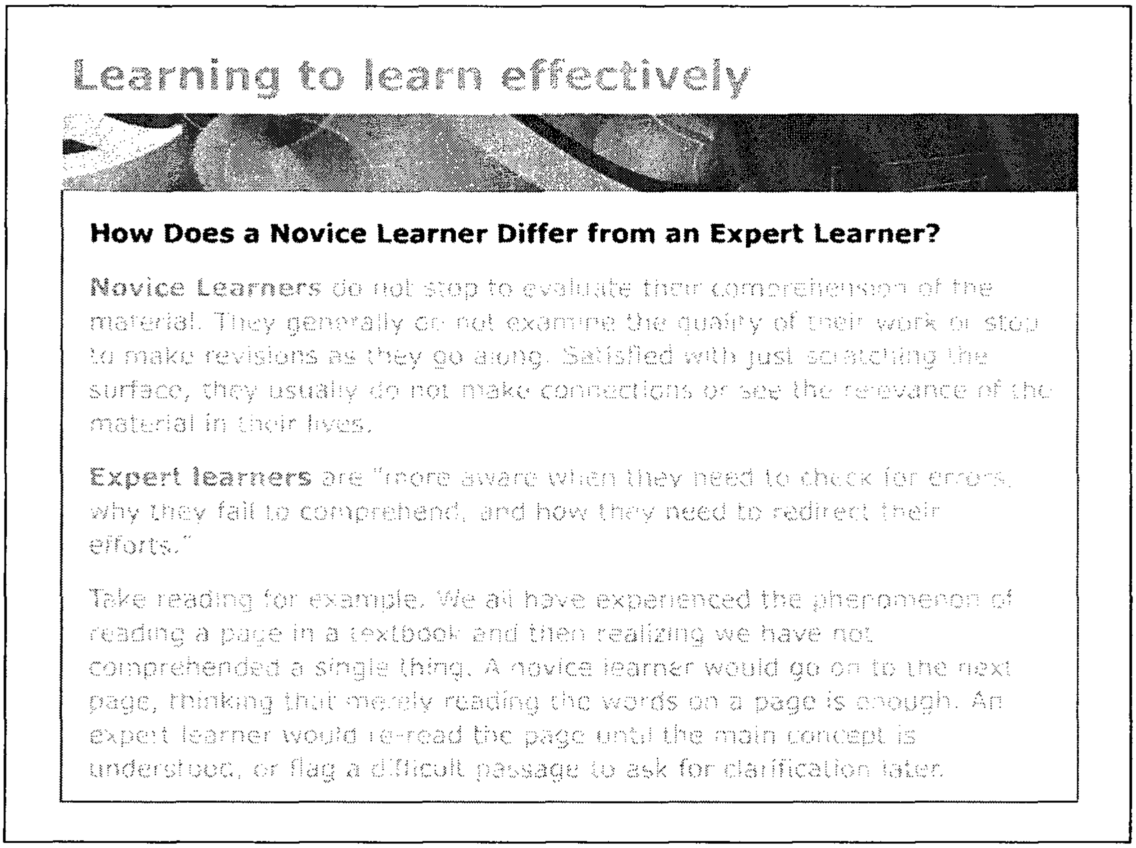
Treatment

All participants in the experiment were subjected to one of three levels of metacognitive information and activities to aid in comprehension and recall. All participants in the three treatment groups were exposed to the exact same instructional material and the same posttest questionnaires.

Treatment #1: Instructional Metacognitive Group

Participants in this group received a brief (7 screen pages) instructional package on how cognitive and metacognitive strategies should be applied during the completion of the online instructional tasks. Participants were then exposed to two 1-hour sessions of instruction (10 instructional modules in total) without any additional cognitive and metacognitive prompts.

Figure 6: Sample Metacognitive Activity Screen



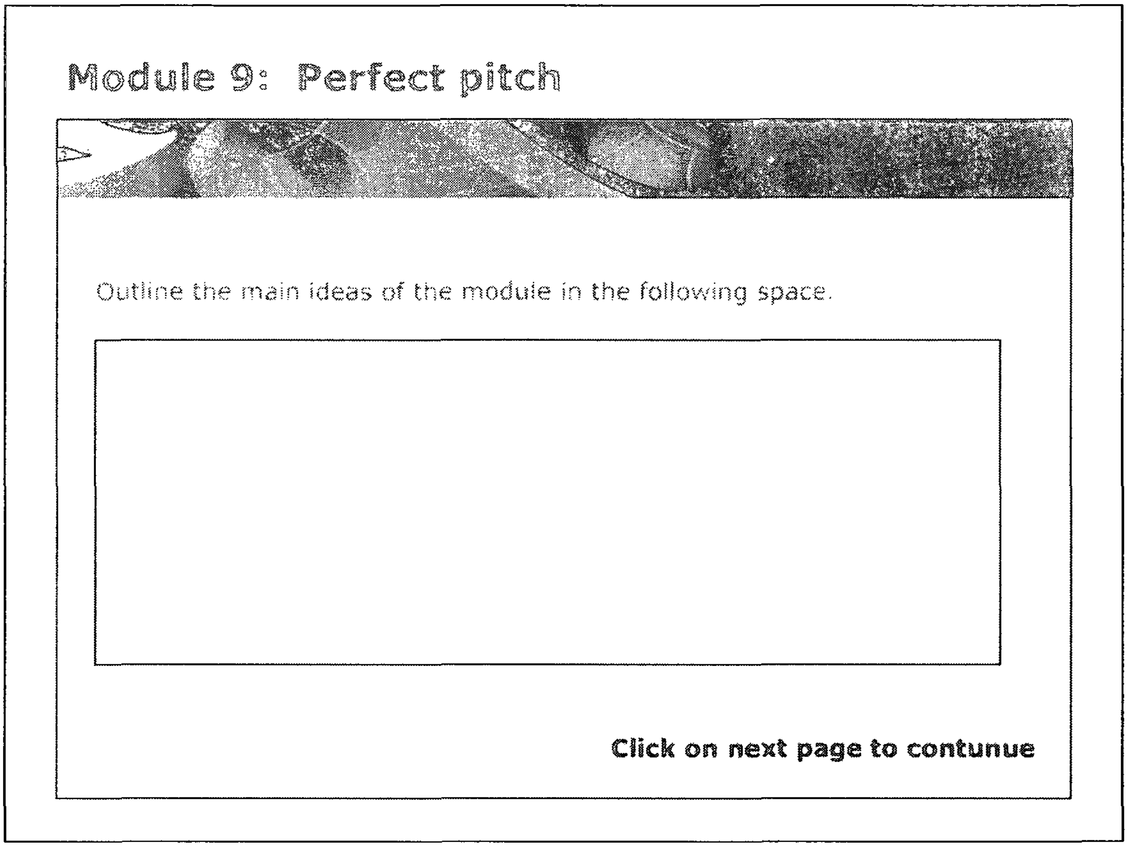
Treatment #2: Optional Metacognitive Activity Group

Participants in the second group received the same material as in the first but were prompted to use the introductory metacognitive strategies at the beginning of each session and at the end of each instructional module. In this treatment group, learning tasks were optional and participants were informed that they could be omitted if so desired.

The metacognitive strategies offered in this treatment group were based on the self-regulating learning model of Winne (1996) and included:

- identification of beliefs about the learning context
- identification of learning goals
- identification of motivational beliefs
- elaboration strategies (paraphrasing, summarizing ...)
- knowledge organization strategies (outlining general ideas)
- application of knowledge learned (providing examples of application)
- self-evaluation of performance and strategies used to learn the material

Figure 7: Sample Evaluation Screen



Treatment #3: Mandatory Metacognitive Activities Group

This group received the same treatment as the second treatment group, with the exception that participation in the metacognitive activities were mandatory.

Participation in the metacognitive activities were retained to allow further analysis and to verify participants actually performed the requested tasks.

Instrumentation

Many researchers are developing approaches and tools to evaluate the level and type of self-regulatory learning strategies used during instructional contexts. Self-regulated learning is a complex multifaceted and interconnected phenomenon, which draws from several theoretical fronts (Lindner, Harris & Gordon, 1996).

The measurement debate and how well it can be evaluated continues to provide abundant fuel for discussion between scholars. To select the most adequate tool for this experiment, all available self-regulated learning measures as presented in academic literature were reviewed. The amount of tools presently under development in this area reflects the strategic impact that self-regulated learning strategies can have in different instructional contexts. Out of the list first obtained, the four strategies the most documented in the literature were selected as follows:

***MAI* (Metacognitive Awareness Inventory)**

The Metacognitive Awareness Inventory (Schraw & Dennison, 1994) attempts to measure the concept of metacognitive awareness. In a study by (Hammann & Stevens, 1998), the MAI (a 52 item inventory) was found to be significantly correlated with predictions of performance test, test scores, and perceived accuracy of responses.

***MSLQ* (Motivated Strategies for Learning Questionnaire)**

The Motivated Strategies for Learning Questionnaire (Pintrich, 1991) attempts to measure motivation to learn and subsequently use learning strategies. The questionnaire is comprised of 81 items presented in a 7-point Likert scale. The motivation scale is divided in three motivation subscales, two expectancy subscales and a test anxiety subscale. The learning strategy component was made up of five cognitive/metacognitive subscales and four resource management strategy subscales.

The social-cognitive framework on which the MSLQ was founded proposes that motivation and learning strategies are not specific traits of the learner, but that they are active and contextually bound. It also proposes that learning strategies can be learned (Pintrich, 2000).

***SRLI* (Self-Regulated Learning Inventory)**

The Self-Regulated Learning Inventory (Lindner & Harris, 1992; Lindner, Harris & Gordon, 1996) is comprised of 80 self–reported items presented in 5-point Likert scale format. The inventory is divided into five subscales: Metacognition, Learning Strategies, Motivation, Contextual Sensitivity, and Environmental Control. Lindner & Harris (1992) reported a consistency coefficient ranging from 0.63 to 0.80 for the individual subscales.

***SESRL* (Self-Efficacy for Self-regulated Learning Scale)**

Bandura (1997) proposed that human behavior was mediated by self-efficacy, in other words, beliefs about the capacity to perform a given task or behavior. The Self-Efficacy for Self-regulated Learning Scale (Zimmerman, 1992) measures a learner's perceived capability to use a variety of self-regulated learning strategies. This 11-question questionnaire uses a 7-point Likert-type scale requesting answers ranging from not confident at all to completely confident on self-efficacy learning issues. This tool was developed for middle school students in Rome, New Jersey. Kennedy (1999) reported an internal consistency reliability coefficient of alpha at 0.95. On subscales the coefficient alpha ranged from 0.72 to 0.88.

Choosing between the available tools

According to Vispoel & Chen (1990), there is no single self-efficacy measure that is appropriate for all studies and instructional contexts as the development of self-efficacy measures is very context dependent. Our goal was therefore to determine which of the tools available would be best suited for the experiment.

According to Ertmer & Newby (1996), the MSLQ measures mainly strategies used within a specific course of study. The SRLI assesses the learner's general strategy use. Even if the performance on these two measures are highly correlated ($\underline{r} = 0.612$, $p < 0.005$), some difference in performance may be attributed to the difference in focus of each of these tools.

The MAI mainly focuses on metacognitive awareness, and less on the actual application of cognitive skills in a given learning context. The Self-Efficacy for Self-regulated Learning Scale has also limited experimental history.

Out of the four measures examined, the SRLI was selected as it appeared to be the best adapted to the goals of the experiment. The SRLI also provided good documentation on how to use the tool. Earlier studies using SRLI have also demonstrated that there is significant relationship between self-regulated learning as measured by this instrument and GPA (Lindner, Harris & Gordon, 1996). The fact that it focused on the general strategy of learners clearly differentiated it from other instruments and more aligned with the experimental setting of this research.

Once the instrument was selected, the questionnaire was integrated in the LMS so that it could be administered at the beginning of the first trial of the experiment. This approach had multiple advantages in the automation of the experiment. This included the automatic compilation of the results obtained (that was nonetheless double checked manually) and automatic matching of results obtained by participants. This was accomplished through a transparent integration of the SRLI into the LMS as one of the activities of the program. A copy of the SRLI questionnaire use in this study is available in appendix B.

Procedure

Running an online experiment is challenging under the best of conditions. Recruiting and managing participants in this context requires patience and method. In this section, the different activities that were planned and delivered in the management of this experiment will be elaborated.

The first step in the process was to make presentations in running courses to recruit participants. Over the period of two months, 13 presentations were made to solicit participation. In each of these presentations, the following elements were covered (following an established script) to make sure that all the participants receive the same information:

- A short explanation of the context of the study. It was mentioned that it was part of a Ph.D. dissertation requirement, but no specific information about the purpose of the experiment was divulged other than for research about online education.
- A brief description of the time commitment (available for two online sessions of about 1 to 2 hours over a 2-week period) and the technical constraints of

participation (a computer with an Internet connection running a recent version of the most common web browsers).

- A description of the incentives available for participating in the experiments. In this case, all the participants that completed the experiment received their choice of a downloadable song provided graciously by a local Internet provider. All participants were also entered in a drawing where one of three cash prizes and one of five books were to be won.

When a participant accepted to take part in the experiment, he or she was provided with an approved consent form (in compliance with the published standards of research and ethics of Concordia University). A copy of the consent form appears in appendix C.

Once a participant returned a signed consent form, they were registered on the LMS and randomly assigned to one of the three treatment groups. We attempted to generate random assignments with a computer program. The results obtained (200 random numbers) were slightly skewed toward one group. To avoid this, it was decided to manually do the random assignment of the participants. Three identical numbered poker chips (with a 1, 2 or 3 written on them) were placed in bag. For each participant, a chip was drawn from the bag providing the assignment to the treatment group. The chip was then returned to the bag for the next participant assignment.

An automatic email was then sent to each participant with instructions on how to access the online system. This included the URL address of the experiment, individual usernames and passwords, the log-in procedure and the contact information of a help desk if the case of technical. Six participants had difficulties logging into the system. The login problems were all related to a specific firewall configuration on the participant's computer and resolved within 24 hours. Participants were also reminded that they should not discuss the experiment (either the content or procedure) until notified by the experimenter that the experiment had been completed.

If a participant did not log in the LMS within 2 days of the initial email, a reminder was sent every two days. After two reminders, any participants who did not login were subsequently dropped from the experiment and no further communication attempts were made.

In the first trial of the experiment, all participants were asked to complete a Self-Regulated Learning Inventory (SRLI) composed of 80 self–reported items (Lindner & Harris, 1992; Lindner, Harris & Gordon, 1996). Once completed, participants were directed to a brief instructional module (five to ten minutes) on how to use metacognition to enhance learning. Once completed, participants were directed to the five content modules. All 3 groups were exposed to the exact same instructional content. The only difference was that two of the three groups were alternatively exposed to the self-regulating activities before or after each of the instructional modules. The final activity was the completion of a 32 question post-test on the material included in the five instructional modules.

If a participant did not complete all the required activities of first trial, they were also dropped from the experiment. An email was sent to these participants to explain the situation and to thank them for their partial participation.

Five days after completing the first trial of the experiment, an email was sent to the participants, inviting them to do the second trial of the experiment. This email also included the login procedure and the individual username and password. As with the first trial, if a participant did not log in the LMS within 2 days of the invitation email, a reminder was sent every 2 days to remind them of the experiment and after two reminders, dropped from the experiment.

Once participants were logged in for the second trial, there were transparently directed to their assigned treatment group (same as trial one). In the second session, all participants were exposed to five new modules of instructional material and were asked to complete a 33-question post-test.

If a participant did not log in to the second trial of the experiment or if all required activities were not completed in the second trial, a final email was sent to explain the situation and to thank them for their partial participation.

Recruiting presentations were done until the targeted minimum number of participants was reached for each treatment group. All participants that had already begun the experiment in trial one or two were allowed to complete the experiment and be part of the final result.

A final email was send to every participant to thank them for their participation and included a one-paragraph explanation of the experiment. In this email, they were also provided with the names of the drawing winners and how the downloadable song could be claimed.

Since time on task can be a critical factor when delivering self-paced instructional material over the Internet, specific time on task was tracked during the experiment. The time spent on the following activities were individually monitored and kept:

- time on the SRL inventory questionnaire
- time on the instructional package on metacognitive skills
- time on the instructional material
- time on the posttest

CHAPTER 4

RESULTS

Participants

As described in the procedure section, a total of 129 participants took part in the online experiment. To improve treatment validity, participants that did not complete all assigned tasks of the experiment (for example, failed to respond to post-test questions) were rejected from the sample. In all, five participants were rejected from the first trial of the experiment, and no participants were rejected in the second trial of the experiment.

As illustrate in Table 2, rejected participants were in two of the three treatment groups: the Instructional Metacognitive Group (first treatment) and the Mandatory Metacognitive Activities Group (third treatment). The relative amount of participants that were rejected due to lack of experimental compliance was less than 4% of the original sample.

Table 2: Sample Distribution (including distribution of rejected participants)

Group	Number of Participants rejected in Trial 1	Number of Participants that completed Trial 1	Attrition between Trial 1 and Trial 2	Number of Participants that completed Trial 2	Number of Participants rejected in Trial 2
1	2	42	14	28	0
2	0	42	14	28	0
3	3	40	11	29	0
All groups	5	124	39	85	0

In the first trial, participants were continually recruited until all treatment groups reached a minimum of 25 members. Since participants were randomly assigned to conditions, this resulted in treatment groups with uneven numbers of participants per group, but consistent with typical random distributions. In the first trial, group size ranged from 40 to 42 participants and in the second trial, treatment group size varied from 28 to 29 participants per group.

The second trial of the experiment was administered 7 to 12 days after the completion of the first trial which allowed participants to drop out between the two trials of the experiment. Because of the relative independence of the content between the two trials of the experiment, participants that dropped out after completing the first trial were kept in the analysis of the first trial. In this regard, the aggregate of the two trials of the experiment was not a repeated measure design.

As demonstrated in table 3, the drop rate between trial one and two of the experiment was fairly high. An average 31% of participants that completed the first trial of the experiment failed to participate in the second trial. When contacted, most of the participants mentioned the lack of available time or motivation as the key factor explaining their dropping out. For this reason, out of the 124 participants that completed the first trial of the experiment only 85 successfully completed the second trial.

The percentage of the dropouts between the different treatment groups was fairly evenly distributed, ranging between 27.5% to 33.3%. Because of the sample size and the relative difference between groups, the dropout factor was not considered significant. However the impact of the high level of dropouts *between* the two trials of the experiment may be of concern and will be addressed in Chapter 5 - Discussion.

Table 3: Dropout Distribution Between Trials of the Experiment

Group	Number of Participants that completed trial 1	Number of Participants that completed trial 2	Percentage of participants dropped from the experiment
1	42	28	33.3%
2	42	28	33.3%
3	40	29	27.5%
All groups	124	85	31.5%

The covariate

There are three basic reasons to use a covariate in this type of experiment. First, a covariate can be used to reduce the variability in the dependent measure so that it will be easier to find between groups significant results. Secondly it will also allow to correct groups estimated means after the effect of the covariate is removed. Finally the results obtained with the covariate will allow us to investigate the treatment by covariate interaction (Stevens, 2002). The presence of a treatment covariate interaction (TCI) could indicate that the treatment has a differential effect on different individuals in the targeted population (Cronbach & Snow, 1977).

In this experiment, the Self-Regulated Learning Inventory (SRLI) scores were used as a covariate. The descriptive statistics obtained and presented in table 4 indicate that the random assignment was fairly successful on confirming the covariate factor. The three groups displayed very similar means and standard deviations.

Table 4: Descriptive Statistics – SRLI Covariate Measure

Group	Mean	Standard Deviation	N
1	264.81	32.55	42
2	264.12	33.86	42
3	269.83	32.46	40
Total	266.19	32.80	124

A preliminary step in the analysis of the covariate was to determine if the covariate used was a predictor of the final performance of the participants (the first hypothesis of this experiment). The reliability results of the SRLI as a covariate was very high (Cronbach's Alpha of 0.93 and higher was obtained).

The following table provides the group performance results ($p > 0.05$) on the use of the SRLI as a covariate.

Table 5: Summary ANOVA (Group results across SRLI)

Source	Type III Sum of Squares	df	Mean Square	F	P
Between groups	478.15	2	239.08	.190	> 0.05
Within groups	103428.60	82	1261.32		
Total	103906.75	84			

Reliability analysis was also performed on each of the treatment groups to determine if there was a differential effect. As demonstrated in the table below, SRLI scores provided consistent prediction of the participant's final performance for all treatment groups in the experiment. The data obtained indicates a significant correlation between the SRLI scores and performance scores.

Table 6: Reliability Statistics of the SRLI Covariate

Groups	Cronbach's Alpha	Number of Items
All groups	0.930	80
1	0.928	80
2	0.935	80
3	0.932	80

As mentioned earlier, one of the main objectives in the covariate analysis was to determine if the covariate could explain some of the variance in the experiment. Even if statistical reliability results provided a very good fit with performance, the results from ANOVA did not explain enough of the variance to be kept in the experiment. By comparing the sum of squares obtained from ANOVA with and without the SRLI scores, we found that the covariate explained very little of the variance in the equation (the sum of squares was 756.404 with the covariate versus 754.943 without).

To confirm these findings, the covariate results were also recoded into four equal number groups to determine if a block approach would provide significant results.

Because of the difference in sample size in the two trials of the experiment, two separate analyses of variance were performed using SRLI results, compared to the post-test results of both trial 1 and 2. Both of these analyses provided no significant results ($p > 0.05$). The following two tables provide the summary results obtained from these analyses.

Table 7: Summary ANCOVA (Group results Trial 1 with Covariate included)

Source	Type III Sum of Squares	df	Mean Square	F	P
Group * Covariate	180.996	2	30.166	1.343	> 0.05

Table 8: Summary ANCOVA (Group results Trial 2 with Covariate included)

Source	Type III Sum of Squares	df	Mean Square	F	P
Group * Covariate	121.997	2	20.330	0.594	> 0.05

Considering prior results, it was determined that covariate analysis brought no additional value to the study. However covariate analysis did allow to recuperate one degree of freedom in the analysis of variance.

Test of the design

Preliminary analysis of the performance results showed fairly small yet consistent patterns of results. Under similar experimental conditions, it is possible to observe that the mandatory metacognitive activity group (group 3) outperformed the two other groups in both trials of the experiment. The same pattern can be observed for the optional metacognitive activity group (group 2), as it outperformed the condition that had no embedded SRL strategies (group 1) in both trials of the experiment. The following two tables provide the descriptive statistics for each of the trials of the experiment.

Table 9: Descriptive Statistics - Dependent Variable (Trial 1)

Experimental groups	Mean	Standard Deviation	N
1	19.21	5.59	42
2	20.00	5.37	42
3	22.40	4.37	40
Total	20.51	5.28	124

Table 10: Descriptive Statistics - Dependent Variable (Trial 2)

Experimental groups	Mean	Standard Deviation	N
1	21.36	7.88	28
2	24.04	4.24	28
3	25.45	4.69	29
Total	23.64	6.00	85

As illustrated in table 11 the effect size (Cohen's D) for the different group comparison and trials in the experiment, there is a medium effect and consistent effect size between group 1 and 3 in both trial of the experiment. Other group comparisons do not offer consistent nor strong effect size.

Table 11: Effect Size (Cohen's D)

Comparison	Trial 1	Trial 2
Group 1 vs. Group 2	0.144	0,442
Group 2 vs. Group 3	0,493	0,316
Group 1 vs. Group 3	0.641	0,651

Since the covariate measure was removed, a one-way ANOVA combining the results from both trials was performed to determine if there were any significant differences between treatment groups. The results in the following table indicate significance between groups ($p < 0.05$).

Similar results were obtained when individual analysis of variance was performed on each of the trials of the experiment (see table 12 for trial 1 and table 13 for trial 2). Again, results of the analyses indicated significant differences between groups ($p < 0.05$) in each of the trials of the experiment.

Table 12: Summary of the Analysis of Variance (Trial 1 Results Only)

Source	Type III Sum of Squares	df	Mean Square	F	P
Group	224.321	2	112.160	4.232	<0.05
Error	3206.671	121	26.501		
Total	3430.992	123			

Table 13: Summary of the Analysis of Variance (Trial 2 Results Only)

Source	Type III Sum of Squares	df	Mean Square	F	P
Group	245.129	2	122.564	3.621	< 0.05
Error	2776.565	82	33.831		
Total	2921.694	84			

Further comparisons were performed using Tukey HSD. The results revealed that only one of the possible comparisons was significantly different ($p < 0.05$). Group 3 (Mandatory Metacognitive Activities) significantly outperformed Group 1 (Instructional Metacognitive).

Table 14: Summary of Analytical Comparisons Using Tukey HSD with Trial 1 Results

Source	Mean difference	Standard error	Sig.	P
Group 1 VS Group 2	-0.79	1.12	0.764	>0.05
Group 1 VS Group 3	-3.19	1.14	0.014	<0.05
Group 2 VS Group 3	-2.40	1.14	0.088	>0.05

Table 15: Summary of Analytical Comparisons Using Tukey HSD with Trial 2 Results

Source	Mean difference	Standard error	Sig.	P
Group 1 VS Group 2	-2.68	1.56	0.203	>0.05
Group 1 VS Group 3	-4.09	1.54	0.026	<0.05
Group 2 VS Group 3	-1.41	1.54	0.632	>0.05

By comparing the results, the data revealed that the level of significance between groups 1 and 3 slightly diminished from trial 1 to trial 2, but that the conclusions of the analytical comparisons remained the same.

The results obtained by the second group (Optional Metacognitive Activities) generated additional questions. An additional analysis was performed on the second group to determine if the number of metacognitive activities performed by participants might have been the significant factor in the results obtained.

To test this hypothesis, the participants of this treatment group were reassigned to three subgroups on the basis of the number of metacognitive activities they performed out of the total of 12 (six per trial of the experiment). Participants that completed two of the six activities (or less) were reassigned to group 2A. Participants that completed three to four metacognitive activities were assigned to group 2B, and finally the participants that completed five or more metacognitive activities were assigned to group 2C. Separate analyses were performed for each trial of the experiment to determine if participation and results were different over time. The following tables provide the descriptive statistics obtained by the reclassification of the participants of the second group.

Table 16: Descriptive Statistics (Trial 1) – Group 2 Reassigned on the Basis of the Number of Activities Completed

Experimental groups	Mean	Std. Deviation	N	% of N total
2A	18.50	6.28	10	24
2B	18.87	4.22	15	36
2C	21.88	5.45	17	40
Total	20.00	5.37	42	100

In the first trial of the experiment, participants of this second group are fairly well distributed in their level of participation to metacognitive activities. The results obtained are also consistent with the general results obtained in the experiment. The performance results slightly increase, as the number of metacognitive activities is increased.

Table 17: Descriptive Statistics (Trial 2) – Group 2 Reassigned on the Basis of the Number of Activities Completed

Experimental groups	Mean	Std. Deviation	N	% of N total
2A	23.59	4.50	17	61
2B	27.00	3.46	3	11
2C	23.88	3.91	8	28
Total	24.04	4.24	28	100

The distribution obtained in the second trial of the experiment was skewed towards group 2A (two or less activities). More than half of the participants did not participate actively in the metacognitive activities during the second trial. The mean obtained by group 2B significantly outperformed the other 2 subgroups, but only 3 participants were in this subcategory. With a sample size so low, it is difficult, if not impossible to draw reasonable conclusions.

Other variables investigated

Other possible confounding variables were also evaluated. Time on task, participant's gender and level of study (graduate versus undergraduate) were investigated to determine if any of these variables could have influenced results. In all three cases, the analysis showed that these factors did not influence significantly to the performance result obtained ($P > 0.05$).

Summary of the results

In summary, 129 participants took part in the online experiment. 124 completed the first trial and 85 completed both trials of the experiment. The following results were obtained:

- The percentage of the dropouts between groups was fairly evenly distributed, ranging between 27.5% to 33.3%.
- Even if statistical reliability results were fairly high, the results from the analysis of variance showed that the SRLI did not explain enough of the variance to be kept as a covariate.
- A one-way ANOVA was performed and the results indicated significance between groups ($p < 0.05$).
- Further comparisons were performed indicating significant results and consistent effect size between group 1 and 3 in both trials of the experiment.
- Further analysis was performed on the second group to determine if the number of metacognitive activities performed might have been a factor. No significant results were obtained from this analysis.

CHAPTER 5

DISCUSSION

This study inquired into the following three research questions: (A) Is there a significant and consistent correlation between the self-regulated learning measures (SRL) and performance measures? (B) Will participants who are exposed to metacognitive embedded activities obtain significantly better results than others? (C) Can participants exposed to mandatory embedded metacognitive activities obtain significantly better results than those exposed to the optional embedded metacognitive activities?

In this section, the results obtained in this experiment will be discussed. In addition to the three experimental hypotheses, the secondary data that was uncovered in the analysis of the results will also be discussed.

The predictive value of the SRL measure

For the first hypothesis, the relationship between the selected Self-Regulated Learning (SRL) measure and the performance obtained on the posttest for both trials of the experiment were tested. Even if the reliability results obtained by Self-Regulated Learning Inventory measure (SRLI) in this experiment were impressive (Cronbach's Alpha of 0.92 and higher), result obtained were counter to expected outcomes. The SRLI measure used as a covariate did not explain enough of the variability in the experiment nor did it correlate with the outcome measures in the experiment. The results of Pearson's correlation coefficient confirm this finding. The link between the two measures in trial 1 was fairly low $r = .26$, $p > .05$. Coefficient in trial 2 show even less correlation between the two data set $r = .16$, $p > .05$.

There are a few potential explanations for the discordance between the SRL measure and the performance results. First we need to consider that these measures might actually be measuring different things. The SRL measure is mainly focused on the process of metacognition. In the literature it often obtains very high correlation with more global measures like cumulative grade point averages (GPA). The performance measure on the other hand, was mainly focused on content and how well the participants could understand and remember them. If we take Bloom's taxonomy (Bloom, 1956) as a point of reference, the multiple-choice questionnaires evaluated the "knowledge" and "comprehension" levels of the participants as they were mainly concerned with the recall or recognition of specific facts, procedural patterns, and concepts. The SRL measure on the other hand, mainly focused on more executive processes that could be identified to the "analysis", "synthesis" and "evaluation" categories of Bloom's taxonomy. This difference in focus may help explain the lack of correlation between dependant variable and the performance measure used in each of the treatments.

Further investigation is required to better understand how SRL measures could be linked to immediate performance requirement and why the results obtained are not aligned the results previously obtained with SRL measures and inventories (Duncan & McKeachie, 2005; Lindner & Harris, 1992).

Another potential cause for this lack of results might also be found in the sampling methodology used in the experiment. Because the sample was composed of undergraduate and graduate students, the sample could have been skewed towards more motivated or self-regulated individuals. Furthermore, the fact that the experiment was held online might also have contributed to this situation as participants that elected to participate and stay in the experiment are also more likely to be more motivated and self-regulated individuals.

Other researchers are already attempting to obtain finer grained results by looking at the different subscales they integrate (Duncan & McKeachie, 2005; Sperling, Howard, Staley & DuBois, 2004). For example, the interrelation between motivational and cognitive factors has been suggested by researchers like (Pintrich, 2000) who have underlined the importance of the dynamics between motivation and cognition in learner performance. Motivational components include learners' perceptions of the learning environment and self-perceived beliefs. Cognitive factors may consist of learners' content knowledge as well as a variety of cognitive learning strategies.

The use of SRL measures and inventories offers not only a broad potential for future research but many practical applications. Specifically, with the emergent trend towards online learning, the success of learners can be enhanced through the consistent use of self-regulation strategies. Researchers are just beginning to evaluate the impact of the variations in methods used to measure and implement SRL to advance theory about this central cognitive activity in learning. Winne & Perry (2000) strongly suggest that a multi-trait/multi-method framework and studies are needed to better understand the methodological variations in measuring SRL.

Finally, the participants that dropped out of the experiment might represent learners that could be portrayed as less motivated or display less self-regulating behaviours. Inversely, the participants remaining in the experiment might have displayed more self-regulation than would have been initially expected, again reducing the magnitude of the effect found with the SRLI. This might also partially explain the drop in the correlation results from trial 1 to trial 2.

Initially it was hypothesized that it would be possible to identify individuals that are more likely to have difficulty with online learning environments by using a SRL inventory tool. In this particular study, the raw data from the individuals that were dropped from the experiment was not saved. With more foresight, the SRL inventory results from the individuals who dropped out following the completion of the first trial of the experiment should have been kept. It would have then been possible to compare their results in order to determine if a correlation exists between low scores on this measure and cases of attrition. In this experimentation, it was not possible to experimentally verify this idea, but this insight warrants further investigation.

The effect of embedded activities

The second experimental hypothesis was to determine if learners exposed to metacognitive embedded activities would obtain significantly better results than those who do not. The results obtained by the embedded treatment groups have been consistent and well aligned with our second hypothesis. The two groups that participated in the embedded metacognitive activities outperformed the single group that did not, but the magnitude of the responses obtained was not as significant as we had expected based on our initial assumptions.

It is necessary to explain why only one of the experimental comparisons showed significant differences. Only the mandatory metacognitive activity group (Group 3) and the instructional metacognitive group (Group 1) showed any significant difference. Even if the results obtained provided the right directionality and are perfectly aligned with our hypotheses, based on our analysis it would be imprudent to assume that the sole use of embedded SRL activities was a significant factor.

The fact that the same results were obtained in each of the two trials is also promising, but the level of the effect achieved does not allow deeper conclusions to be drawn. However, the outcome warrants further investigation.

To further explain the not significant results obtained by Group 2 (optional metacognitive activities), it was hypothesized that since the participants had a choice, the ones that chose a greater variety of metacognitive activities would also exhibit enhanced results on the performance measures. The additional analysis did not support this assumption. Even if the participation distribution was skewed towards less participation (17 participants out of 28 in group 2A), the results did not show significance in either direction. Individuals that completed only a few metacognitive activities achieved almost the same results as the ones that completed more activities. Since two out the three groups had very low participation after the recoding (Group 2B with 3 participants and Group 2C with 8), it is not believed that these results would have been conclusive even if significant results had been obtained.

From the information gathered in this experiment, it is possible to suggest that the presence of optional embedded SRL activities does not stimulate participants enough to make them learn more effectively. In addition, the presence of embedded metacognitive activities did not generate a large enough effect on the participants in the sample.

The impact of mandatory embedded SRL activities

In the third hypothesis, it was proposed that when the performance results obtained by the optional metacognitive activity (Group 2) and the mandatory metacognitive activity group (Group 3) were compared, there should be a significant difference. The performance data obtained was again perfectly aligned with this hypothesis, but the size of the effect between the two groups was not large enough to be conclusive. These results were again consistent in both trials of the experiment. There is no choice but to conclude that by itself, the inclusion of mandatory embedded SRL activities did not provide a significant effect.

Strength of the effect obtained

In this experiment, there is an interesting paradox as the results were a perfect fit with the different hypothesis proposed, yet none of the group comparisons originally proposed in the hypotheses were significant. This suggests that the strength of the effect (or the combined effects) may be too small to be registered by the chosen analytical tools.

There are many factors that might explain the small effect size. One obviously would be that the effect itself is small or inexistent. The consistency and the directionality of the results suggest that there is an effect as the data are perfectly aligned with the hypothesis. In the absence of an effect, more random results would have been expected. The relatively small sample size in educational research, such as in this study can also be a factor to consider. Clearly, if an effect size is calculated from a very large sample it is likely to be more accurate than one calculated from a small sample (Olejnik & Algina, 2000).

Another possible explanation for the weakness of the effect could be found in the sample that was use in the experiment. The assumption was that individuals exposed to metacognitive activities embedded in an instructional activity would achieve significantly higher learning performance scores than individuals who did not. However if the sample participating in the experiment were already effective self-regulated learners, the distribution could be skewed, and at the same time minimize the effect size obtained.

By selecting volunteer undergraduate and graduate students and eliminating drop outs, the experimental design could have encouraged the retention of participants that were highly motivated and therefore more likely to demonstrate SRL behaviours. This could be another factor that might explain the reduced strength of the effect obtained. With the available data, it would not be possible to verify this hypothesis, however it would be an avenue worthy of further investigation.

Combined effect of mandatory embedded SRL activities

An interesting outcome of the experiment was the result obtained by a combination of embedded activities that were also mandatory. The combined effect of these two factors was one of the key elements uncovered in this research.

It has been proposed that learners might not always use regulating strategies even if they are aware of such strategies or even if they are consistently offered embedded in the instruction (Elen & Clarebout, 2006). The results of this experiment clearly show that when learners are required to engage in SRL activities, they benefit from it. There is also evidence that effectively supporting the use of the regulating activities is being investigated more broadly in recent researches on self-efficacy, work avoidance and procrastination (Meijer, Veenman & van Hout Wolters, 2006; Wolters, 2003).

Recent discussions in the literature (Howard, Clark & Early, 2006) also suggest that we should pay more careful attention to the unconscious and automated aspects of the process involved in cognition and self-regulation. This might also explain some of the discrepancies between the optional and mandatory treatment groups in this experiment. Learners in the SRL optional group might not have valued the importance of using metacognitive activities as they might have used previously acquired strategies unconsciously and automatically.

Motivation and how it was built in the experimental procedure might have been another contributing factor to consider more carefully. The adoption of and the engagement in self-regulated learning behaviours appears to be directly linked to the perception of the importance of the task to be accomplished (Pintrich, 2000). It was assumed that participants decoded the importance of the learning content by the way it was presented in the instructional treatment. Making an activity mandatory might have suggested to the learner that the activity is important, thus triggering more attention and engagement. The reverse might also hold true, as making an activity optional might have indicated that the activity is less important. Further analysis of these variables might provide interesting insights on how learners interpret these cues.

This is coherent with the arguments of researchers like Salomon (2006) that propose that it might be difficult to determine the net contribution of a single variable in the learning process. Effects are often the result of multiple factors and interactions. This experiment might provide a demonstration of this complexity as only an aggregate analysis of multiple factors provided significant results. Many authors and researchers in the current literature suggest that metacognition and self-regulation are complex behaviours that cannot easily be broken down in more discrete factors (Elen & Clark, 2006; Mayer, 2006).

The information gathered on this combined effect is promising but still preliminary. A more focused experimental setting would be required to determine if this effect can be replicable and if it can be applicable in other context or to broader populations.

The effect and limitations of online experimentation

Very little has been written on the subject of running online experiments in the literature, yet the demand to better understand the implications of online environments is growing rapidly. The complexity and challenges of running an online experiment are important factors that we gradually uncovered in this experiment. Initially it was decided that this study was to be done completely online to preserve a certain ecological validity of the experiment. The desire was to replicate many of the factors that a learner would typically encounter while learning online. The result was that the use of a less structured experimental environment produced some important by-products that need to be considered for future research.

From the beginning of the process, the recruitment of participants and the management of attrition were a factor of concern. Online experiments offer less control over the conditions of participation of the participants, and therefore appears to facilitate dropping out. As a result one third of all participants eventually dropped out during the study.

It was previously discussed that attrition might actually skew the sample to exclude participants that are less motivated. In this experiment, it is not clear that the high attrition rate made it more difficult to obtain significant results. However the level of attrition might be neutral or even beneficial as individuals that are less likely to perform well are eliminated. When compared to experiments where motivation is a central factor, the exclusion of dropouts might reduce the general variability on that factor, thus making it more difficult to find significant results.

Because online experiments are often administered over relatively longer periods of time, they become more fragile to experimental contamination. Information about the experiment becomes harder to control and environmental factors such as external class workload, exam periods or even vacations conspire to add complexity to the experimental process. While ecological validity is a desirable goal, it might also water down or interact with the magnitude of the effect to be observed. To compensate, random assignment of the sample only insured that the consequential factors were equally distributed, but did not prevent the overall effect to influence the results obtained. While there was no evidence of experimental contamination in this study, it remained a key concern throughout the process.

Finally, the efforts required to run an online experiment needs to be mentioned. The level of work and availability required to run and administrate online research required far more effort and time compared to a more controlled and traditional experimental setting. Notwithstanding the complexity previously mentioned about the recruitment of participants and management of drop outs, an online experiment also requires the setting up and testing of an online learning environment, the development of the online instructional material, as well as an extensive provision for technical support for the duration of the study.

Conclusion

There is a continuing debate about the effectiveness of online environments designed for learning and how metacognitive strategies can help support more effective learning in these environments (Azevedo, 2005). The present study has both theoretical and practical contributions to this debate. Theoretically this study supports the growing volume of research on the use of self-regulation in an instructional context. It also points out some novel elements not yet explored in the literature about self-regulation in the learning process. From a practical perspective, this study provides preliminary information on how self-regulation strategies can be integrated in online instruction and also offers some preliminary data on how effective these strategies could be.

SRL inventories continue to provide us with useful insight on learner behaviours in different instructional contexts (Winne & Perry, 2000). Their potential capacity to predict short and long term performance makes them useful tools, however better ways are needed to understand the multiple ways in which they may be potentially used. In the long term, SRL type inventories may provide guidance on how to adapt instructional environments and strategies to the needs of different learners.

In this study, the use of mandatory embedded metacognitive activities resulted in significantly better retention and performance scores. The outcomes obtained in this experiment are promising, although further investigation and replication is required to determine what are the operant factors in this effect.

The impact of making metacognitive activities mandatory is also supported in recent research on self-efficacy, work avoidance and procrastination (Wolters, 2003) and support the idea that learners may or may not use SRL skills depending on the learning task at hand. There is also a growing body of literature that supports the use of embedded activities and instructional approaches in the use of self-regulating behaviours (Elen & Clarebout, 2006).

An interesting feature in this study was the exclusion of several potentially mitigating factors, such as the level attained in formal education, gender and time on task. These factors did not appear to have any effect on the self-regulation of the participants in this experiment.

The future of SRL research is promising in that it may provide insights on how to make online learning and learning environments more effective. In an article by Perry & Winne (2006), they describe a computer program that goes even further in facilitating the measurement of self-regulated learning (SRL) over time and in different contexts.

Recommendations for further research

As previously discussed, this research probably raised more questions then provided answers. Many of the research questions that were attempted were not easily corroborated in the existing literature. In fact, instances of similar research could not be found at all. This is in agreement with a recent meta-analysis that demonstrates that self-efficacy measurement in online learning environments is typically limited to computer use and related technology anxiety and that current instructional design models are not well adapted to promote self-efficacy in asynchronous learning environments in general (Hodges, 2008). It is therefore possible to conclude that the potential for additional research in self-regulated learning from both a measurement and design perspective is vast.

The use of SRL inventories

In this research a standardized SRL inventory was automatically administered to the participants and the results were stored for later use. Furthermore, the results obtained here were consistent with results obtained in traditional learning contexts. The predictive potential of SRLI might be promising but the result obtained in this experiment raises multiple questions on the use and the application of these tools in an online context.

The fact that an integrated SRLI can provide insight on the performance of online learners opens a multitude of additional inquiry paths. First and foremost, there is an obvious need to replicate the experiment in other contexts in order to better understand the results obtained here.

Since the SRL inventory did not explain adequately the variance, it is also a factor that deserves further investigation. It is not known, for example, if the results obtained were caused by a highly skewed sample group or that the metacognitive activities introduced an effect that was independent of the SRL baseline differences in the sample. Only additional research can provide some of these answers.

In most online instruction, the assumption is that learners are considered equals when entering in a course. In most existing online environments, instruction is rarely adapted to support special needs or other identifiable differences inherent in some learners. The potential of using SRL inventories to provide information on how instructional designers could develop adaptive learning is very promising. This is an area that could offer many applications and well worth supplementary investigation.

The use of embedded metacognitive activities

A second direction for investigation is in the use of embedded metacognitive activities. Even if this research offers many promising outcomes and a few significant results in this area, the general directionality and structure of the results obtained strongly suggest that there are other operating variables at play. Further investigation and replication on the strategic use of embedded metacognitive activities must be performed.

Running online experiments

This research raised many questions about the inherent implications of running experiments in the less controlled context of the public Internet. For example, additional research would be needed to investigate the effect of attrition and how it may or not be skewing sample distribution and results.

A good deal of current research typically avoids less controlled contexts due to the inherent complexity in managing sample populations and other variables. However the proliferation of online learning, with more and more organizations adopting it in favour of traditional training approaches, it has become imperative that more research is done in this area. From an academic perspective this is a matter of ecological validity in authentic learning contexts, which means there is a significant need to develop research methodologies and relevant literature on the running of online experiments.

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APPENDIX A:

EXAMPLES OF THE ONLINE MATERIAL USED

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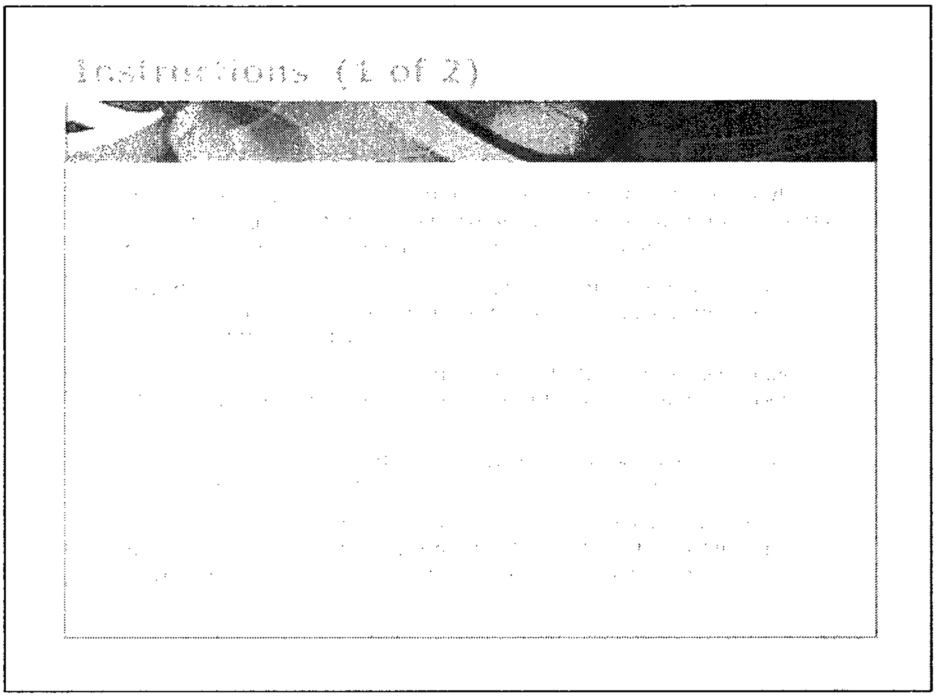


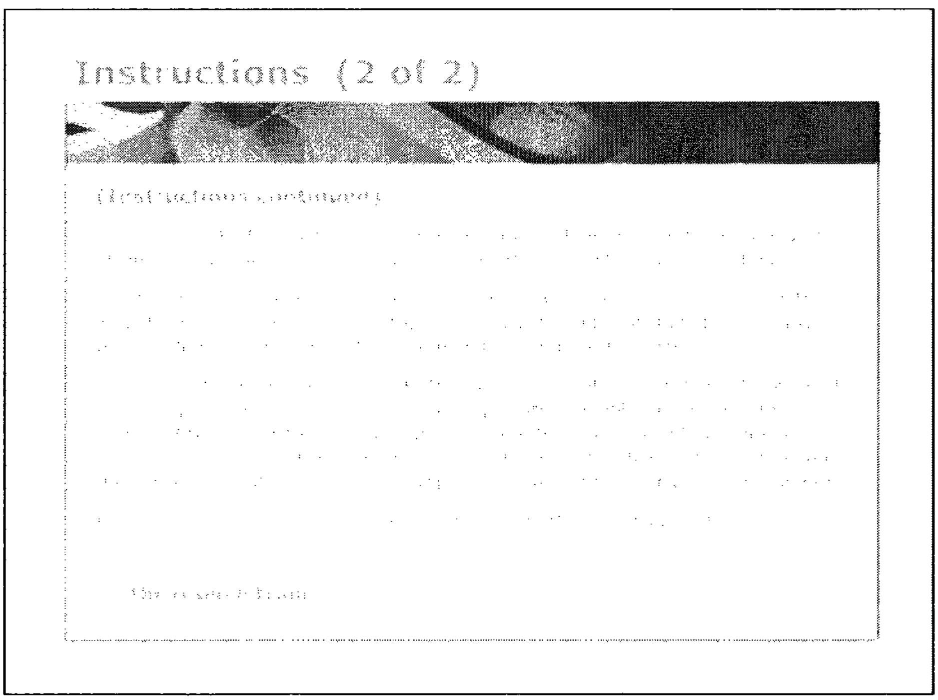
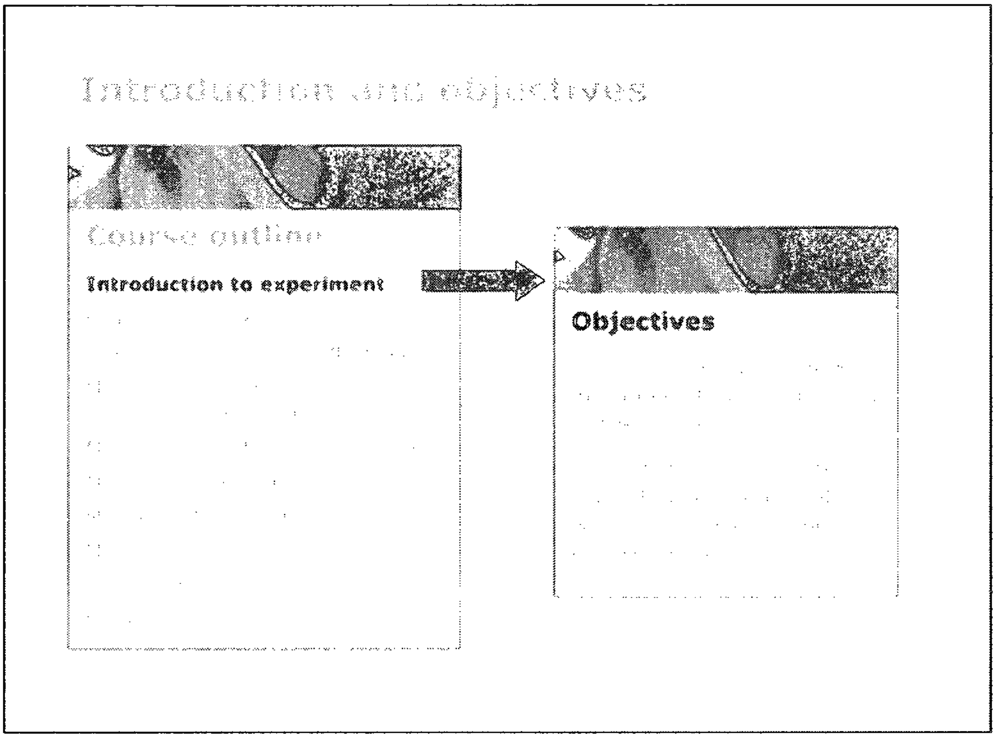
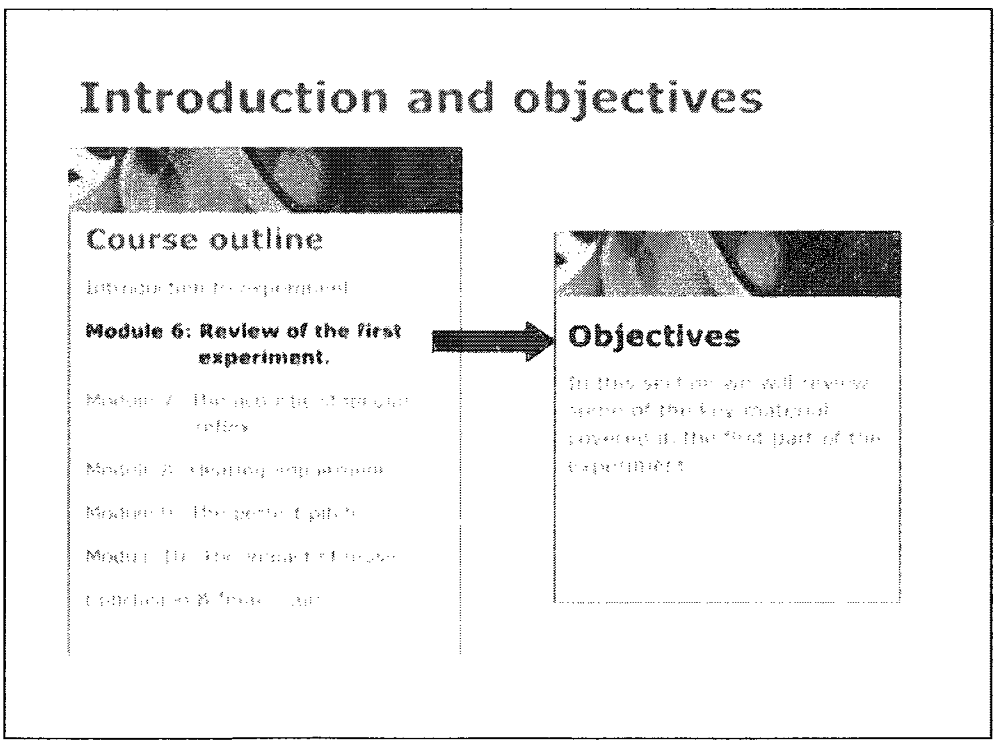
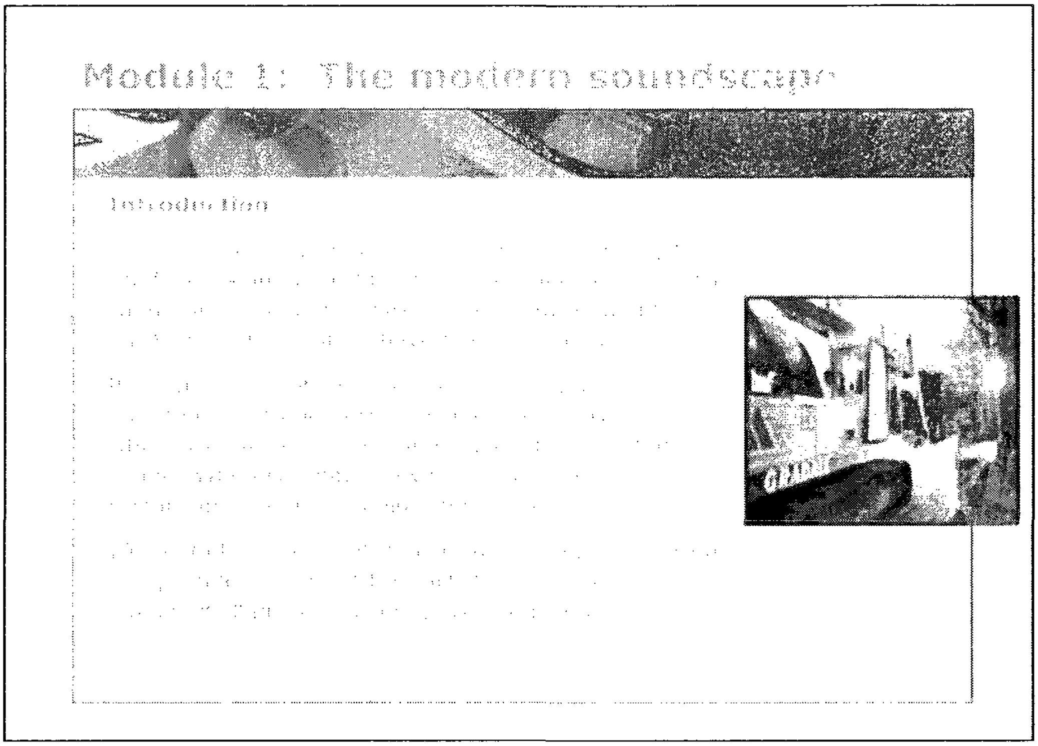


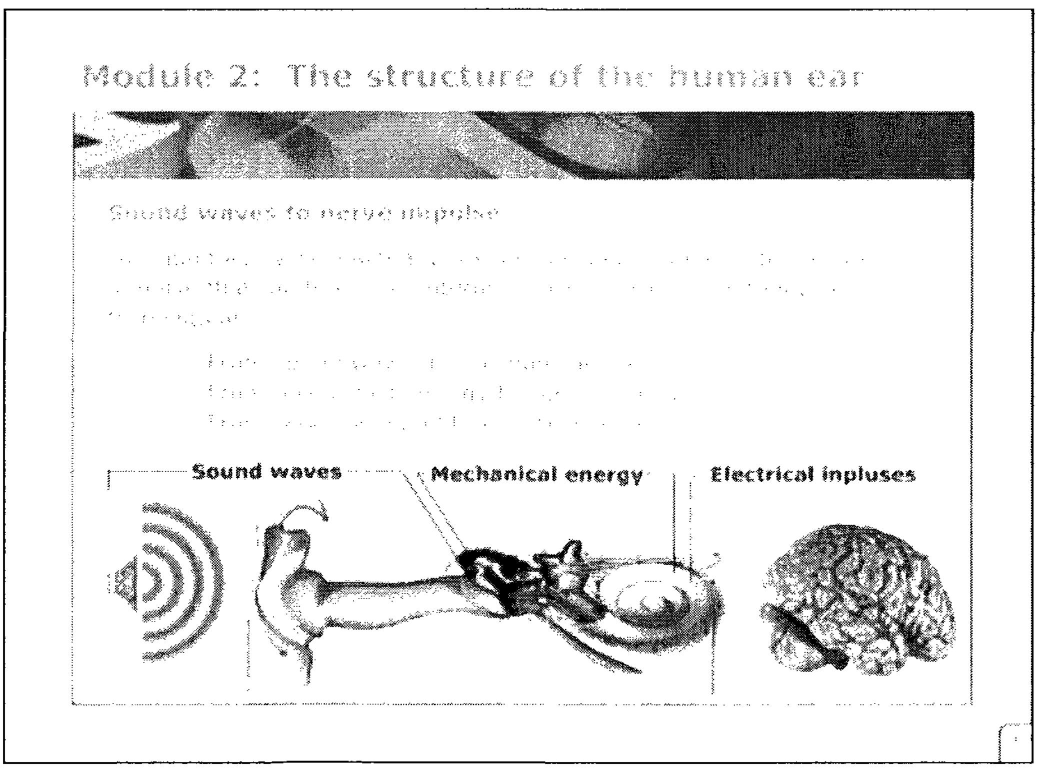
Table of contents (trial 1 and trial 2):

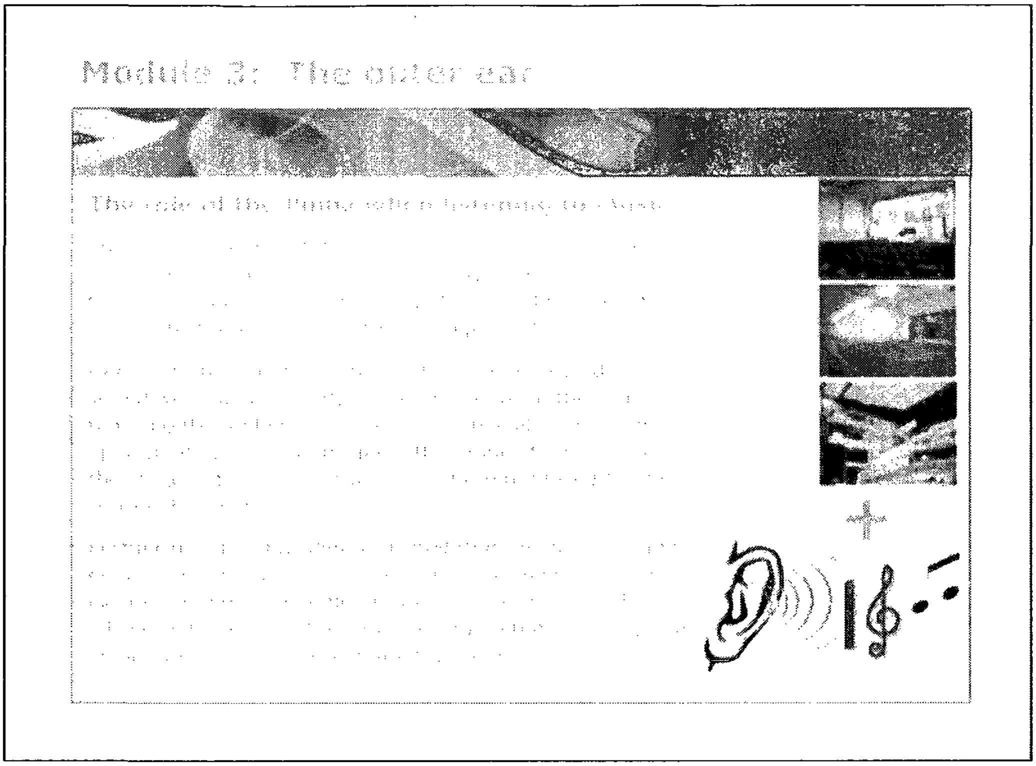


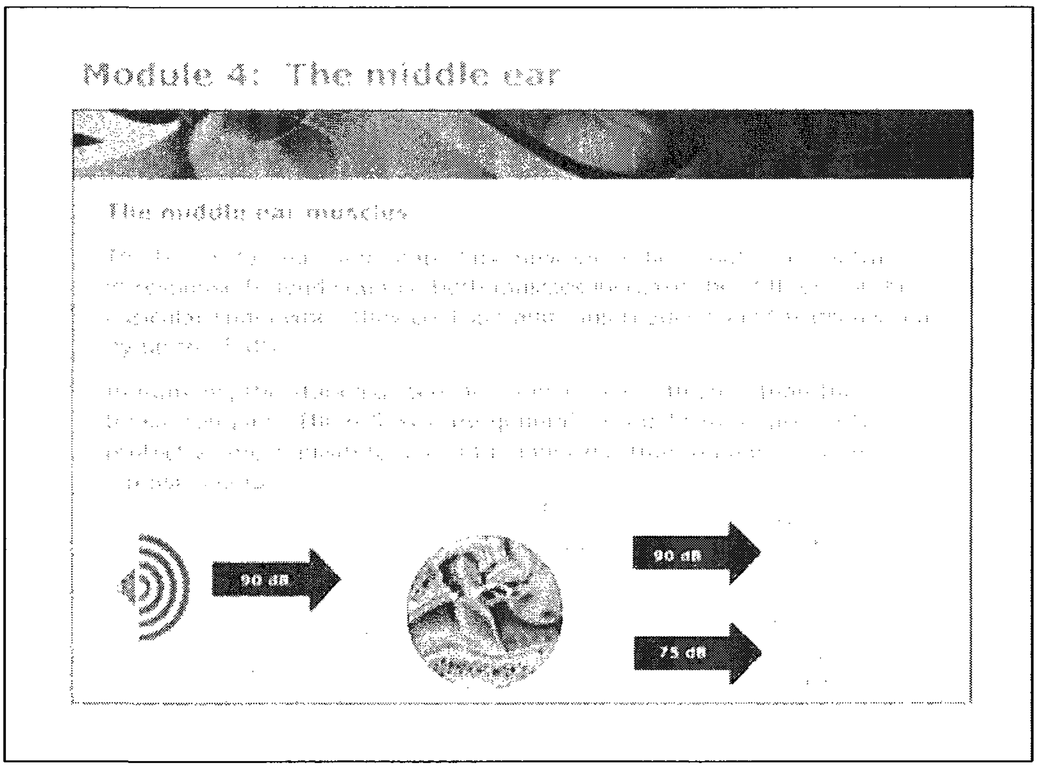


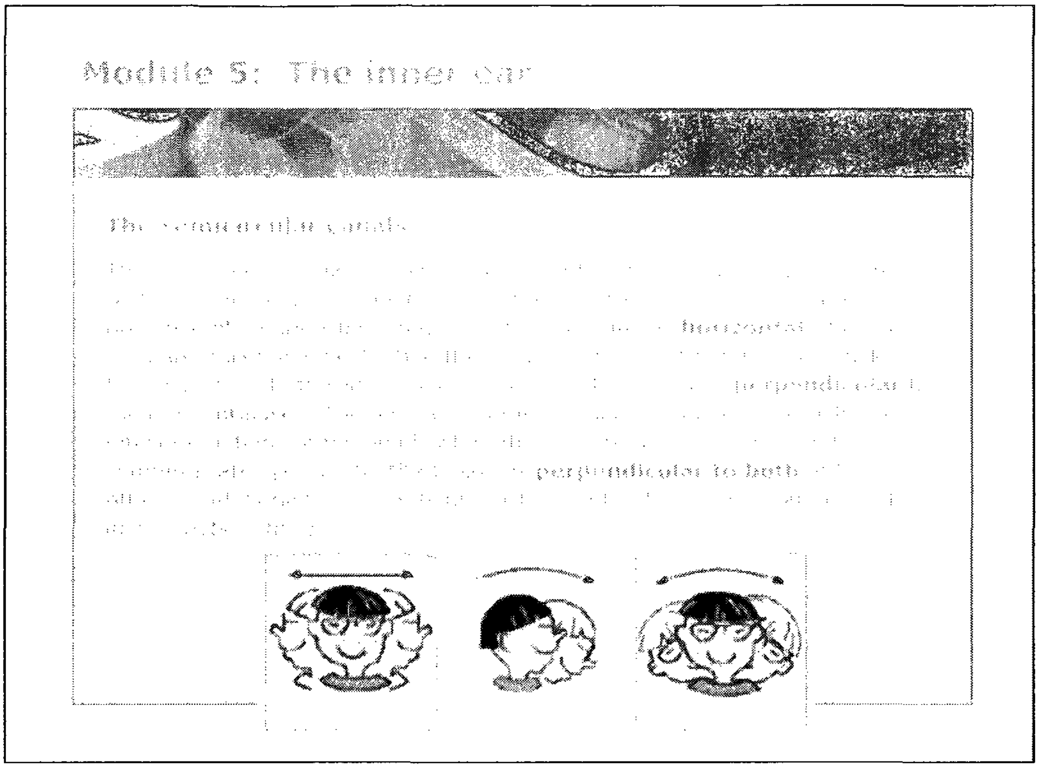
Five examples of information delivery pages:



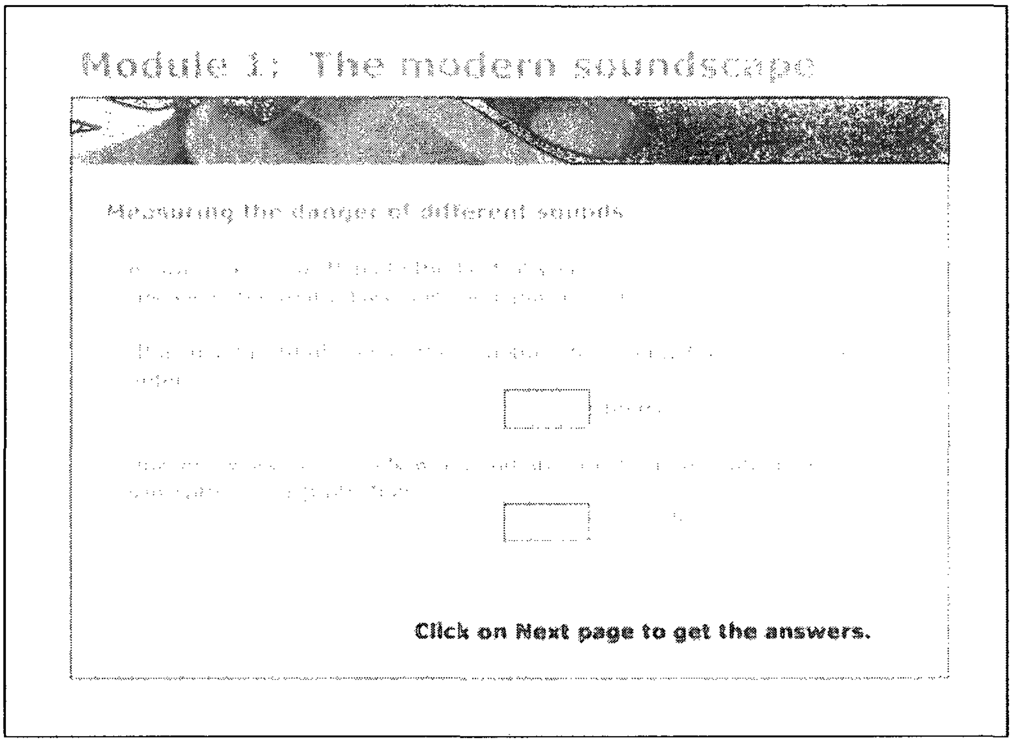


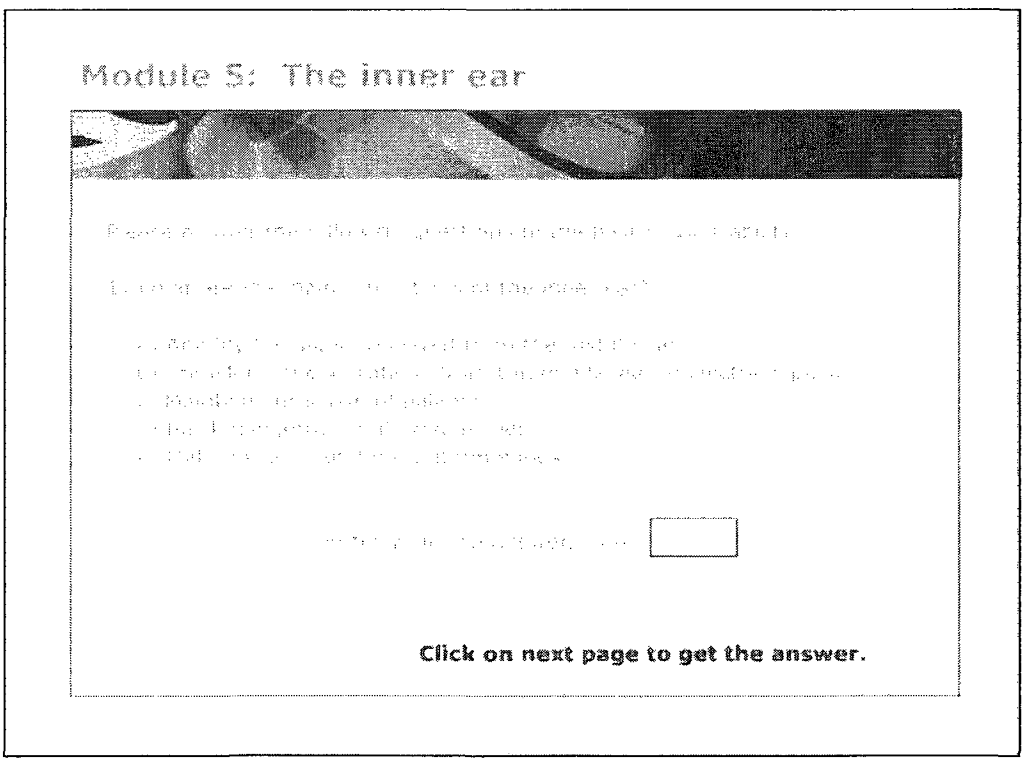

Module 3: The outer ear

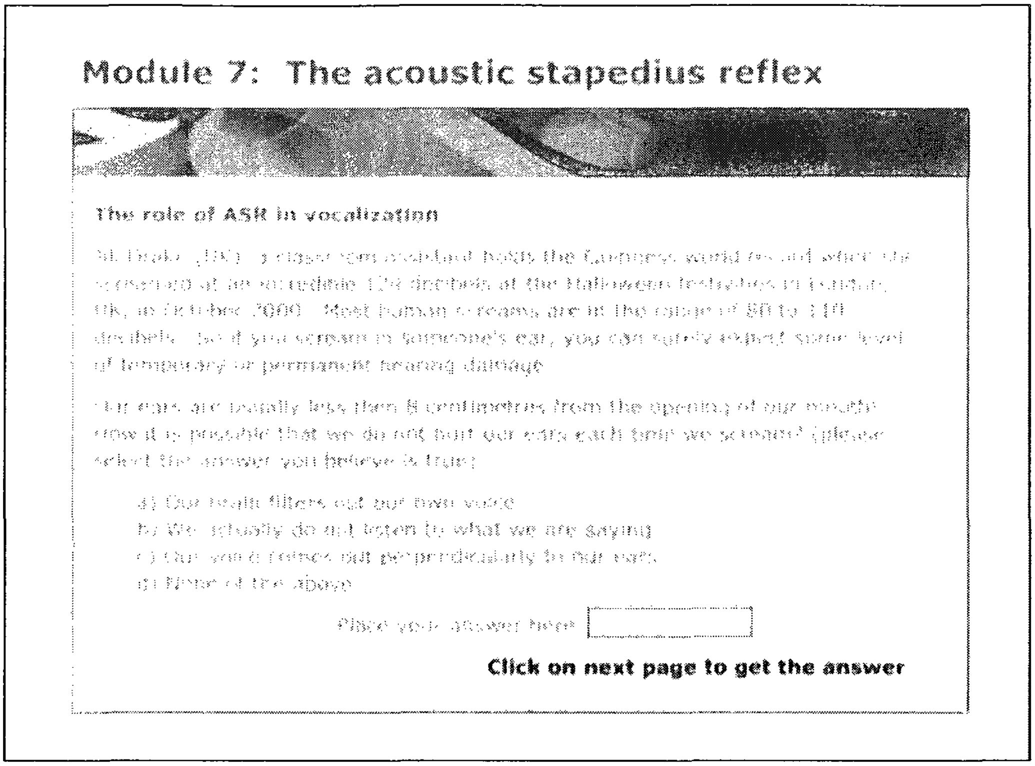

Module 4: The middle ear
The middle ear muscles
90 dB
90 dB
75 dB


Module 5: The inner ear
The semicircular canals

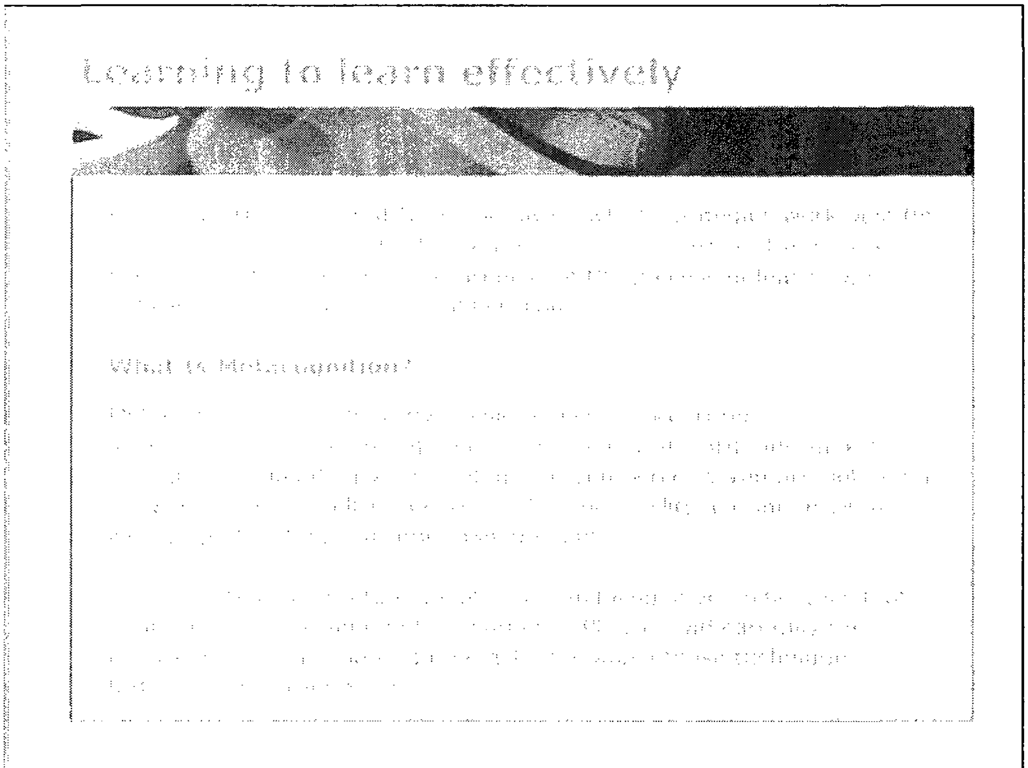
Three examples of interactive screens:

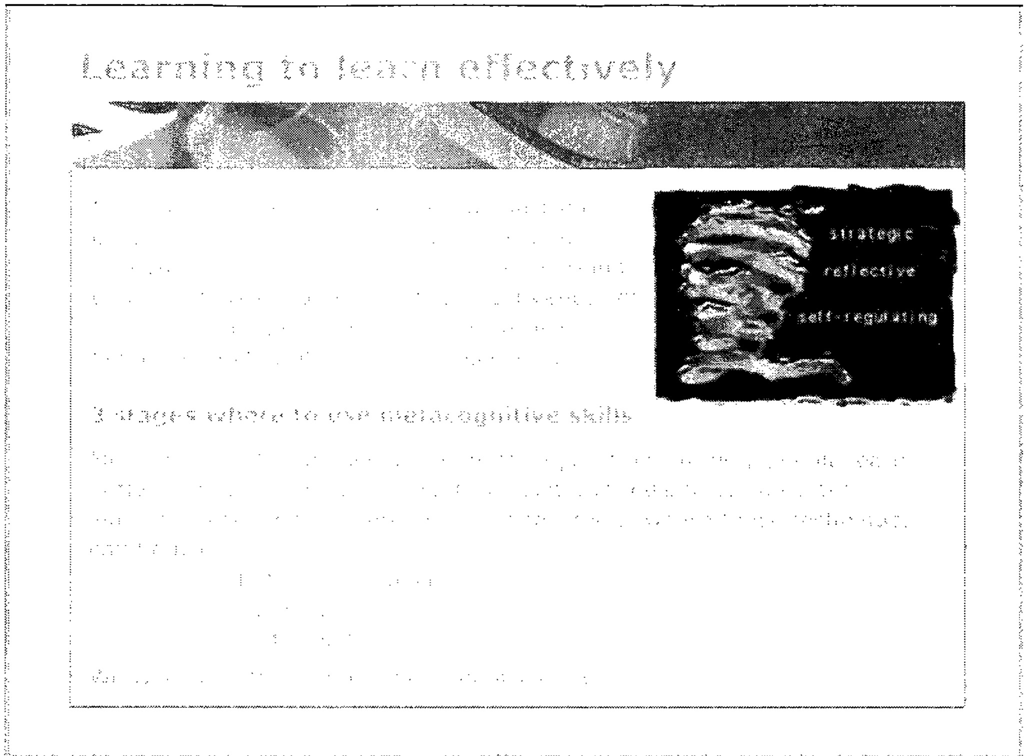


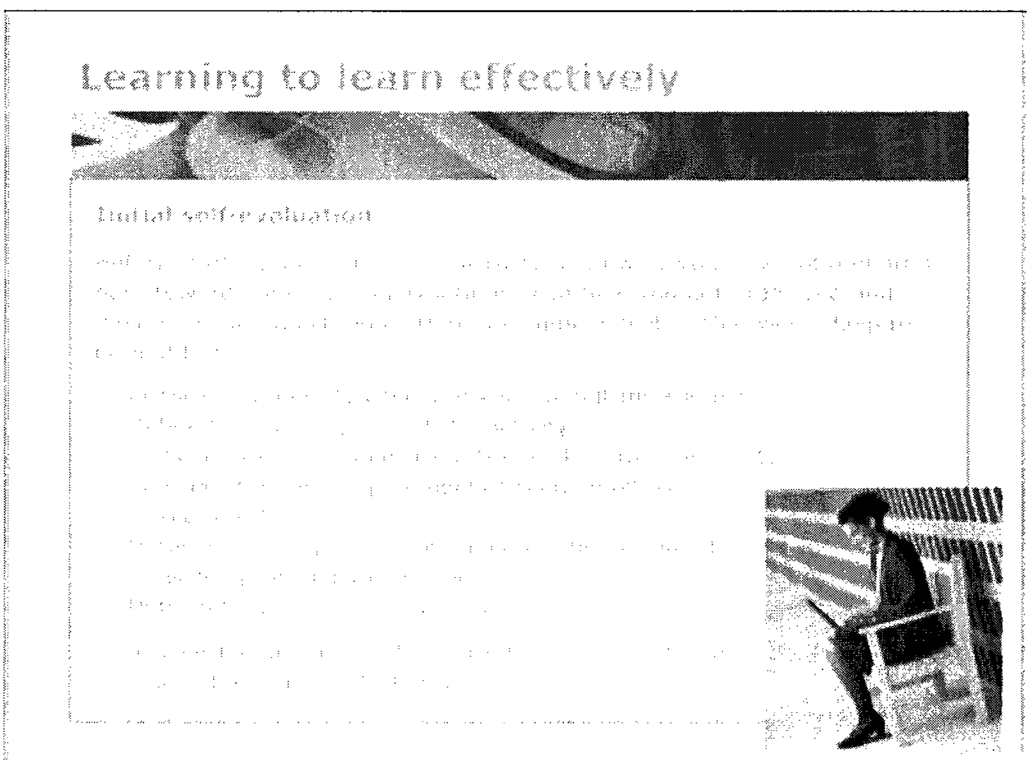



Module 7: The acoustic stapedius reflex
The role of ASR in vocalization
b) We actually do not listen to what we are saying
d) None of the above
Click on next page to get the answer

Five examples of the instructional package on metacognitive strategies

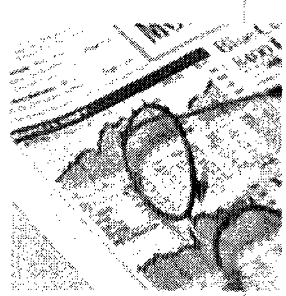



Learning to learn effectively
strategic
reflective
self-regulating
3 stages where to use metacognitive skills


Learning to learn effectively
Initial self-evaluation

Learning to learn effectively

Planning stage



Learning to learn effectively

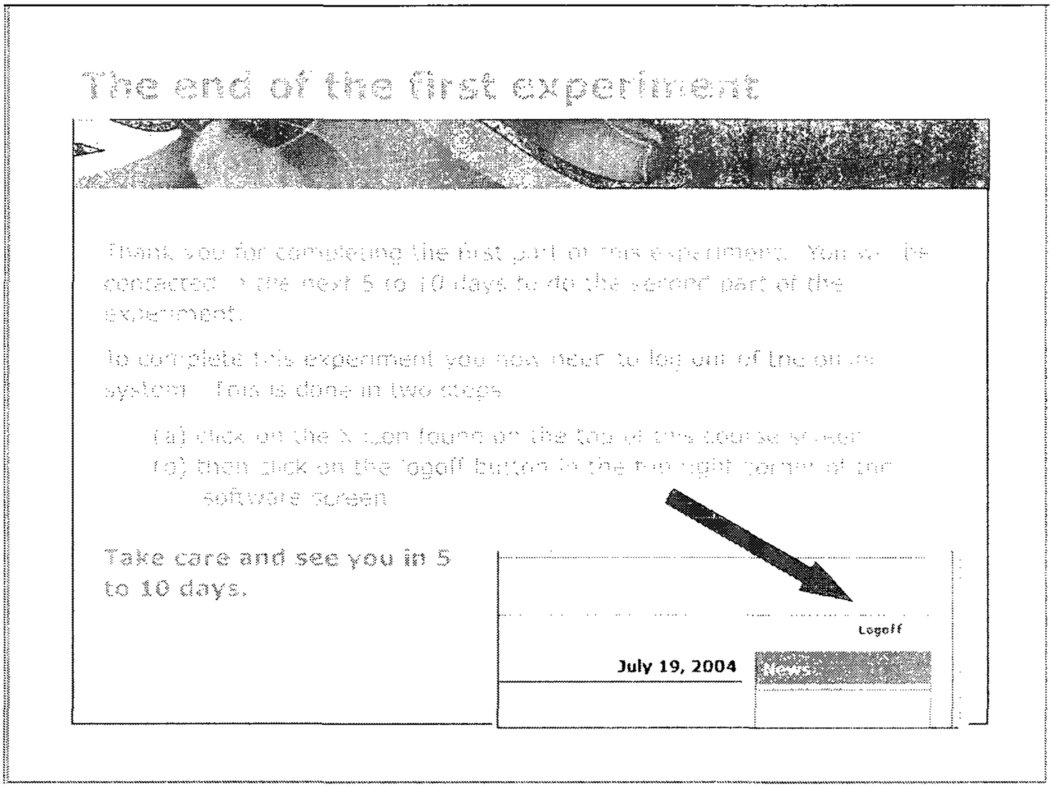
Self-monitoring stage

One of the main strenghts of metacognitive strategies, is the ability to adapt to unfamiliar material and situations. To do so, an effective learner must monitor at regular intervals the success of his or her planning and strategies. Her are a few activities that you should perform a few times within any learning activity:

- Reflect on the learning process, keeping track of what works and what does not work for you
- Monitor your own learning by questioning and self testing
- Provide your own feedback
- Keep concentration and motivation high

If the results you obtain do not support effective learning, then review your planning and strategies from the information gathered.

Example of instruction to log out of the experiment

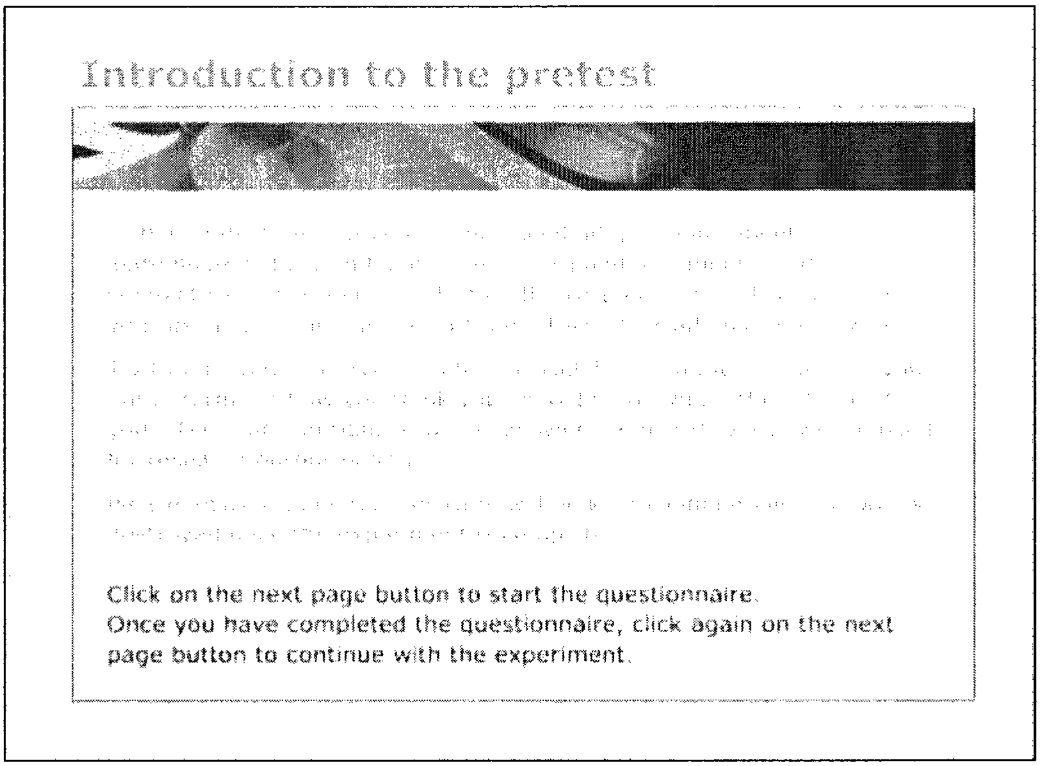


APPENDIX B:

EXPERIMENTAL QUESTIONNAIRES

SRLI questionnaire (trial 1 – 32 questions)

Introduction screen



Pretest - instructions

In this section you will be asked 80 questions about your learning and studying habits, please respond as candidly and completely as possible by selecting the response most descriptive of your usual approach, and or attitude, towards academic coursework.

Try to rate yourself according to how well the statement describes you, not in terms of how you think you should be or what others think of you. There are no right or wrong answers. Your responses will be kept strictly confidential and are for research purposes only.

Please answer all items. Answers will be kept confidentially and will be destroyed once the experiment is completed.

Pretest - 5 point Likert scale used for all the questions:

- Almost always typical of me
- Frequently typical of me
- Somewhat typical of me
- Not very typical of me
- Not at all typical of me

Pretest – questions:

1. Studying is a mysterious process. Sometimes what I do is successful, other times it is not. But in either cases, I do not really know why?
2. I come to each class session prepared to discuss the assigned reading material (e.g., chapter, handout, articles)
3. Mastery of new knowledge or skills is more important than how well I do compared to others.
4. If I am struggling to understand the material presented in a course, I will try to get some useful hints from someone who does.

5. When reading a text or listening to a lecture, I consciously attempt to separate the main ideas from the supporting ideas.
6. In classes I find note taking to be necessary, I review my notes from the previous class before the next meeting.
7. In order to help me do my best and keep myself focused, I develop specific, short-term goals for the courses in which I am enrolled.
8. If I am having trouble understanding material as presented in a class or text, I will try to locate and read different materials, which will help to explain or clarify the ideas with which I am having trouble.
9. After studying new information for a class, I pause and perform a mental review in order to determine how much of what I have read I am able to recall.
10. When reviewing my class notes, I try to identify the main points of a lecture by marking or highlighting them.
11. When I fall behind most of the rest of the class in a subject, I worry I may not be smart enough to succeed.
12. When unclear material is presented in class, one strategy I use is to check my notes against those of a classmate.
13. When reading a text or reviewing my notes, I sometimes stop and ask myself: Am I understanding any of this?
14. I try to pick out and write down the main points during a class lecture.
15. To help me stay on track, I promise to reward myself if I do well on a test or in a course.
16. When they are available and I feel I need the help, I participate in a study group sessions.
17. When evaluating my level of readiness before taking an exam, if I determine I am not quite ready, I construct a plan to help me be better prepared.
18. To help me retain and understand what I am studying, I diagram, outline or otherwise organize the material I am learning.
19. I find that if I am mot doing as well as I expected in a course, I become less motivated.

20. When studying, I isolate myself from anything that might distract me.
21. If my attention starts to drift when studying, I pull myself back on task by mentally saying things like: « Stay focused », « Work carefully », etc.
22. To help me understand and comprehend the material I am studying, I try to rephrase it in my own words.
23. In deciding which class or section to enroll in, I look for situations that offer a modest degree of challenge.
24. I study pretty much on an « as the need arises » basis.
25. After having taken an exam, I consciously try to determine how well I did in selecting and preparing for the concepts that actually appeared on the test.
26. When learning unfamiliar material that is complex, I organize (e.g., outline, map) it in such a way that it fits logically together in my mind.
27. I only strive to do well in classes or courses that are important or interesting to me personally.
28. When studying, I set aside a certain amount of time and chose an appropriate place where I will not be interrupted.
29. When reviewing sections of a text or my notes in preparing for an exam I deliberately pause and attempt to recall from memory everything I can about those sections before I reread them.
30. To help make it easier for me to understand what I am studying, I will try to relate it to or think of examples from my own life.
31. Even if a course becomes boring, or is less then interesting to begin with, I continue to work hard and try to do my best.
32. Due to competing demands, I find it difficult to stick to a study schedule.
33. Even when I feel like I put a lot of effort into preparing for an exam, I do not do as well as expected.
34. When learning new material, I try to elaborate, expand on, or otherwise add « life » to what I am leaning.
35. Whenever I am not doing as well in a course as I would like, my approach is to identify the problem and develop a plan to solve it.

36. To help me accomplish the academic goals that I have set, I develop, post and regularly review a plan or schedule to follow.

37. After studying for an exam, I try to reflect on how effective my study strategy was in helping me learn the material on which I have been working.

38. When studying or learning concepts or ideas that are abstract, I try to visualize or think of a concrete situation or event in which they might be useful or occur.

39. I feel confused and undecided about what my educational goals should be.

40. Although I know what things I should be doing to get better grades, I often don't do them because of conflicts and distractions which come from my life.

41. When studying, I mark or otherwise keep track of any concept, terms, or ideas I do not fully understand.

42. When I learn unfamiliar concepts or ideas which are related, I use mental imagery to help tie them together.

43. Even when a class turns out to be more difficult or less interesting then I expected, it is still personally important for me to do my best.

44. I study pretty much on a «cram the night before the exam» basis.

45. When studying, instead of simply rereading everything twice, I go back and focus on the concepts, ideas or procedures I found the most difficult to understand or remember.

46. If a topic I am learning is unfamiliar, I try to think of an analogy or an experience with which I am already familiar.

47. Even when I find myself really struggling in a class, I do not give up and try to do my best.

48. Even when struggling in a course, I find it very difficult to go to the instructor and talk about the situation.

49. Before reading a chapter in a textbook or other assigned reading, I first skim through the material to get a general idea of the topic and ask myself, « What do I know about this topic already? »

50. When I have to learn or recall a lengthy set of related items from memory, I try to associate each item with an unusual image.

51. I tend to believe that how much I learn from a given class or course is primarily determine by myself.

52. To help me get the most from my course, I ask questions or otherwise seek clarification from my instructors as much as I can.

53. Before I begin to seriously study, I carefully examine and analyze the amount of familiarity and difficulty of the material I need to master in order to succeed.

54. When studying for an exam, I have a hard time distinguishing the main ideas and concepts from less important information.

55. I approach most of my classes with considerable confidence because I know what I am capable of it academically.

56. If I do not understand something during a class meeting, I will ask for additional clarification.

57. After preparing for an exam, I ask myself, « If I had to take a test on this topic right now, what grade would I expect? »

58. Before reading a chapter in a textbook, I read the review question at the end of the chapter (or provided by the instructor) to help me decide what to focus on when studying.

59. When learning becomes stressful or difficult, I actively try to get a handle on the situation by doing things such as increasing effort or seeking additional information to help clarify the task.

60. I use a calendar – daily planner or otherwise keep track of my classes, assignments, and important dates.

61. When faced with a problem in my classes, to help me succeed I develop a plan or strategy to use as a guide and to evaluate my progress.

62. During class presentations, I attend carefully to any cues the instructor provides about which concepts and ideas are the most important to learn and retain.

63. I believe that ability determines academic success or failure.

64. Even when unsure if I understand what is being presented, I do not ask questions in class.

65. After taking an exam, I review and evaluate the strategies I used in preparing for the exam to determine how effective I was and how I could use this information to improve in preparing for future exams.

66. When taking notes in class, I usually try to organize (map, highlight, underline, outline, etc.) the information presented in a logical way.

67. If I don't learn a concept or a skill fairly quickly, I become discouraged and stop trying.

68. In preparing for a class presentation or a term paper, I carefully investigate and fully utilize the resources of the campus library.

69. When preparing to study a chapter in a textbook or other material, in order to determine where to focus my attention, I skim over the entire text to get a mental picture of how the material is presented.

70. In reading from a textbook, I focus mostly on the meaning of specific word or terms.

71. I see grades as something an instructor gives rather than something students earn.

72. If I run into an unfamiliar word or term in a reading for a class, I stop and look it up in the dictionary.

73. When stuck on a problem or in my attempt to comprehend material for a class, I try to think of an analogy or a comparison between my present situation and similar situations I have been in.

74. During class lectures I find it difficult to separate the main point from the less important material.

75. The grades that I received are pretty much a matter of how hard I work and how much time I put into studying.

76. I turn my assignments on time and keep-up with the assigned reading in my courses.

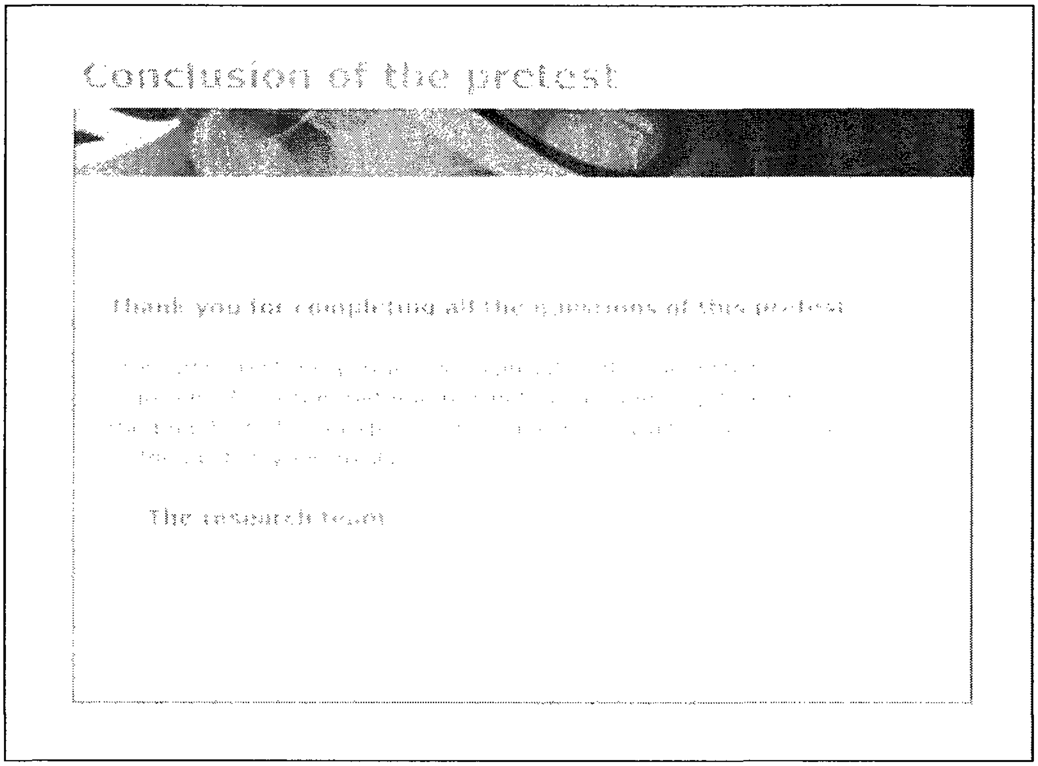
77. When preparing for a class paper, presentation or project, I not only think about the topic and create an outline to work from, but I try to anticipate any questions the audience might have.

78. I always try to learn new or unfamiliar material exactly as stated in my text or by my instructor.

79. I enjoy taking courses that are challenging or cover unfamiliar subject material because they represent the greatest opportunity for learning.

80. Deciding how to most effectively use my time in preparing for exams is difficult for me.

Screen concluding the pretest:



Posttest questionnaire (trial 1 – 32 questions)

1. What does a decibel measure?
   - Frequency of sound
   - Intensity of sound
   - The pitch of a sound
   - Both a & b
   - Both b & c

2. What is the difference between two sounds if one is 20 decibels higher then the other?
   - One sound is 2 complete octaves over the other
   - One sound is 20% louder then the other
   - One sound is 100 times louder then the other
   - One sound is 200 hertz more the other
   - None of the above

3. What is the threshold where sound can start to cause ear damage?
   - 65 dB
   - 85 dB
   - 105 dB
   - 120 dB
   - 160 dB

4. At what intensity a sound may perforate your eardrum?
   - 85 dB
   - 105 dB
   - 120 dB
   - 160 dB
   - 200 dB

5. How much time can someone sustain a sound of 75 db without having permanent ear damage?
   - 30 seconds
   - 60 minutes
   - About 8 hours
   - Regular exposure can cause permanent ear damage
   - This level can not cause any permanent damages

6. What variable may indicate that a person is more sensitive to loud noise?
   - Individual that have larger pinna (external ears)
   - Elderly individuals in general
   - Individuals that are taller then average (over 2 meters)
   - Individuals that have light colored eyes
   - None of the above are good indicators of sensitivity to loud sound

7. Which of a low pitch sound (around 100 Hz) and a high pitch sound (around 4000 Hz) will be perceived as louder (if they are of the same intensity)?

    - The pitch of a sound has nothing to do with perceive loudness.
    - It varies background sounds present in the environment
    - Lower pitch sounds (around 100 Hz) are usually perceived as louder
    - Higher pitch sounds (around 4000 Hz) are usually perceived as louder
    - Perception of loudness in relation to pitch varies among individuals.

8. If a sound is perceived as louder in the right ear then the left, what conclusion can we get from this?

    - The source of the sound is somewhere in the back of the head.
    - The sound bounces on a surface to get to the other ear
    - The source of the sound is more to the right of the head
    - The source of the sound is more to the left of the head
    - The source of the sound is probably lower the head.

9. If a sound is perceived as louder then another, what can you conclude from this?

    - The loudest sound is closet.
    - The loudest sound is more to the side of the head
    - The sound at the source is louder then the other
    - Both a, b & c
    - No simple conclusion is possible from this situation

10. Why do some animals like elephants and whales perceive sounds over great distances?

    - The size of the animal is the key factor
    - These animals have better sensitivity to lower intensity sounds
    - These animals have better sensitivity to low frequency sounds
    - These animals have better sensitivity to high pitch sounds
    - No animals can actually perceive sounds over more end 2 miles.

11. Why do some animals like dogs react badly when a vacuum cleaner is turned on near them?

    - The sound of the vacuum cleaner is too loud for their ears
    - The vacuum cleaner emits low frequencies that are painful to the dog's ear
    - The vacuum cleaner emits high frequencies that are painful to the dog's ear
    - Certain animals are particularly sensitive to the sound of electric motor
    - Depends highly on the character of the animal

12. What is the Pinna?

    - The lobe of the external ear
    - The canal that connects the exterior world to the tympanic membrane
    - A small wing that is present in some animals
    - The external part of the hear
    - A small piece of flesh hanging in the ear canal

13. What are the main functions of the Pinna?

- Physically protect the eardrum and selectively lets frequencies into the ear
- Funnels sound towards the ear canal and provides information on the location of the source of sounds
- Filters low frequency sound and protects against high pressure situations
- Prevents objects entering the inner ear and collects the Cerumen (ear wax)
- The Pinna has no specific functions

14. Which of the following is not a part of the Pinna?

- Helix
- Tragus
- Lobule
- Stapedius
- All of these are parts of the Pinna

15. What differentiates a sound coming from the back of the head from one that comes from the front?

- The sound coming from the back will always sound louder
- The vibration gathered from the posterior skull will differentiate the sound coming from the back of the head
- The sound coming from the front will have various sound reflections coming from the shape of the pinna
- The pinna and the stapedius will filter some of the low frequencies of the sound coming from the front
- Nothing, it is almost impossible to differentiate sound coming from both these directions

16. What element of the ear system allows us to perceive the acoustic characteristics of a concert hall?

- The ear drum
- The cochlea
- The ossicles
- The semicircular canal
- The pinna

17. What are the functions of Cerumen (ear war)?

- Moisturizes, cleans the hear and prevents it from infections
- Protects against loud noise and protects the fragile skin of the ear canal
- Blocks the entrance against foreign objects and moisturizes the ear canal
- Protects the ear drum and protects against infection
- Cerumen has no specific function, it is human waste being taken out of the body

18. What is the most common cause of wax build up against the ear drum?
    - Lack of outer ear cleaning

    - The use of air conditioning systems
    - The immersion of the head in liquids (bath, pools ...)
    - The insertion of objects in the ear canal
    - The use of hair dryers pushing hot air in the ear canal

19. What makes the tympanic membrane vibrate?

    - The movement of the middle ear ossicles and muscles
    - The movement of the head on all 3 axis (X, Y and Z)
    - The tug of someone on the lobe of the pinna
    - The equalization of pressure coming from the Eustachian tube
    - The impact of sound waves against it

20. What is the shape of the eardrum?

    - A cone
    - A flat circle
    - A triangle
    - Semicircular at the top and flat at the bottom
    - None of the above

21. What is the name of the three ossicles?

    - Mateus, incus and stapes
    - Malleus, tympani and stapes
    - Stapedius, tympani and incus
    - Malleus, incus and stapes
    - None of the above

22. What transformation occurs in the middle ear?

    - Sound waves are transformed into kinetic energy
    - Sound waves are transformed into electric impulses
    - Kinetic energy is transformed into electric impulses
    - Electric impulses are transformed into sound waves
    - No transformation actually occurs in the middle ear

23. What transformation occurs in the inner ear?

    - Sound waves are transformed into kinetic energy
    - Sound waves are transformed into electric impulses
    - Kinetic energy is transformed into electric impulses
    - Electric impulses are transformed into sound waves
    - No transformation actually occurs in the inner ear

24. Why does the inner ear need to amplify the intensity of sounds?

- The sound entering the ear canal is too weak to continue on
- To compensate for the energy lost when passing from air to liquid
- To insure that weaker high frequency sounds can still be heard
- To compensate for ear damages that occur as we get older
- Actually the middle ear does not amplify sound at all

25. What is the main function of the stapedius and tensor tympani?

- Protect against impulsive sound (like a pistol shot)
- Protect against loud high frequency sounds
- Protect against loud low frequency sounds
- Protect against loud sounds in general

26. What are the two components that help us maintain balance?

- Cochlea and vestibule
- Cochlea and the semicircular canals
- Cochlea and Saccule
- Vestibule and the semicircular canals
- None of the above

27. Why are the semicircular canals perpendicular to each other?

- To secure the inner ear in the cranial cavity
- To provide X,Y and Z axis references for balance
- To provide X,Y and Z axis references to determine sound origin
- To allow sound perception even when the body is in movement
- None of the above

28. What are the names of the three chambers in the cochlea?

- Scala vestibule, scala media, scala tympani
- Scala decibela, scala frequencia scala eutachia
- Caverna decibela, caverna frequencia, caverna eutachia
- Caverna vestibule, caverna media, caverna tympani
- None of the above

29. What is the function of hair cells found in the chambers in the cochlea?

- They act like wave breakers, allowing only certain frequencies to continue further
- They clean the cochleal chambers from residue
- They selectively react to certain frequencies and generate nerve impulse
- They protect the neuron from excessively loud or sudden noise
- None of the above

30. How can a musician train themselves to ear more precisely tones?

- They need to voluntarily tense up the ear muscle to reduce the width of the sound in the inner ear
- The need to train their brain to select only the peak sensation of sound
- They need to be regularly exposed to finer and more compressed tones
- They need to protect their ears against industrial and city noise
- None of the above

31. About how many hair cells and neurons are usually involved in sound perception in the cochlea?

- 30,000 neurons and 15,000 hair cells
- 15,000 neurons and 30,000 hair cells
- 30,000 neurons and 30,000 hair cells
- 15,000 neurons and 15,000 hair cells
- None of the above

32. What is the name of the canal connected to the nasal cavity that helps equalize pressure in the inner ear?

- The semicircular canal
- The Eustachian tube
- The tympanic canal
- The ear canal
- The cochleal canal

Posttest questionnaire (trial 2 – 33 questions)

1. What does the acronym ASR stands for?

    - Acoustic Standard Response
    - Acoustic Standard Reflex
    - Acoustic Stapedius Response
    - Acoustic Stapedius Reflex
    - None of the above

2. What types of frequencies are usually blocked by the acoustic stapedius reflex?

    - Loud sounds of low pitch
    - Loud sounds of high pitch
    - All loud sounds
    - Sounds of 4000 Hz or more
    - None of the above

3. If a sound is heard over a great distance, what component of that sound usually reaches you?

    - Very high frequencies
    - Mid pitch tones
    - Lower pitch tones
    - Frequencies between 400 and 1200 Hz
    - None of the above

4. How can someone scream without harming his or her ears?

    - By screaming straight forward away from their ears
    - By mentally blocking the harmful tone in your scream
    - By yawning while screaming, thus blocking the middle ear
    - By not listening to what we are saying
    - None of the above

5. What is the range of most human screams?

    - Between 110 and 140 decibels
    - Between 65 and 95 decibels
    - Between 100 and 130 decibels
    - Between 80 and 110 decibels
    - None of the above

6. What is the difference in intensity between a scream recorded in the middle ear and outside the head of the emitter?

   - The sound outside the head is 20 decibels higher then in the middle ear
   - The sound levels in both cases are exactly the same
   - The sound outside the head is 20 decibels lower then in the middle ear
   - The sound outside the head is 10 decibels higher then in the middle ear
   - The sound outside the head is 10 decibels lower then in the middle ear

7. How can we still other hear sounds when we talk or scream?

   - We do not listen to ourselves talking or screaming
   - The frequencies in our voice differs from the sounds in the environment
   - The acoustic stapedius reflex is perfectly synchronized with our voice
   - The cranium acts like a filter to isolate our voice
   - None of the above

8. What would happen if lower frequencies were not blocked in the middle ear?
   - Higher pitch sounds would overwhelm lower pitch sounds in the cochlea.
   - Lower pitch sounds would overwhelm higher pitch sounds in the cochlea.
   - We would become tone deaf
   - We would be at risk of eardrum perforation
   - None of the above

9. How fast can echolocating bats use their acoustic stapedius reflex to cover the rapid clicks they make to orient themselves?

   - About 50 times per minute
   - About 100 times per minute
   - About 50 times per second
   - About 100 times per second
   - None of the above

10. Which of the following water mammals use echolocation?

    - Turtles
    - Dolphins
    - Whales
    - All of the above
    - Only b and c

11. What are the different types of hearing impairments?

    - Cochleal, tympanic and vestibular hearing loss
    - Outer ear, middle ear and inner ear hearing loss
    - Conductive, sensory and neural hearing loss
    - Pitch, intensity and neural hearing loss
    - None of the above

12. Which of the following is not a common source of hearing loss?

- Serious infections such as meningitis
- Repeated exposure to loud industrial sounds
- Repeated exposures to impure waters
- Head injuries
- Listening to loud music

13. What is the decibel hearing level (dBHL) where someone is considered profoundly deaf?

- 55 dBHL
- 85 dBHL
- 95 dBHL
- 105 dBHL
- None of the above

14. What is the most commonly used hearing test?

- The brainstem responses (ABR) test
- The otoacoustic test
- The decibel depreciation test (DDT)
- The audiometer test
- None of the above

15. In what circumstances is magnetic resonance imaging (MRI) used?

- When doctors suspect problems with the auditory nerve
- In cases of facial paralysis, like Bell Palsy
- When doctors suspect brain abnormalities
- When they believe that the problem is psychosomatic
- None of the above

16. What is a sensory hearing loss?

- When there is a problem with the auditory nerve
- When hair cells in the cochlea are damaged
- When the inner ear is full of fluids
- When auditory neurons are damaged
- When there is a problem with the middle ear muscles

17. What can be the consequence(s) of having a perforated eardrum?

- Partial hearing loss
- Inner ear infections
- Cochleal infections
- All of the above
- Only a and b

18. What element of the ear system allows us to perceive the acoustic characteristics of a concert hall?

- The ear drum
- The cochlea
- The ossicles
- The semicircular canal
- The pinna

19. What can be done in the case of eardrum perforations?

- Nothing it will heal by itself
- Surgery is required
- Depending on the size of perforation a or b
- Antibiotics are required
- None of the above

20. Why do young children under 3 are more susceptible to inner ear infections?

- They do not have the antibodies required at that young age
- The Eustachian tube is too small and less able to keep germs out
- The forming eardrum lets infections through at that age
- The pus (fluids) of young children is not yet formed
- None of the above

21. Which of the following cannot help you prevent inner ear infection (otitis media)?

- Avoid cigarette smoke
- Avoid individuals with cold
- Wash your hand regularly
- Try not to touch your nose and eyes
- All of the above can help prevent inner ear infection

22. What is perfect pitch?

- The ability to recognize tones without first hearing any reference tone
- The ability to recognize sound intensity without first hearing any reference sound
- The ability to recognize tones most of the time
- The ability to situate spatially any sound in any circumstances
- None of the above

23. What is the accuracy level of someone recognized with perfect pitch?

- Plus or minus 1% of frequency tolerance
- Plus or minus 3% of frequency tolerance
- Plus or minus 5% of frequency tolerance
- Plus or minus 10% of frequency tolerance
- Plus or minus 15% of frequency tolerance

24. What are the two processes that compose perfect pitch as Dr. Levitin proposed?

- Pitch status and pitch transformation
- Pitch recognition and pitch transformation
- Pitch status and pitch labeling
- Pitch recognition and pitch labeling
- None of the above

25. What do individuals with Williams-Beuren Syndrome provide to the study of perfect pitch?

- They demonstrate that the cochlea is key in having perfect pitch
- They demonstrate that perfect pitch is learned
- They demonstrate that brain functions have little to do with perfect pitch
- They demonstrate that there is an innate component to the perfect pitch
- None of the above

26. Why having perfect pitch might interfere with some language skills?

- Because language skills have nothing to do with pitch recognition
- Because different people pronounce the same word at different pitches confusing the recognition process
- Because vowels tend to be all in similar pitches
- Because high pitch vowels are difficult to distinguish
- None of the above

27. What is relative pitch?

- The ability to localize any sound at any time
- The ability to recognize a tone without outside reference
- The ability to recognize the difference between two tones
- The ability to measure the distance between two sources of sound
- None of the above

28. What is tone deafness?

- The inability to ear high pitch sounds
- The inability to ear low pitch sounds
- The inability to differentiate different tones
- The inability to localize the source of a sound
- None of the above

29. What is the threshold where sound can start to cause ear damage?

- 65 dB
- 85 dB
- 105 dB
- 120 dB
- 160 dB

30. According to the National Academy for Child Development, what happens when young children listen to music?

- Their signing skills increases
- Their motor skills get better
- Their heartbeat slowly synchronizes itself with the tempo of the music
- Their general intelligence increases
- Nothing really happens

31. What is the Mozart effect?

- The fact that scores on general intelligence tests are better after listening to certain of Mozart's sonatas
- The fact that scores on spatial-temporal tests are better after listening to certain of Mozart's sonatas
- The fact that scores on motor skill tests are better after listening to certain of Mozart's sonatas
- The fact that scores on general knowledge tests are better after listening to certain of Mozart's sonatas
- The fact that individuals are calmer after listening to certain of Mozart's sonatas

32. Can music training enhance mathematical abilities?

- Yes, all kinds of music improve mathematical abilities
- Yes, but only certain aspects of music improve mathematical abilities
- Yes, but only classical music has been known to improve mathematical abilities
- Yes, but only spatial and geometrical skills are improved
- No, there is no proven link between music and mathematical abilities

33. Can learning a second language have an effect on the brain?

- Knowing a second language usually increases mathematical abilities
- Knowing a second language usually increases pitch discrimination
- Knowing a second language usually increases the ability to sing
- Knowing a second language keeps cognitive functions sharper as we get older
- Knowing a second language has no proven effect on other cognitive abilities

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APPENDIX C:

PARTICIPANT CONSENT FORM

Consent form to participate to an online research

(Please print)

Name: ____________________________________

Phone number 1: ____________________________________

Phone number 2: ____________________________________
(Optional)

Email: ____________________________________

I agree to participate in this online experiment conducted by Claude Martel of the Educational Technology and Communication Studies departments of Concordia University.

I have been informed that the purpose of this research is to determine how individual can learn more effectively when they learn online.

I understand that this experiment has 2 online components where I will be asked to follow an online course and answer questionnaires. The first part can be completed at my convenience anytime after receiving the log in information from the researcher. The second part requires to be done 5 to 12 days after the completion of the first part of the experiment. I will receive the instructions for the second part of the experiment by email. I understand that my participation might require a minimum of 2 hours and a maximum of 4 hours of my time.

I understand that all the information provided in my participation in this study will be held confidentially and that it will be destroyed when the final experiment report has been completed. I also understand that the data and the results of this experiment might be published, but that the names and individual results of participants will not be disclosed.

I understand that I am free to withdraw my consent and discontinue my participation at anytime without negative consequences.

I have carefully studied and agree with the restrictions and obligations that are in this consent form. I freely consent and voluntarily agree to participate in the study.

__________________________ __________________________

Signature Date

If at any time you have questions about your rights as a research participant, please contact Adela Reid, Research Ethics and Compliance Officer, Concordia University, at extension 7481 or by email at Adela.Reid@Concordia.ca.