THE AUDIO RE-SEARCHER: EXAMINING THE EFFECTS OF AUDIO NOTE TAKING IN A MULTI-MEDIA, WEB-BASED ENVIRONMENT

by

Frank Zander

THESIS SUBMITTED IN PARTIAL FULFILLMENT OF
THE REQUIREMENTS FOR THE DEGREE OF

MASTER OF ARTS

in the
Educational Technology and Learning Design Program
Faculty of Education

SIMON FRASER UNIVERSITY

Fall 2011

APPROVAL

Name: **Frank Zander**

Degree: **Master of Arts**

Title of Thesis: **The Audio Re-Searcher: examining the effects of audio note taking in a multi-media, web-based environment**

Examining Committee:

Dr. Ann Chinnery
Chair
Assistant Professor
Faculty of Education

Dr. Kevin O'Neil
Senior Supervisor
Associate Professor
Faculty of Education

Dr. Maureen Hoskyn
Supervisor
Associate Professor
Faculty of Education

Dr. John Nesbit
External Examiner
Professor
Associate Dean, Graduate Studies in Education

Date Defended/Approved: September 26, 2011

SFU SIMON FRASER UNIVERSITY
THINKING OF THE WORLD

STATEMENT OF ETHICS APPROVAL

The author, whose name appears on the title page of this work, has obtained, for the research described in this work, either:

(a) Human research ethics approval from the Simon Fraser University Office of Research Ethics,

or

(b) Advance approval of the animal care protocol from the University Animal Care Committee of Simon Fraser University;

or has conducted the research

(c) as a co-investigator, collaborator or research assistant in a research project approved in advance,

or

(d) as a member of a course approved in advance for minimal risk human research, by the Office of Research Ethics.

A copy of the approval letter has been filed at the Theses Office of the University Library at the time of submission of this thesis or project.

The original application for approval and letter of approval are filed with the relevant offices. Inquiries may be directed to those authorities.

Simon Fraser University Library
Simon Fraser University
Burnaby, BC, Canada

Last update: Spring 2010

ABSTRACT

This thesis comprises two studies. The first study was a survey of 100 university students that investigated podcast-based audio-learning practices. The second study quantitatively evaluated effectiveness of creating and inserting tags (cue points) to study and review a lecture podcast. Using a multi-media web-based tool, participants enhanced the podcast by self-selecting important segments and inserting tags and notes on a visual interface of the audio timeline. 69 university participants (not from first study) were randomly assigned to two groups. All participants listened to a half-hour lecture on sensation and perception. The first group listened to the first half of the lecture without tagging, then created tags during the second half. The second group tagged, then listened. The listen-then-tag group significantly out-performed the tag-then-listen group on a test of recall, but only for the second half of the lecture. Possible explanations for this finding and directions for future research are explored.

Keywords: Enhanced podcasts; podcast; audio; annotation; notetaking; lecture cues; highlighting; usability; media in education;

DEDICATION

To my wife Wendy Belter and my children Layne and Olivia Zander, your love patience and understanding have made this thesis possible. Wendy, you are the apple of my eye, the light of my life, the wind beneath my wings. You are the peanut butter on my toast, the sugar in my coffee, the gin in my tonic. You ARE my tonic. My daily restorative tonic. Though not my hair tonic, obviously. But you get my drift: I couldn’t have done it without you!

ACKNOWLEDGEMENTS

I have profound gratitude for my senior supervisor, Dr. Kevin O'Neill. Kevin was instrumental in my entry into the SFU *Educational Technology and Learning Design* Master's program. Further, throughout this endeavour, his sage guidance, on matters both practical and intellectual, has been both generously offered and warmly received.

Next, a heartfelt thank you to Dr. Maureen Hoskyn for her encouragement and feedback in her dual roles of thesis supervisor and research-design mentor. Without Maureen's formidable knowledge of statistics, this thesis would have been nearly impossible.

I also want to thank Dr. John Nesbit. I benefited greatly from his instruction on cognition, multi-media learning and instructional design.

In addition, I want to thank Dr. Cheryl Amundsen and Jodi MacQuarrie for their generous support and encouragement and their remarkable instruction. Being a student in their classes has been a pleasure and a great intellectual journey.

Finally, I want to acknowledge the multiple contributions of my wife, Wendy Belter. Through many edits and corrections, Wendy single-handedly taught me how to write clearly and how to insert quotes and cite sources in APA format. Without Wendy's instruction and emotional support, I would not have been able to complete this Master of Arts degree.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

GLOSSARY

API	Computing application programming (also program) interface
Enhanced podcast	A podcast synchronized with static images such as artwork, photos, or slides. (McLoughlin & Lee, 2007, p. 2)
MP3	A digital audio format commonly used by MP3 players to listen to music or audio
Podcast	“A digital recording of a broadcast, made available on the Internet for downloading to a computer or personal audio player.” (Oxford English Dictionary, 2010)
RIA	Rich Internet Application
SFU	Simon Fraser University
Tagging	The process of adding visual bookmarks
Time Index	The time location of a particular point or segment within audio or video media
VCR	Video Cassette Recording
UI	User Interface - the sensory interface through which users interact with a computer application.

1: INTRODUCTION

This thesis aspires to contribute to our scholarly understanding of learning by annotating audio recordings of lectures. It further explores theoretical and practical design requirements for a tool that makes the productive use of such recordings possible. The results may have implications for how educators create and provide audio-based study materials, and how students listen to and annotate them. A better understanding by the education community of the effective use of digital audio content as a study aid may further inform the design and use of future instructional tools as well as praxis involving audio-recorded lectures.

1.1 Background

The landscape of educational technology and the delivery of course content is changing. Technological advancements in media (both audio and video formats) and broadband internet access make it a realistic expectation for educators to deliver high-quality, web-based, multi-media content. Text is no longer the default medium. Society in general, and universities and businesses in particular, are jumping on the multi-media bandwagon (Noble, 2002). For instance, Massachusetts Institute of Technology (MIT) makes lectures available to the public free of charge via “open courseware” (MIT OpenCourseWare, 2008). MIT OpenCourseWare contains a substantial amount of video and/or audio content. iTunes U (Apple Inc., 2008) “delivers content from hundreds of top colleges” free of charge to anyone who cares to download the MP3 files.

Locally, within the Simon Fraser University (SFU) context, many courses include audio lectures - podcasts - (see Table 1) with restricted access to enrolled SFU students (Stranger, 2011, July 8, personal communication).

Table 1: SFU Course Recording Statistics

Year	2006	2007	2008	2009	2010
Spring	n/a	140	148	114	152
Summer	n/a	78	72	63	52
Fall	156	132	133	136	154
Total Courses	156	350	353	313	358

1.2 Statement of the Problem

Although the recent increase in access to audio recordings of lectures is a boon to educational practice in many ways, the quantity of digital audio content poses a challenge to educators and learners alike. How will educators apply sound educational theory to support learning when dealing with audio content? Moreover, how will learners be able to manage the vast quantity of audio content available to them? A review of the research and theory on working with text- and audio-based media can provide some guidance to help answer these questions.

1.3 Research Questions

This research seeks to answer two questions:

1. Does annotating audio files - inserting topic headings and notes - improve recall as measured by a multiple-choice comprehension test?
2. How usable do participants find the newly-developed *Audio Re-Searcher* tool?

1.4 Research Hypotheses

Other studies (e.g., Griffin, Mitchell, and Thompson, 2009) have found that lecture podcasts with synchronized images or text enhance learning. In addition, notetaking and review of notes provide a useful learning function in the majority of cases (K. A. Kiewra, 1985; Titsworth & Kiewra, 2004). This study examines the learning effect of combining tagging (creating synchronized cues) and notetaking in a multi-media environment. The independent variable in this study is the instructional format (listening-only or listening-plus-tagging/notetaking). The dependent variables are participants' scores on multiple-choice tests of recall. Based on the prior research of others on notetaking and enhanced podcasts, it is predicted that learners in the listening-plus-tagging/notetaking condition will, on average, show a positive or at least neutral learning effect, in comparison to learners in the listening-only condition.

1.5 Significance of the Study

Today, many students in the post-secondary environment listen to audio recordings of lectures, both instructor-prepared podcasts and personal in-class recordings. This research aims to understand students' current notetaking and review practices related to audio-recorded lectures. It also involves testing a new web-based educational tool, the *Audio Re-Searcher*, which was designed to aid students in using audio study materials productively. Finally, this research examines the learning effects of combining tagging (creating synchronized cues) and notetaking in a multi-media environment.

2: LITERATURE REVIEW

As a contextual backdrop to the survey and lab study, this chapter reviews the relevant literature on podcasts and notetaking.

The first section examines podcast usage and issues of: (1) students' use of lecture podcasts for study purposes; (2) the efficacy of lecture podcasts enhanced with synchronized images or text: and (3) student absenteeism when courses are augmented with podcasts.

The second section reviews the tradition of notetaking and the research on learning with notetaking. Specifically, this section reviews findings regarding the conditions under which notetaking has and has not been found to be beneficial for learning and the theoretical explanations that have been put forward for these findings.

The third section reviews Mayer's (2001) Cognitive Theory of Multimedia Learning (CTML) and extends it to incorporate notetaking. The chapter concludes with a summary.

2.1 Podcasting

It is hard not to notice widespread usage of mobile-audio devices by students. On the bus or walking across campus, students are plugged into their iPods or other MP3 music players. Further, students' access to mobile audio devices is increasing. Evans (2008) found in 2008 that 74% of his participants owned a mobile-audio device (iPod or equivalent) and an additional 7% planned to purchase a device in the next six months. Undoubtedly, that percentage will have increased in the last three years.

Thus, educators and researchers have speculated that educational podcasts can take advantage of the ubiquity of mobile-audio devices to enhance students' opportunity to learn (Brock, 2007; Clark & Walsh, 2004; Lee & Chan, 2007). For example, Apple has begun providing a service called "iTunes U" to facilitate access to these resources. At the present time, "[m]ore than 800 universities have active iTunes U sites" (Apple Inc., 2011). In addition, non-students can access university-level audio lectures. Apple Inc. (2011) boasts that iTunes houses "[m]ore than 350,000 free lectures, videos, films, and other resources" and that "... half of these [800 university] institutions - including Stanford, Yale, MIT, Oxford, and UC Berkeley - distribute their content publicly on the iTunes Store." This is not only an American phenomenon: SFU instructors have created 23,622 audio lecture recordings over the past three years (SFU, 2011).

A common assumption is that students listen to educational podcasts on their mobile-audio devices and that, therefore, we must reach students in the mobile space "where they live" (Coghlan et al., 2007, p. 3). However, students' predilection for being plugged in to mobile audio devices obfuscates where and how students are studying from audio-lecture podcasts. In contradiction to the assumption that students will listen to audio lectures on mobile devices, it turns out that, even when they have access to mobile audio devices, students generally prefer to reserve their iPods for listening to music and to instead listen to audio lectures on laptops and desktop computers while "at home" (Brittain, Glowacki, Van Ittersum, & Johnson, 2006, p. 26). Evans (2008) reports that "80% [of 200 participants] listened [to recorded lectures] on a PC via a Web Page" (p.

495). Further, Lane (2006) notes that "[a] strong majority of students - 87% of all respondents - reported listening to course podcasts on a computer, rather than an MP3 player" (p. 4). Hews' (2009) review of podcasting asserts that "[st]udents… tend to listen to [course-related] podcasts at home using desktop computers, rather than on the move (e.g. commuting to school)" (p. 341).

Students' preference for listening to course recordings at home, rather than while on-the-go or multitasking, has researchers speculating. Hew's (2009) review of podcast usage offers three possible explanations: (1) students need to focus when learning from podcasts, and choose home as the most distraction-free environment (Edirisingha, 2007); (2) students prefer to have boundaries between their public space (social, leisure) and learning space (study) activities (Lee & Chan, 2007); and (3) students find it difficult to integrate information from multiple sources (text, notes, or webpages) while in motion (walking, commuting, or exercising) (Lee & Chan, 2007). However, the explanation with perhaps the most intuitive appeal is Edirisingha's (2007): "students needed a static space to take notes while listening to podcasts" (p. 3).

Knowing that students are studying from audio lectures on stationary hardware (laptops or desktops) rather than mobile devices, it makes sense to create podcasts that can take advantage of this hardware. Specifically, students can make use of their computer screens to display enhanced podcasts. Enhancing podcasts with synchronized images or text may improve opportunities to learn by taking fuller advantage of students' preferred hardware in their stationary study-space.

2.1.1 Enhanced podcasts

It appears that enhanced podcasts - "audio podcasts that have synchronized images [or text]" (McLoughlin & Lee, 2007, p. 2) - enhance learning. Kennedy et al. (2010) found that, "[p]articipants [two randomly-assigned groups of undergraduate teacher-education candidates] interacting with the enhanced podcasts outperformed their audio-only counterparts on three of four measures of recall and application" (p. 1). In addition, Griffin, Mitchell, and Thompson (2009) found that, on average, students achieved "significantly higher test scores" (p. 532) when PowerPoint slide transition points were synchronized with audio compared to a non-synchronized presentation (PowerPoint and audio presented separately). Also in 2009, McKinney, Dyck, and Luber compared the efficacy of attending a lecture to listening to an enhanced podcast containing both the same lecture and PowerPoint slides that were synchronized with the audio content. Interestingly, the enhanced podcast group outperformed the live lecture group. McKinney et al. (2009) note that "[t]his result was surprising given the assumption that students who attend class and take notes normally score the best on exams" (p. 621). Perhaps we can attribute the success of the enhanced-podcast group, in part, to the indexing of the podcast. The synchronized PowerPoint slide images were set up as audio chapter markers (tags) that allowed the student to navigate to specific audio segments. Students using this enhanced podcast commented that "… chapter markers [PowerPoint slide images] were useful for studying and reviewing desired sections of the podcast" (p. 621). In addition, students also commented that the markers (tags) helped to keep them on track. Further, the authors established that on average, students in the enhanced podcast group who employed the strategy of notetaking achieved higher scores than the students who just listened to the enhanced podcast.

2.1.2 Attendance at Lectures

Knowing that students can and do learn from audio-recorded lectures outside of the classroom has prompted many researchers to inquire about the relationship between student attendance and podcasts, with mixed findings (Bongey, Cizadlo, & Kalnbach, 2006; Copley, 2007; Hew, 2009; Holbrook & Dupont, 2011; Jensen, 2007; McKinney et al., 2009; Traphagan, Kucsera, & Kishi, 2010; Walls et al., 2010).

Some worry that the ready availability of podcasts of lectures will lead to empty classrooms (Read, 2005; Silverstein, 2006). Holbrook and Dupont (2011) posit that "… absenteeism is, at least, encouraged when podcasts are made available to students" (p. 241). And when Traphagan et al. (2010) studied the impact of webcasts - video and audio combined - they found that "class attendance counts were lower in the webcast section than the no-webcast section for most lectures" (p. 29).

However, several studies have found the drop in attendance to be minimal. For example, Copley's (2007) study of undergraduate attendance and podcast use shows that although some students (12% of the total sample) did not come to class when audio lectures were available, the vast majority of students continued to attend. Walls et al. (2010) found that 89% of participants indicated that having podcast files available would not have affected their course attendance. Similarly, Brittain et al. (2006) found that fewer than 10% of students using online-lecture-media saw them as a substitute for attending class. Further, Bongey (2006) randomly tracked classroom attendance and did not find large declines in attendance when lecture content was available as podcast and suggests that "… students do not use the podcasts as a way to avoid attending class" (p. 359).

Although a growing body of research indicates that attendance declines - slightly - when podcasts, enhanced podcasts or webcasts are available, other research, as mentioned earlier in this section, shows that using enhanced podcasts improves test outcomes (McKinney et al., 2009). Therefore, taken together, these findings suggest that lecture attendance may not be a reliable gauge for learning outcomes when students have access to recorded audio lectures. Learning - through lecture review and notetaking - appears to be happening, albeit outside the classroom.

2.2 Notetaking

The practice of notetaking - interpreting text and then making notes - can be traced back two millennia (Jackson, 2001). She further states that "[i]ndeed the custom [of notetaking] may be as old as script itself, for readers have to interpret writing, and note follows text as thunder follows lightning" (p. 53).

In an educational context, Crawford (1925) found that "notes which are full, clear and definite are more effective than those which are brief, sketchy or vague" (p. 290). In addition, educational theorists have long recognized the importance of having learners identify the main concepts embedded in newly-learned information as a means to enhance comprehension and retention. For example, as far back as 1946, Robinson recognized this when he developed the SQ3R reading strategy. With this approach, the reader turns section headings into questions, reads the section with the question in mind and then immediately tries to answer the question from memory. A few years later in the 1950s, Pauk created the Cornell method of notetaking, which is remarkably similar to the SQ3R reading system (Pauk, 1997). In the Cornell method, the learner "tags" written lecture notes or course readings with main ideas, questions to be answered and terms to be defined in the process of reviewing the notes or readings.

However, implementing the SQ3R system can be difficult and relatively ineffective (Jairam & Kiewra, 2009). Further, Jairam and Kiewra (2009) cite Willmore's (1966) results whereby students who simply underlined text outperformed students who used SQ3R. However, Kiewra (1989) reviewed 32 studies and found that in 24 of them, "students with access to review their notes performed better on various tests than students that were not permitted to review from notes" (p. 148). In the remaining eight studies, differences between reviewers and non-reviewers were not statistically detectible. Further, in most experiments, students in the notetaking-while-listening-to-a-lecture condition on average outperform students in the listening-only condition (K. A. Kiewra, 1985; Titsworth & Kiewra, 2004). In addition, reviewing notes can improve test scores. Rickards and Friedman (1978) found that, "…students who take and have notes for review will outperform those who only take notes or students who don't take any notes but do mentally review the passage prior to recall" (p. 141). Clearly, taking notes and then reviewing them enhances learning.

How does notetaking help students learn? Di Vesta and Gray (1972) posited that "notetaking serves two purposes: external storage [providing a resource for later review] and encoding [allowing for subjective associations]" (p. 8). Carrier and Titus (1981) state that "the major benefit of notetaking appears to be that it gives the student an external record that he or she can review" (p. 395).

Wittrock developed *the model of generative learning* in 1974. The central principle of generative learning is that, "people tend to generate perceptions and meanings that are consistent with their prior learning" (Wittrock, 1977, p. 88; Wittrock, 2010, p. 41). Extending the definition of encoding and incorporating Wittrock's (1974) *model of generative leaning*, Peper & Mayer (1986) theorised that "notetaking can be a *generative activity* that encourages students to build connections between what is presented and what they already know" (p. 34). Building on this active view of notetaking, in 1996 Mayer developed the Selecting, Organizing, and Integrating (SOI) model. The SOI model (see Figure 1) is an extension of Mayer's 1989 input-output information processing model. Within the SOI model, the input is "Text" and the output is "Performance". Mayer defines performance as retention or transfer on tests.

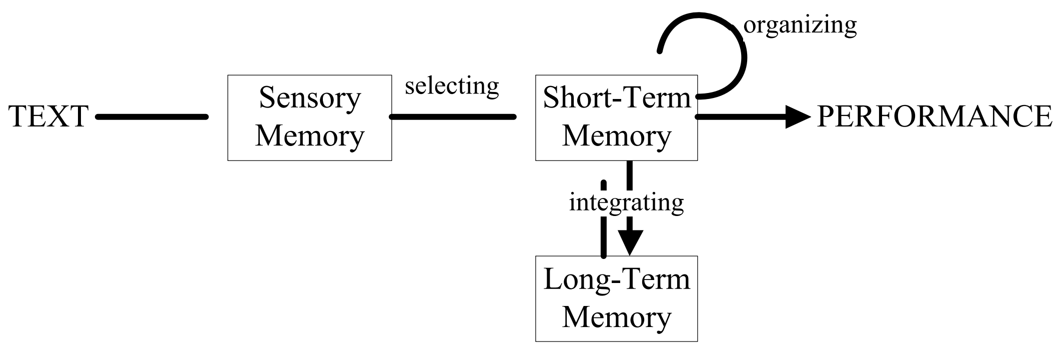


Figure 1: Mayer's (1996) **model of three cognitive processes in knowledge construction**

With the SOI model, Mayer explains the generative process of knowledge construction when learning from text. However, an understanding of how notetaking fits with podcasting in a multimedia environment, as well as how information is processed in working memory, requires exploring Mayer's (2001) cognitive theory of multimedia learning.

2.3 Cognitive Theory of Multimedia Learning

In 2001 Mayer extended the SOI model to include multimedia learning. The resulting cognitive theory of multimedia learning (CTML) includes inputs for words and pictures as well as the original selecting, organizing and integrating process (see Figure 2). In addition, Mayer updated the 1996 model (see Figure 1) by replacing the concept of "short-term memory" with that of "working memory". Mayer's (2001) representation of working memory and multiple sensory inputs is based on Paivio's (1978) dual coding theory (DCT). DCT describes how images (text and pictures) and sounds (auditory words and language) are processed via separate channels and then combined and integrated in one's working memory before being transferred to one's long-term memory.

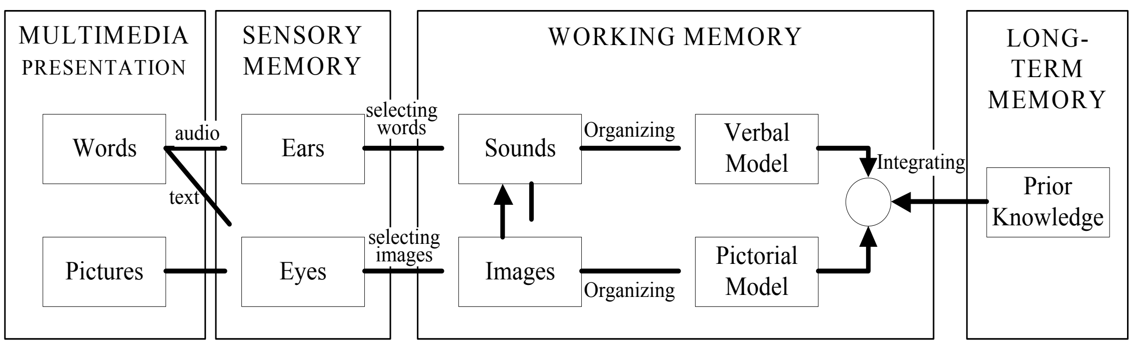


Figure 2: Mayer's (2001) **a cognitive theory of multimedia learning**

There is support for Mayer's CTML. For example, Moreno and Mayer (2002) found that "[s]tudents better comprehended the explanation when the words were presented auditorily and visually rather than auditorily only, provided there was no other concurrent visual material". Sweller (2005) dubbed this as the "reverse redundancy effect" (p. 164).

Interestingly, Mayer's (2001) model does not include a representation of external storage (output). Therefore, I have created a model that includes a representation for external storage (see Figure 3). This discursive model combines Mayer's 2001 CTML model with Di Vesta and Gray (1972) view of notetaking as external storage. Further, the outputs (notes) - external storage - are inputs on subsequent iterations of the model, whereby notes are reviewed or revised.

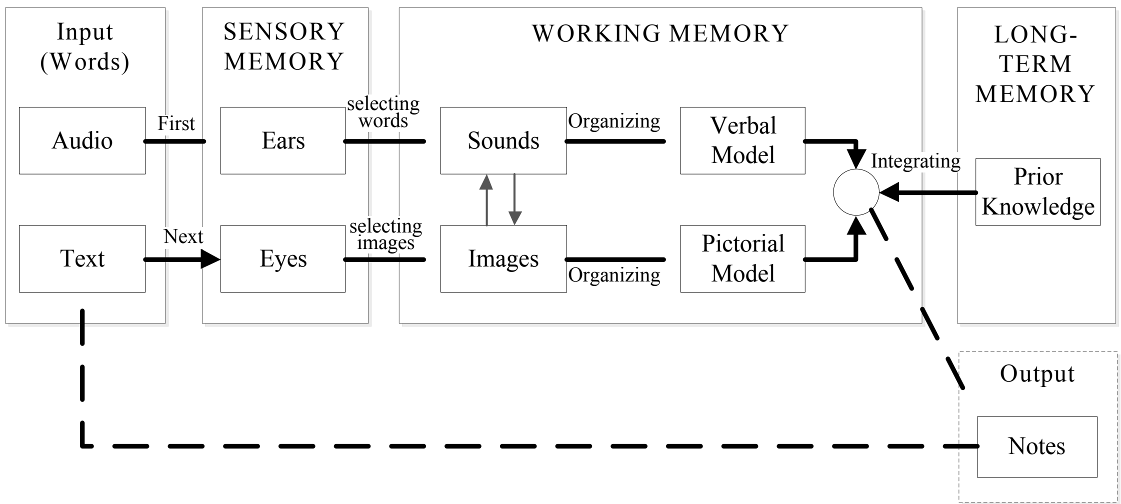


Figure 3: Mayer's (2001) CTML model - modified (shown as dashed lines) for lecture notetaking

Using this SOI based model (see Figure 3), note-makers first engage in a "selecting process" (Mayer, 1984, p. 32). Mayer defines selecting as "… the process of making sense … of what is and is not important" (Mayer, 1996, p. 365). During this first step, selected information is added to working memory (Mayer, 1996). For example, while listening to a lecture, the listener selects what to write in his or her notes. The second step in the SOI process is organizing the selected information into a coherent structure. Mayer (1996) states, "organizing involves the creating of a coherent structure that accommodates the key pieces of information" (p. 366) - for example, organizing and connecting key lecture ideas. The third step in the SOI model is integrating or relating the knowledge constructed in short-term memory with knowledge from long-term memory. Mayer (1996) describes this process as, "building external connections between the organized new knowledge and organized existing knowledge" (p. 366) - for example, when the listener organizes lecture information and connects it to prior knowledge. The output (see Figure 3) from this model - notes - can be thought of as external storage.

2.4 Conclusion

For as long as people have studied text, they have annotated the text directly or made separate notes. Research shows that notetaking is beneficial to learning. Recorded lectures, in the form of podcasts, are becoming an increasingly popular educational tool. However, podcasts do not have the same built-in opportunities for notetaking and review that textbooks or paper-based lecture notes have. This could be a problem: by providing podcasts of lectures, we may inadvertently draw students' attention to a medium that does not readily support proven study practices.

Therefore, if instructors and learners are to get the most out of podcasts, new resources may be required that support students' notetaking efforts to select, organize and integrate knowledge.

3: AUDIO RE-SEARCHER

The *Audio Re-Searcher* is a web-based application created as a resource to enhance learning from audio (Zander, 2011). This chapter describes the inspiration for it, the rationale and design considerations underlying it, and the architecture and software development tools used in creating it.

3.1 Problems with Reviewing Audio

When studying from print media, many students rely on making highlights and annotations. In fact, we commonly assume that a textbook which is not marked up has not been studied carefully (Jackson, 2001). However, unlike print media, it has not been possible to highlight or annotate audio content. Reviewing or quoting distinct audio sections is problematic because the listener must spend substantial time searching for those segments, essentially re-listening in real time rather than “skimming” as one would a familiar text.

Audio from many university and college level courses is freely available on the internet (MIT OpenCourseWare, 2008). However, searching and reviewing this wealth of audio material takes considerable time and effort. Due to these problems, audio has been an inefficient and difficult-to-use educational resource and, as a result, students, (who are usually pressed for time), are unlikely to listen to an audio lecture more than once. To be an effective learning resource, audio would ideally be as easy to highlight or annotate as print media are.

3.2 Description of the *Audio Re-Searcher*

The *Audio Re-Searcher* is an educational resource that allows learners to listen and re-listen to audio content (saved as MP3 audio files) outside of the classroom. The central aim of this tool is to transform learners' practices from passive listening to active engagement. As learners listen to audio content, they can identify main ideas and create time-indexed "tags" to capture them. The learner can also add text-based notes to these tags, which are represented by stars and placed on a visual timeline of the audio (see Figure 4). The learner can save the tags and notes on the *Audio Re-Searcher* server for later use - continued editing, sharing or evaluation - from any location where a web browser is available.

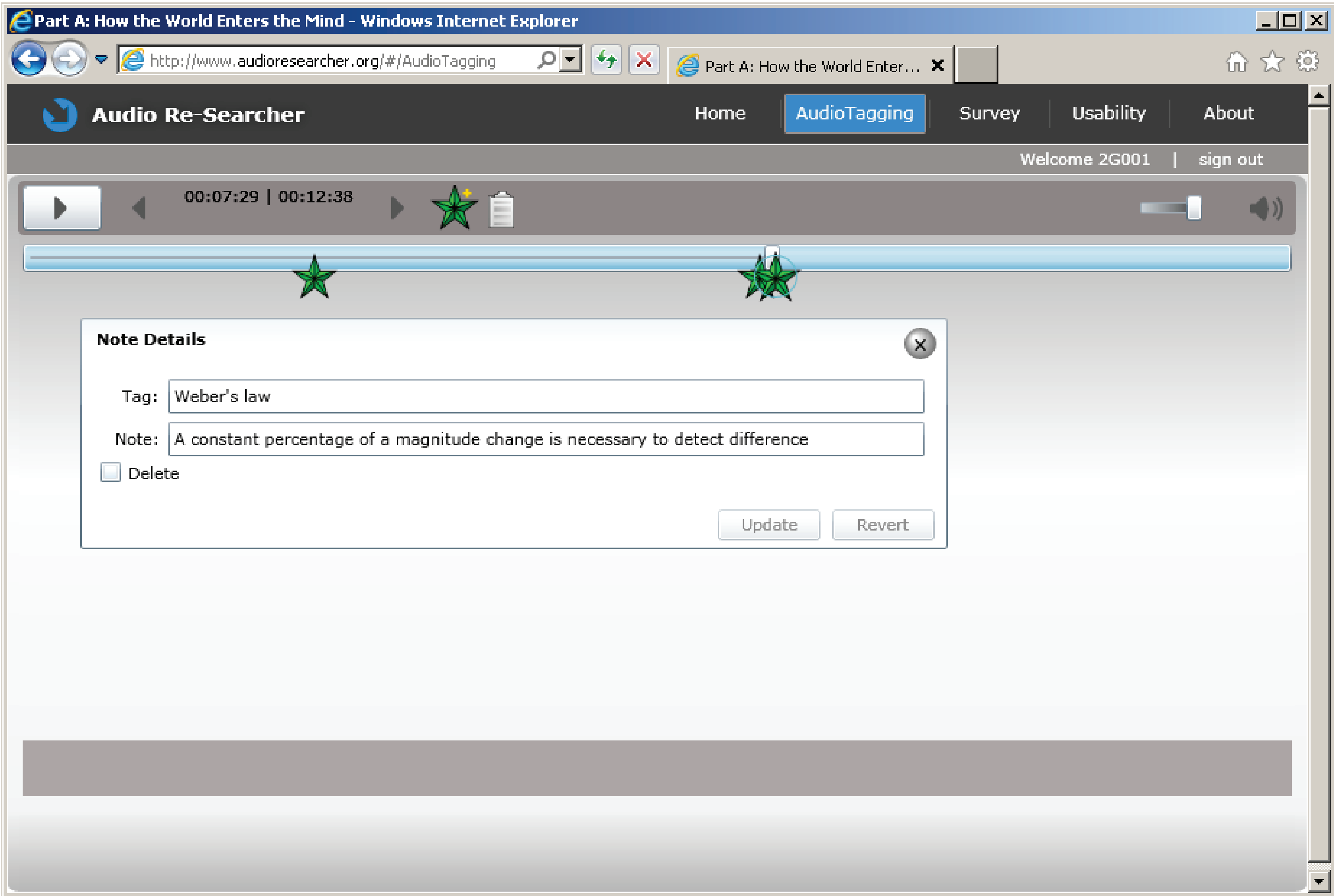


Figure 4: ***Audio Re-Searcher*** **Interface**

3.3 Theoretical Inspiration

It is generally understood that students who engage in notetaking have the benefit of an external memory storage mechanism for review (Austin, Lee, & Carr, 2004; Di Vesta & Gray, 1973; K. A. Kiewra, 1985; K. Kiewra, 1989). Further, as previously discussed, the act of notetaking, when the student can create linkages to prior knowledge, can be part of a generative process of knowledge construction (Peper & Mayer, 1986; Wittrock, 1974) as outlined in Mayer's (1996) SOI model. One way to enhance audio learning is to provide cue points (Griffin et al., 2009; McKinney et al., 2009; Titsworth & Kiewra, 2004) or supply corresponding written lecture notes (Austin et al., 2004).

Using the *Audio Re-Searcher*, the learner is presented with audio on a timeline (see Figure 4). During listening, the learner selects an important audio segment to tag. The learner can then create a note for the tag, which may help organize and integrate new information with prior knowledge. At this point, the tag and note are automatically saved (complete with audio time-index location) to the database. Later, if the learner reviews the audio with tags and notes, she might benefit from the "*reverse* [emphasis added] redundancy effect" (Sweller, 2005, p. 164), whereby audio enhanced-by-text is superior to audio alone (Moreno & Mayer, 2002). Thus, in a way similar to notetaking, the *Audio Re-Searcher* may function as a form of external storage to aid in the selecting, organizing, integrating and reviewing of course content.

It is important to emphasize that self-selection of "important" passages in an audio file is central to how the *Audio Re-Searcher* is hypothesized to enhance learning. Good students know what is important to select when underlining text, and the process of actively selecting key points is central to the larger learning process. For example, Rickards and August (1975) found that study participants who selected and underlined text recalled nearly twice as much incidental material compared to participants provided with pre-underlined text. They suggest that, "… the natural inclination of readers is to underline highly important material, rather than that which is least important" (p. 864). Clearly, the identification and selection of important information plays an important role in generative learning.

3.4 Design Inspiration

The design requirements for the *Audio Re-Searcher* grew originally out of a personal need to be able to find, organize, and re-listen to a distinct segment of an audio file without having to search or re-listen to the whole file. For a graduate-level course in which I was a student, I recorded the class lectures and discussions and posted them to a website, with the permission of the instructor and the other students (Zander & Nesbit, 2008). I did this to help a fellow student stay connected to the course while she was out of the country. As I listened to the recordings in the process of podcasting them, I was amazed to realize the number of times I had missed key points in the lectures. Further, I was shocked to hear segments that I did not remember at all, despite my presence and active engagement in class. Evidently, I had something to gain by reviewing the audio content of the course.

As the old adage states, "necessity is the mother of invention." During the process described above, I discovered that the amount of effort required to remember and locate a specific sound bite seems to increase exponentially in relation to the length of the audio file. Finding key points in a five-minute audio segment is not a problem, but identifying main ideas, as well as remembering when they occurred, in a two-hour recording of a lecture and class discussion is a near-impossible task. Therefore, I developed a strategy of taking notes and paying attention to the times at which important information occurred in the audio. This time index allowed me to go back to the source to review, clarify and reflect on key concepts and quotes. However, maintaining notes and time indexes in a Word document was clearly not an optimum way to organize or revisit audio content.

An “aha!” moment occurred when I watched a video that one of my classmates had annotated with visual captions. It occurred to me that a technology that provides a visual timeline of an audio file, to which a listener can add captions, might be a powerful learning tool.

3.5 Design Features

The *Audio Re-Searcher* has six core design features that make it useful as a learning tool.

First, the tool needs to be simultaneously available from multiple locations and compatible with multiple hardware platforms (MAC or PC). Further, the tool needs to looks and feels the same on these platforms. Developing these features as design requirements ensures that users will have a consistent interface whenever and wherever they choose. The *Audio Re-Searcher* meets the “simultaneously available” requirements by accessing the application over the internet in a standard web browser. Further, as a *SilverLight* application, the *Audio Re-Searcher* displays consistently in multiple web browsers (Safari, FireFox, Internet Explorer, Google Chrome, and Opera).

Second, the interface is minimal, which should make the system easy to use and require a minimal learning curve. Common media-player controls (similar in style to the

VCR player controls used on *YouTube*) guide learners toward specific tasks. In addition, a clutter-free and compact interface minimizes visual distractions and focuses listeners' attention. Further, complex tasks such as organizing time indexes, tags and notes happen in the background, and therefore do not distract the learner.

Third, the *Audio Re-Searcher* gives control of the learning process to the learner. Almost a century ago, Dewey (1916, p. 61) condemned the idea of "teaching by pouring in." Winne (2006) has shown how important it is for learners to self-regulate the learning process. Therefore, a major feature of the *Audio Re-Searcher* tool is that individual learners can author tags and notes to "make sense or to have meaning" (Bruner, 1990, p. 49) from what they are hearing.

Fourth, learners using the *Audio Re-Searcher* have authorial ownership of their tags and are able to edit, update, delete, and share tags and notes while the application is running on the internet. This provides a dynamic format that is fundamentally different from static, closed-captioned applications. Usually, closed-captioned applications feature pre-tagging and are broadcast with non-changeable captions. In contrast, *Audio Re-Searcher* allows the learner to interact with the audio by adding and revisiting tags at any time.

Fifth, the *Audio Re-Searcher* minimizes instructor effort. Cuban (1986, p. 66) states that:

> …teachers will seek out those tools that meet their tests of efficiency: Is it simple? Versatile? Reliable? Durable? What is the personal cost in energy versus return in worth for students? Will these

new machines help solve problems teachers (and not nonteachers) define?

Given this definition of efficiency, working with and preparing an audio file for instructional use needs to be uncomplicated. This suggests it would be most efficient to use uncut and unedited audio recordings (podcasts) of in-class lectures. This has the several benefits:

1. Instructors do not have to spend time to create a separate scripted or edited version of an in-class lecture as a podcast.
2. Providing the uncut in-class audio lecture, and then tagging important bits in the *Audio Re-Searcher*, eliminates the need for audio-editing knowledge or software. In fact, instructor-provided tags are not mandatory.
3. Instructors can take advantage of student participation in creating shared tags. Howe (2006) coined the term "crowdsourcing" to describe the outsourcing of task to a large group or crowd. Narrowing this term by restricting the "crowd" to the student participants, I developed the term "class-sourcing": instructors can "class-source" the tagging of recorded lectures.
4. To minimize effort and to keep audio lectures intact, instructors are not required to slice-up long lectures into short audio segments. In addition, listeners can benefit from context when the whole audio is available.
5. To minimize effort and keep the tagging process as simple as possible, an instructor adds tags through the same interface as the learner.

6. As a web-based educational application, learners (and instructors) can keep their tags and annotations as private as they choose. In its default setting, the *Audio Re-Searcher* keeps tags and annotations private. However, if learners (or instructors) want to share their annotations, they can place a check mark in the "Public" box for an individual tag, thereby making a tag and note contents visible to anyone logged into the system. However, the "Public" tag (and accompanying notes) does not reveal authors' names or login information.

Given what is known from previous research, these six features should arguably make the *Audio Re-Searcher* useful in an educational context where students have the opportunity to study from lengthy segments of digital audio.

3.6 Interface

For reasons identified above, the interface design of the *Audio Re-Searcher* can be summed up as "purposefully underwhelming" (Zander, 2008, p. 8). The simplicity of the design is meant to minimize extraneous cognitive load (Chandler & Sweller, 1991; Mayer, 2005) and demand on limited working memory (Baddeley, 1992).

Early on, I redesigned the three typical VCR-style buttons - "play", "pause", and "stop" - to have only one "play/pause" button. One button now does the job of pausing or playing audio, depending on the context. I also replaced "forward" and "rewind" buttons with a timeline-slider button - play head - to control one's location on the audio timeline. The learner is easily able to skip back ten seconds or drag the time index to any location on the timeline. Further, based on the "spatial continuity principle - students learn better when corresponding words and pictures are presented near rather than far from each other on the page or screen" (Mayer, 2001, p. 81), I grouped the "play/pause", "time index", "tagging" and "note" buttons close together, to reduce the need to search for the most-often used buttons (see Figure 5).

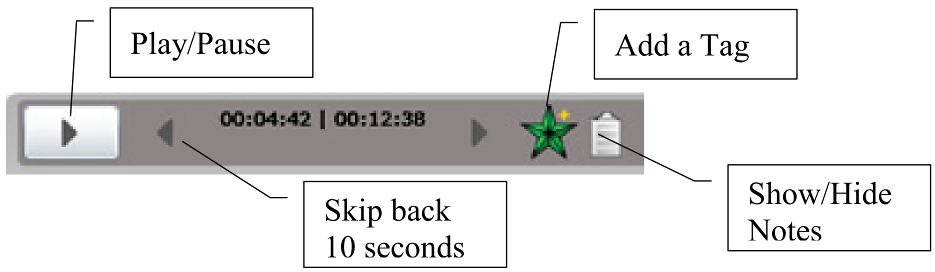


Figure 5: Grouped Controls

I intentionally chose icons rather than text buttons because I wanted the *Audio Re-Searcher* to be accessible to non-English-speaking learners. Unfortunately, in the current version of the *Audio Re-Searcher* there are multiple English-only text prompts. However, as these items are dynamic text strings, the ability to accommodate other languages can be integrated in a future version.

3.7 Architecture

This section presents and describes the software architecture and components used in creating the *Audio Re-Searcher*, starting with an overview and diagram of the interconnected components. I then describe the following components in more detail: (1) software used; (2) the media player selected; (3) database services; (4) database schema; (5) data logging; and (6) ASP.net membership.

3.7.1 Overview

The *Audio Re-Searcher* was created by combining and reworking Microsoft web and database technologies in a unique way. Programming, user interface and database customization were required in developing the *Audio Re-Searcher*. Figure 6 shows a schematic diagram of interactions between the custom programming, the interface, and database tables.

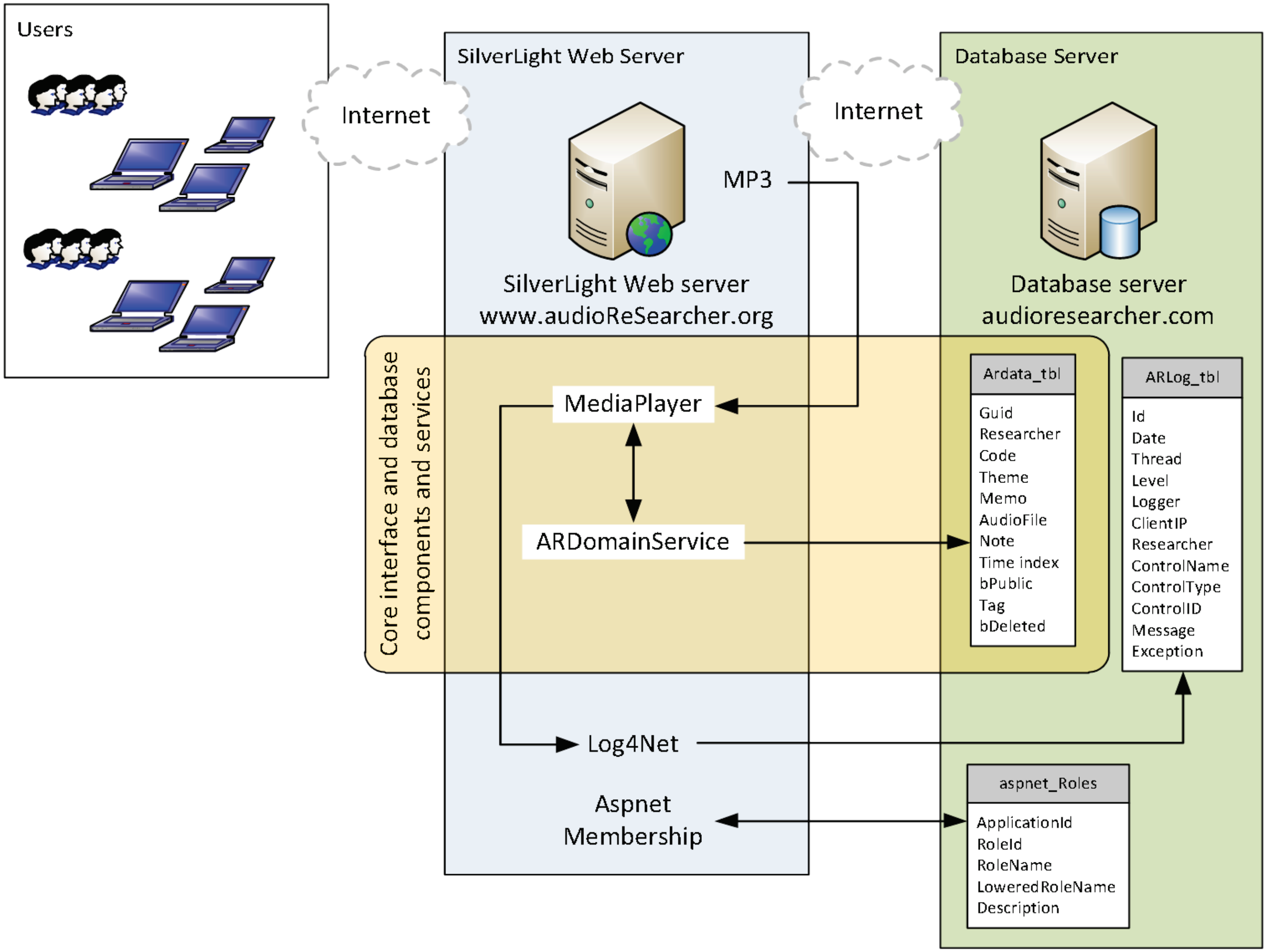


Figure 6: ***Audio Re-Searcher*** **Architecture**

3.7.2 Software Used

I built the *Audio Re-Searcher* application in C# using *Microsoft Visual Studio 2010* and *SilverLight 4* (Microsoft, 2010a; Microsoft, 2010b) because of ease of use and compatibility with other Microsoft technologies. The customizations of the media player used in this project are based on Heuer's (2009b) and Liberty's (2009) SilverLight media player examples. In addition, the tools used to create the *Audio Re-Searcher* are freely available to the educational community (Microsoft, 2011).

3.7.3 SilverLight Media Player

I selected the SilverLight Media Player because the functionality and look of the player could be adapted to the *Audio Re-Searcher*'s educationally-based design requirements. Out of the box, the SilverLight Media Player includes a visual timeline as well as VCR-style controls for working with audio and video. Unfortunately, the default layout heavily favours usage as a video player (see Appendix 11). Fortunately, the SilverLight Media Player can be modified. Using C# programming language, the *Audio Re-Searcher* modifications include: (1) changes to the look and location of default controls; (2) new custom controls; (3) storing user tags to a to database; (4) displaying user tags stored in a database; and (5) logging controls events to a database.

3.7.4 Data Services - ARDomainService

Connecting the user interface (SilverLight Media Player) to the database required the creation of data services. I extended Heuer's (2009a) *rich internet services (RIA) database example* to work with the SilverLight Media Player . The ARDomainService

(ARDS) - the name of the data service created for the *Audio Re-Searcher* - handles the data transactions between the user interface (UI) and the database. Specifically, the ARDS allows the UI to perform create, read, update and delete (CRUD) operations on the database. Therefore, each time a learner creates a tag, the ARDS handles database transactions behind the scenes. In addition, the ARDS filters tag data based on the user login name and audio file. For example, only the tags created by participant 2G001 are displayed in the IU for participant 2G001 when logged in. Further, when multiple users are logged in (as was the case in the lab study), users see only their own notes and not the notes of others. The ARDS effectively serves and stores the tag data based on user login name and audio lecture.

3.7.5 Database schema

I developed a new database table schema (Ardata_tbl) to store tagging information. The design of the schema required the inclusion of fields vital for maintaining each unique tag record. Therefore, the Ardata_tbl contains fields for the participant's name as well as audio file and time index information (see Table 2).

Table 2: Database Table Ardata_tbl with Field Descriptions

Field	Field Description
Guid	Unique Tag Identifier
Researcher	Participant Name
Tag	Text for the Tag
Note	Notes added by Participant
TimeIndex	Time index where the tag is located
AudioFile	Name (URL) of the MP3 file
bPublic	Public (shared) or Private tag
bDeleted	For deletion tracking
Code	Future use (for coding tag data)
Theme	Future use (for theming tag data)
Memo	Future use (for additional user memo)

3.7.6 Data Logging

Participant tagging interactions as well as participant UI usage data is captured and stored in a hosted Microsoft SQL Server 2008 database. The data-logging automation used in the *Audio Re-Searcher* application is an extension of the work of Vaughn's (2009) *Client Logging for .NET*.

3.7.7 ASP.net Membership

I used Microsoft's ASP.net membership provider to handle the creation of user accounts and roles. For the lab study, I defined separate roles and permissions to configure the UI for both groups of participants. Participants assigned to groups automatically had certain features of the program turned on or off based on membership in a role. The role membership ensured that participants used the *Audio Re-Searcher* in the correct configuration for both parts of lab study. Of note, preconfiguring the *Audio Re-Searcher* - with role memberships - eliminated the need for researcher to manually change the UI during the lab study. Participants were automatically guided to the correct content and user interface (for both sections of the lab study) without researcher intervention.

3.8 Summary

Similar to notetaking, the *Audio Re-Searcher* allows learners to select, organize, integrate, and review externally stored information. However, unlike notes created with pen-and-paper, the *Audio Re-Searcher* allows the learner to review and listen to the exact audio lecture content associated with the tags and notes taken. The *Audio Re-Searcher* presents a user-friendly software interface for creating and editing tags and notes synchronized to an audio timeline.

4: RESEARCH METHODOLOGY

This chapter describes the research methodology and participants for two separate studies - the survey and lab study. This chapter also describes the distinct survey and lab study environments. Throughout the chapter, several tables and figures summarize participant demographics.

4.1 Statement of Ethics Approval

Frank Zander has obtained human research ethics approval from the Simon Fraser University Office of Research Ethics for the research described in this thesis. Including, both the survey and the lab study (including questions and System Usability Scale).

4.2 Survey

The survey was conducted to better understand student listening practices and to be able to build and support instructional design technologies for audio learning. The survey also assists in describing the podcast and notetaking practices at the university where the second lab study was conducted. The survey therefore provides additional background context for the second study. In addition, the survey allows us to compare SFU student audio lecture usage to other university students. Further, the survey adds to the growing body of knowledge on student audio lecture (podcast listening) practices (Evans, 2008; Hew, 2009; Lakhal, Khechine, & Pascot, 2007; Lee, McLoughlin, & Chan, 2008; Levinson, 2009; McKinney et al., 2009; Walls et al., 2010). Understanding where and how students are listening to podcasts, gives a better idea of how to design and support audio learning resources.

4.2.1 Participant Recruitment

Participants in the survey were 100 SFU undergraduate students. Participants were recruited at a booth on the SFU Surrey campus. The booth was setup on the concourse level as it provided good visibility to the large volume of students passing through the area. The booth consisted of a poster board (see Appendix 6a) - outlining the study - as well as hand-outs describing the study (see Appendix 6b). In addition, the researcher actively solicited participants from groups of SFU students studying in the concourse area.

4.2.2 Environment

Of the 100 participants, 97 completed an online survey at the recruitment booth. Three participants completed the online survey at home.

4.2.3 Duration

The survey was carried out in October 2010 over nine sessions. One session was conducted during the daytime and eight were conducted in the evening. Daytime sessions were conducted between 10 am and 6 pm. Evening session were conducted between 6 pm and 8:30 pm.

4.2.4 Participant Profiles

The survey participants ($N = 100$) included 51 females and 49 males. The survey participant age range was 31 years, with the youngest participant being 17 years old and the oldest, 48. Survey participants' demographic information by gender for age, GPA, and semesters completed are shown in Table 3.

Table 3: Survey Participant Characteristics

		Gender		
		Female (n=51)	Male (n=49)	Total (n=100)
Age	Mean	20.75	22.20	21.46
	SD	4.20	6.34	5.38
	Range	17-44	17-48	17-48
GPA	Mean	3.08	3.10	3.09
	SD	.49	.53	.51
	Range	2.30-4.00	1.77-4.30	1.77-4.30
Semesters	Mean	5.71	5.65	5.68
	SD	5.32	4.18	4.77
	Range	1-27	1-16	1-27

4.2.5 Excluded Participants

Two potential participants were not permitted to take the survey. The first was unable to figure out how to create a username and password; the second was a visiting high school student.

4.2.6 Participant Incentives

Each participant in the survey was provided with a $5 coffee shop gift card. In addition, participants were entered into a draw with one-in-ten chance to win $50 cash. A total of $500 was randomly awarded to ten participants.

4.2.7 Procedure

Participants read, filled out and signed the informed consent form (see Appendix 1a). Next, they logged into the AudioReSearcher.org website and completed the online web survey (see Appendix 2). Participants took between 2.2 minutes and 15.8 minutes to complete the survey, with an average time of 4 minutes 50 seconds. After completing the survey, participants were given a $5 coffee shop gift card.

4.2.8 Materials

Most participants used one of two laptops provided by the researcher, though some used their personal laptops. Using an internet web browser, they created their own unique username and password and logged into the *Audio Re-Searcher* website. Participants completed the online survey (see Appendix 2) hosted on the *Audio Re-Searcher* website - www.audioresearcher.org.

4.2.9 Data Collection

All survey data was automatically collected - via the online survey form - and stored in a Microsoft SQL Server 2008 database. Participant responses were captured via an online Likert (1934) scale slider (see Figure 7). Behind the scene, data was captured from the slider control and stored in the database.

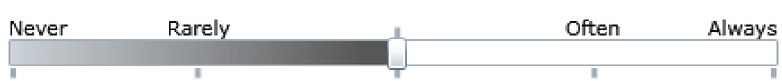


Figure 7: Survey Likert Slider Scale - Never, Rarely, Often, Always

Data entry validation for numeric values consisted of the following programmatic rules (1) Age: between 17 and 120, (2) GPA: between 0.5 and 4.33, and, (3) Semesters: between 1 and 120.

4.3 Lab Study

The Lab Study was conducted to compare the effect of listening to an audio lecture against listening and tagging an audio lecture. Students were randomly assigned to two groups. Both groups listened to two audio lectures. One group acted as the control group (listening only) while the other group listened and tagged the audio. The groups then switched roles (taggers became listens and listeners became taggers) for the second audio segment. This crosswise design optimized participant participation and maximized the comparability of participant test results.

4.3.1 Participant Recruitment

Participants were enrolled in a broad range of programs. Two weeks before the study commenced, 30 - 11" x 17" colour posters (see Appendix 7) advertising the study were placed on bulletin boards on the 3rd, 4th and 5th gallery floors at the SFU Surrey campus.

The posters included information on the details of the study, how to contact the researcher via text message or email to schedule an appointment. The bulk of the applicants chose to make the initial contact (for scheduling an appointment) by sending at text message. To ensure eligibility, applicants were asked (via text message or email) "Are you a current SFU student and have you completed at least one term at SFU?" Eligible applicants were then sent the following instructions: "Sign-up/pick a time slot online @ http://doodle.com/98arfb6uc4wavrvi".

4.3.2 Environment

The Lab study was conducted in a group study room within the Surrey SFU library. Access to the library group study room was convenient (did not require extra security pass access) and was available during evenings and Saturdays. Further, the SFU Surrey campus library location was either known to students or easily located. For uniformity, of the six available library group study rooms, only room 3660 was used. In addition, the selected room (see Figure 8) accommodated six participants.

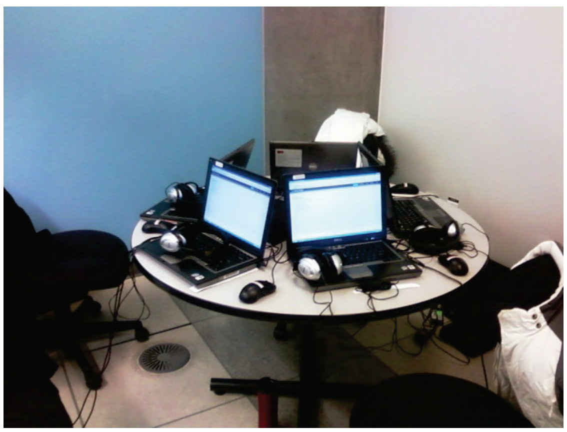


Figure 8: Library Study Room used for the Lab Study

4.3.3 Duration

Lab study sessions started February 5th, 2011 and concluded March 5th, 2011. In total, 20 two-hour sessions were carried out with an average of four participants per session.

4.3.4 Participant Profiles

In total, 89 students signed up for the study. However, nine students did not show up the appointed times. In addition, two students were not admitted to the lab due to lateness. The remaining 78 volunteer participants completed the protocol. Participants' demographic information (age, gender, GPA, and semesters completed) are shown in Table 4.

4.3.5 Excluded Participants

Of the 78 participants, 69 provided usable data. Seven participants did not complete all tests. Four participants did not complete the prior knowledge questions, two participants did not complete the first test, and one participant did not complete the second test. Further, two extremely low participant test scores were excluded as outliers.

Table 4: Lab Study Participant Demographic Information

		Assigned Group								
		Listen - Tagging			Tagging - Listen			Total		
		Gender			Gender			Gender		
		Female (n=12)	Male (n=23)	Total (n=35)	Female (n=16)	Male (n=18)	Total (n=34)	Female (n=28)	Male (n=41)	Total (n=69)
Age	Mean	20.67	20.87	20.80	20.19	21.56	20.91	20.39	21.17	20.86
	SD	2.674	2.702	2.66	1.83	3.82	3.09	2.200	3.216	2.856
	Range	18-28	18-27	18-28	18-24	18-33	18-33	18-28	18-33	18-33
GPA	Mean	2.96	2.99	2.98	2.94	2.80	2.86	2.94	2.91	2.92
	SD	.68	.44	.52	.41	.44	.42	.53	.44	.48
	Range	1.90-4.33	2.08-3.67	1.90-4.33	2.00-3.54	2.00-3.50	2.00-3.54	1.90-4.33	2.00-3.67	1.90-4.33
Semesters	Mean	5.42	6.43	6.09	4.88	6.33	5.65	5.11	6.39	5.87
	SD	2.78	5.18	4.48	3.59	3.58	3.61	3.22	4.49	4.05
	Range	1-11	1-16	1-16	1-12	1-14	1-14	1-12	1-16	1-16

4.3.6 Materials

McKinney (personal communication, 2010, November 30) agreed to and provided a 24-minute recorded lecture on the topic of visual sensation and perception as well as testing materials. This material was previously used in McKinney's (2009) study on podcasting.

For this study, the audio lecture was divided into two sections of equal length, Part One (P1) and Part Two (P2). Multiple-choice questions to test students' mastery of the lecture content - again, also supplied by McKinney - were matched to P1 and P2.

The *Audio Re-Searcher* (www.audioresearcher.org) tool was used by the participants for both listening (audio-only no tagging enabled) and tagging (audio with tagging enabled) conditions.

Participants interacted with the *Audio Re-Searcher* tool on a laptop PC (Dell Latitude D630) running Windows XP using Windows Internet Explorer 8 web browser. In addition, noise-canceling headphones (Maxell HP/NC-II) were supplied for participants to listen to the audio, minimizing auditory distractions present in the library environment. As an option, participants were allowed to bring their own headphones, ear-buds, or laptop. Most participants (a ratio of five to four) chose to use the supplied laptop and headphones.

After having used the *Audio Re-Searcher*, participants evaluated the usability of the *Audio Re-Searcher* via an online version of the System Usability Scale (SUS). SUS - developed by Digital Equipment Corporation - is a widely-used non-proprietary instrument for quickly and easily collecting user's subjective rating of a products usability (Bangor, Kortum, & Miller, 2008). The SUS instrument (see Appendix 3), as well as a comment box on the SUS form, was used to capture data on the usability of the *Audio Re-Searcher* tool. The SUS tool was integrated with the audioresearcher.com website. Participant SUS data was captured via a familiar Likert (1934) scale (see Figure 9). This slider scale allowed for easy data capture and calculation.

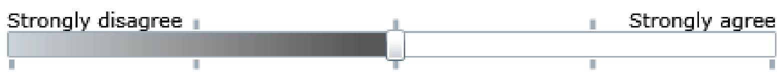


Figure 9: SUS scale - Strongly Disagree to Strongly Agree

4.3.7 Dependant Variables

The dependent variables in the lab study are the two multiple-choice tests of listening comprehension. Each of the multiple choice-tests matched the appropriate audio section. For example test one (see Appendix 4a) matches Part One (P1) and test two (see Appendix 4b) matches Part Two (P2). In total, 50 test questions were supplied by Dani McKinney from McKinneys' (2009) study of podcast learning.

4.3.8 Procedure

Participants were randomly assigned to Group One (G1) or Group Two (G2). As mentioned previously, lecture was divided into two sections of equal length, Part One (P1) and Part Two (P2). All participants listened to the same lecture content in the same order. After each segment, participants had a ten-minute “memory wash” task, intended to clear the contents of short-term memory so that the test results would reflect only what participants had stored in long-term memory. During the memory wash period, participants filled out survey data information and had the option have a bathroom break or look at library books. This memory wash task was followed by five minutes of review.

Next, participants completed a multiple-choice questionnaire relating to their listening comprehension of the content.

The difference between G1 and G2 is the order in which the listening or tagging condition was applied to P1 and P2 (see Appendix 10). Participants in G1 simply listened to P1, without making any tags (“listening” condition), then listened to and created tags for P2 (“tagging” condition). Participants in G2 listened to and created tags for P1 (“tagging” condition), then simply listened to P2, without making any tags (“listening” condition).

After completing the last test (P2), participants filled out an online version of Brooke's (1996) "Software Usability Scale" (SUS) (see Appendix 3).

Concluding the lab session, participants were debriefed and each participant was given $40.00 for the two-hour lab session.

4.3.9 Data Collection

All user interaction with the Audio Re-Searcher tool was logged to a Microsoft 2008 SQL server database. For example, the following participant interaction data was automatically captured and logged to the database for each participant interaction while using the Audio Re-Searcher: (1) time and date, (2) control type , (3) control name, (4) control id, (4) participant login name, (5) IP address, and (6) Message. This rich data capture allows for analysis of participant mouse clicks on interface items (see Figure 4). This also allows for granular analysis individual participant of edits to a tagged notes, word counts and tagging frequency. Lastly, all multiple-choice test questions (see

Appendixes 4a, 4b, 5) and results were hosted and captured on SFUs' web-survey application.

5: RESULTS

This chapter describes and presents the results of the survey and the usability questionnaire, as well as the lab study described in Chapter 4. The chapter is divided into three sections. The first section (5.1) describes the results of the online audio and notetaking survey. The second section (5.2) describes lab study participants' perceptions about the usability of the *Audio Re-Searcher* system. The third section (5.3) describes the results of the lab study. All quantitative data were analysed using IBM® SPSS® Statistics Premium version 19. Throughout the chapter, tables and figures summarize the data and associated analyses.

5.1 Survey

As mentioned previously, the survey was conducted to better understand SFU students' current course related podcast listening practices, and to inform the design and support of instructional technologies for audio learning. In particular, understanding *where* and *how* students are listening to podcasts gives a better idea of how to design and support audio learning resources. Specifically, survey results bolster the design decision to make the *Audio Re-Searcher* a web based tool accessed from a computer screen rather than a mobile device. In addition, the survey provides backdrop context for the second study conducted in the lab.

SFU participants (N = 100) provided demographic information (see Table 3) and answered questions on (a) notetaking habits, (b) audio availability and usage, and (c) lecture attendance.

5.1.1 Frequency Responses

Participants responded to online questionnaire Frequency items via a custom slider control (see Figure 7). The slider control mimicked a "Likert scale" (1934). However, unlike a typical - paper based - Likert scale, the slider control automatically stored information to the database. Behind the scenes, the slider control stored values between zero and ten. This invisible data scaling equates a range whereby *Never* equals zero, *Rarely* equals 2.5, *neutral* or *sometimes* equals five, *Often* equals 7.5, and *Always* equals ten (see Figure 10). Therefore, survey frequency responses presented in the following sections for are based on zero to ten (rather than the typical five or seven-point Likert scale). Lastly, interpreting frequency response on the Likert scale (Never, Rarely, Sometimes, Often, Always) is shown overlaid in Figure 10. Note that participants only saw the Likert scale control (see Figure 7). The Figure 10 shown here is only for interpreting frequency results.

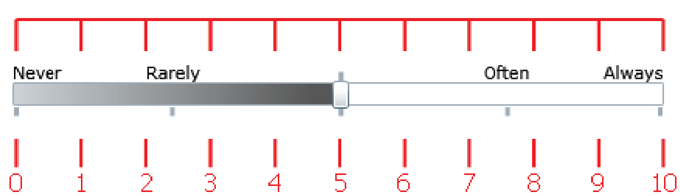


Figure 10: Likert Slider Control Overlaid with Frequency (shown red) Zero to Ten Scale

5.1.2 Notetaking

Survey participants indicated that they sometimes revisit notes, with an average of 5.47 hours spent per week on review (*SD* = 5.76, *n* = 100). Participants indicated that the notetaking was "often to always" done on paper 50% of the time and that 24% used computes to take notes in class. In addition, note review in the "often to always" category at 29% contrasts with note revisions at 10%.

Table 5: Notetaking

n=100	Never to Rarely	Rarely to Sometimes	Sometimes to Often	Often to Always
How often do you make hand written notes (on paper) during class?	20	11	19	50
How often do you type notes (using a computer or laptop) during class?	51	6	19	24
How often do you review your notes?	10	13	48	29
How often do you revise (update/edit) your notes?	39	23	28	10

5.1.3 Audio Provided by Instructor Frequency

Survey participants indicated a lack of available audio instructional materials for their courses In fact, 64% of participants indicated that their instructors "Never" or "Rarely" provided course audio (see Table 6).

Table 6: Audio Provided by Instructor Frequency

How often do your instructors provide course audio (mp3 or podcasts)?	n(%)
Never to Rarely	64(64)
Rarely to Sometimes	22(22)
Sometimes to Often	5(5)
Often to Always	9(9)
Total	100(100)

5.1.4 Listening Location and Hardware

Of the survey 100 participants, 75 indicated that they had accessed lecture content in audio form. Of those 75 participants, the highest percentage of "often to always" listening location was "at home" (see Table 7). Further, participants' preferred hardware for listening to lectures was their laptop (see Table 8).

Table 7: Listening Location

	How often do you listen to audio lectures:			
n=75				
	Home	School	Gym	Commute
	n(%)	n(%)	n(%)	n(%)
Never to Rarely	32(43)	47(63)	70(93)	57(76)
Rarely to Sometimes	5(7)	3(4)	1(1)	4(5)
Sometimes to Often	12(16)	15(20)	2(2)	9(12)
Often to Always	26(34)	10(13)	2(2)	5(7)

Table 8: Listening Hardware

n= 75	Laptop n(%)	Desktop n(%)	Ipod n(%)	Iphone n(%)	Generic MP3 player n(%)	Non Iphone Cell phone n(%)
	What hardware do you use to listen to audio lectures?					
Never to Rarely	21(28)	41(55)	46(61)	59(79)	63(84)	63(84)
Rarely to Sometimes	1(1)	3(4)	3(4)	0	1(1)	1(1)
Sometimes to Often	17(23)	17(23)	10(13)	8(11)	4(5)	6(8)
Often to Always	36(48)	14(19)	16(21)	8(11)	7(9)	5(7)

Some readers may be surprised that surveyed SFU students most frequently listened to lecture podcast audio at home, especially since we see many students listening to audio devices (MP3 players iPods etc.) between classes. It turns out that students are not commonly studying audio lectures while commuting between classes or home. Instead, the survey data indicate that SFU students most frequently study from lecture audio at home. This finding is congruent with Hew's (2009) review of podcast usage. In addition, the survey results indicate that SFU students (like other university students) listen to audio lectures on hardware *other than* iPod devices or MP3 players, despite the popularity of these devices for entertainment purposes. This is similar to the results noted in prior studies (Copley, 2007; Lane, 2006).

5.1.5 Attend when Audio Available

Many educators fear that if students have access to recorded lectures, they will stop attending class. However, Gump (2004) found that the best predictor and motivator of student attendance is how interesting the course is to the student. Therefore, attenuation of student attendance may be the result of instructional quality rather than delivery method (classroom vs. online).

Of the 75 participants who indicated they had accessed lecture audio content, 17% indicated that they would “Never to Rarely” attend lectures even when audio was provided (see Table 9). However, sixty-one percent of surveyed SFU students - with access to audio lectures - indicated that they *often to always* attend courses when audio of the lecture is also available. This finding is somewhat lower than Lane's (2006), who found that 79% continued to attend lectures despite having lecture audio available for download.

Table 9: Attend when Audio Available

Do you attend lectures when audio is also available?	n(%)
Never to Rarely	13(17)
Rarely to Sometimes	10(13)
Sometimes to Often	6(8)
Often to Always	46(61)
Total	75(100)

5.1.6 Discussion

SFU survey participant responses on audio and notetaking practices are generally consistent with prior research findings on where and how university students listen to recorded audio lectures (Evans, 2008; McKinney et al., 2009; Walls et al., 2010). The majority of SFU students, like other university students, report that they continue to attend lectures even when podcasts of the lectures are available. However, unlike other university students, the rate of SFU students’ attendance at lectures - when a podcast is provided - is somewhat lower than prior research has found (Hew, 2009; Lane, 2006; Walls et al., 2010). Perhaps this difference could be attributed to the commuter campus nature of the Surrey SFU campus. In terms of study location, SFU students, like their counterparts elsewhere, prefer to study at home and on stationary hardware.

5.2 Usability

The purpose of including a usability survey in the study was to ensure that the usability of the *Audio Re-Searcher* was not a confounding factor in the lab study results. The fundamental point of the survey was to determine whether the *Audio Re-Searcher* is easily usable and to make sure that this tool did not interfere with students' performance in such a way as to affect the study results.

5.2.1 System Usability Scale

Brooke's (1996) "System Usability Scale" (SUS) was administered to empirically gauge the usability of the Audio Re-Searcher for the target audience. The System Usability Scale comprises ten questions, presented on a Likert scale. Individual *Audio Re-Searcher* test question scores are shown in Appendix 3, however as Brook (1996) notes "... scores for individual items are not meaningful on their own." Therefore, an SUS rating is calculated by taking the overall mean of scores on the ten items.

Of the 69 lab study participants, one did not enter usability information and was removed from the present analysis. Sixty-eight participants provided data for the System Usability Scale. Bangor (2008) developed a rating system to compare SUS scores between different systems (see **Error! Not a valid bookmark self-reference.**). Bangor's (2008) rating system empirically compares products (systems) based on their SUS scores.

Bangor states that "a passable SUS score is (70%) with better products scoring in the high 70s to upper 80s" (p. 592).

Based on available data, the *Audio Re-Searcher* achieved a usability rating of 80%. Using Bangor's (2008) rating system, the *Audio Re-Searcher* usability rating places it in the *acceptable* range (see **Error! Not a valid bookmark self-reference.**).

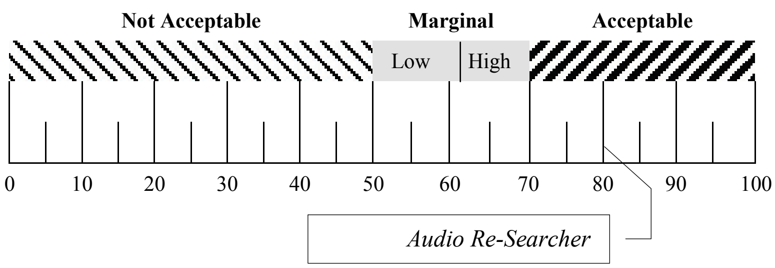


Figure 11: *Audio Re-Searcher* Overall SUS Rating on Bangor's (2008) Rating System

5.2.2 Discussion

One of the benefits of the System Usability Scale (SUS) is that results can be easily interpreted by multiple audiences with varying technical expertise. Bangor states:

> ... the survey provides a single score on a scale that is easily understood by the wide range of people (from project managers to computer programmers) who are typically involved in the development of products and services and who may have little or no experience in human factors and usability. (Bangor et al., 2008, p. 574)

Based on a mean SUS usability rating of 80%, it is reasonable to argue that the *Audio Re-Searcher* interface did not constrain participant's test performance.

5.3 Lab Study

The purpose of the lab study data-analysis is to determine whether learners inserting topic headings and notes while listening to a lecture podcast will improve their scores on subsequent multiple-choice content recall tests. The lab study results contrast the four dependent variable test scores of the two participant groups. As described previously, both groups listened to two half-hour audio lecture segments. One group acted as the control group first (listening only), while the other group listened to and tagged the audio. The groups then switched roles (taggers became listeners and listeners became taggers) for the second audio segment.

This section presents and describes lab study results. The section opens with an overview of the combined results. The overview is followed by a brief section describing the use of Hedges' *g* and confidence interval. Next, details of the four dependant variable results are presented. The section closes with a discussion of the lab study results.

5.3.1 Interpreting Combined Results in a Boxplot

This subsection gives an overall picture of the four test results shown as a boxplot of the combined results (see Figure 13) which will guide the reader's understanding the subsequent detailed results. As mentioned previously, each of the four test results will be presented following the boxplot overview.

However, first an example boxplot (see Figure 12) outlines the key points in reading a boxplot. Key graphic indicators shown in the box plot are (1) the range of scores (minimum and maximum), (2) the median, (3) the upper quartile, (4) the lower quartile, and (5) the interquartile range (25^{th} to 50^{th} percentile). In addition, the range is shown as a whisker. The interquartile range is shown as a wide box bounded by the lower and upper quartiles.

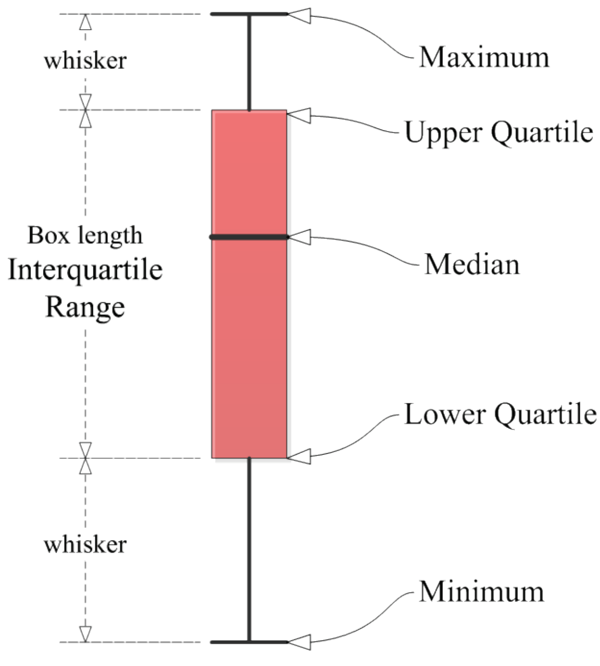


Figure 12: Boxplot Example

With our boxplot example in mind, the four lab study combined results are easily interpreted and compared when presented in a parallel boxplot (see Figure 13).

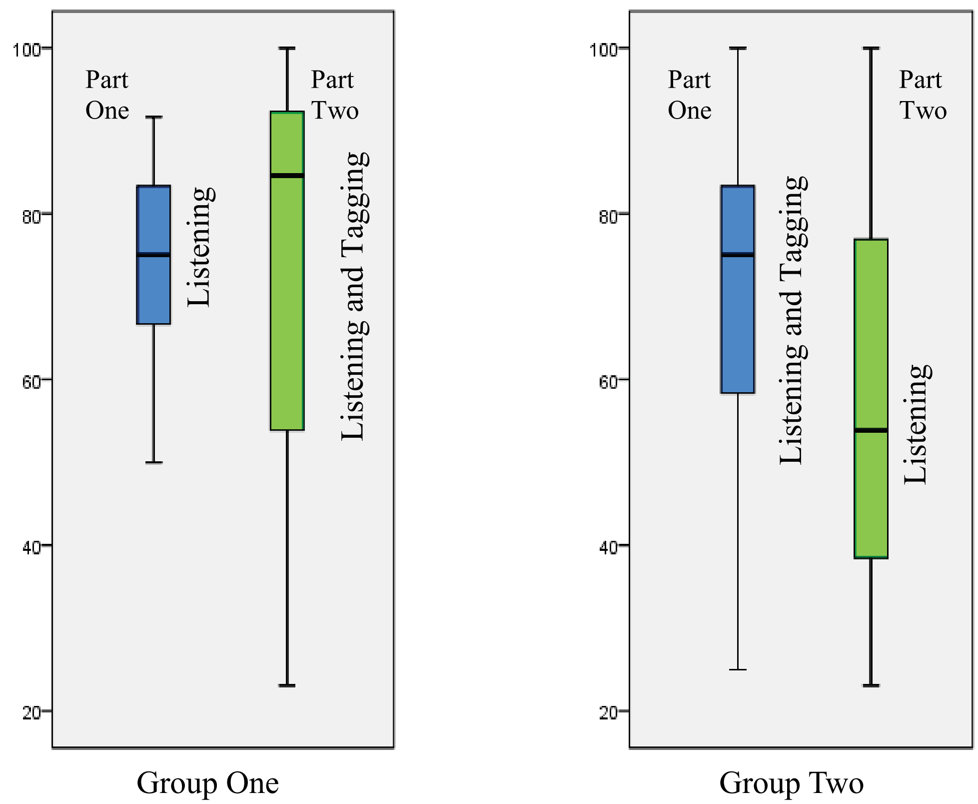


Figure 13: Assigned Group Box Plot of Test Percentages

At first glance, comprehension scores on part one (P1) seem similar for group one (G1) and group two (G2). However, looking more closely, G2 in the tagging condition has a larger spread (standard deviation) on test scores than G1 in the listening condition.

Further, it is startling that G2 did so poorly in the listening condition on the second test (P2). Not only is this result lower when compared to G2 in the tagging condition (P2), it is also lower than G1 in the listening condition (P1). In fact, the results for G2 on the second test are the lowest of all four results. To reiterate: participants who tagged first, then listened, had the lowest scores on the comprehension test, but only for the second half of the lecture, when they were in listening-only mode.

5.3.2 Hedges' *g* , Cohen's *d* and Confidence Interval Size

Statistical analysis in the following sections uses Hedges' *g* rather than Cohen's *d*. The use of Hedges' *g* is recommended when comparing groups of dissimilar sizes (Hedges & Olkin, 1985). For Hedges' *g*, the pooled standard deviation s* is computed as shown in Figure 14.

$$g = \frac{\bar{x}_1 - \bar{x}_2}{s^*} \quad s^* = \sqrt{\frac{(n_1 - 1)s_1^2 + (n_2 - 1)s_2^2}{n_1 + n_2 - 2}}$$

Figure 14: Calculation of Hedges' g

Hedges method allows for the computing of a pooled effect size and is therefore similar to Cohen's *d.* To describe effect sizes, Cohen (1988, p. 25) uses the terms "small, d = .2, medium, d = .5, and large, d = .8" (see Table 10).

Table 10: Cohen's categories of effect size

Effect size (*d*)	Size of Effect
$0.2 \leq d < 0.5$	**Small**
$0.5 < d < 0.8$	**Medium**
$d \geq 0.8$	**Large**

Lastly, throughout the lab study, the confidence interval of 95% is used.

5.3.3 Part One Group Differences Listening Comprehension

This section looks at the first set of listening comprehension test results compared between groups. For part one (P1), conditions were as follows. Group one (G1) acted as the control group and only listened to the audio lecture, whereas group two (G2) listened and tagged.

Two outlier cases with extremely low test scores ($z = -2.14$) were excluded from the analysis. The two Lab study participants with outlying scores were eliminated from all subsequent analyses. Table 11 shows means, standard deviation, and sample size for both treatment groups. Analysis of variance using the listening comprehension outcome variable detected an effect due to treatment ($F1,67 = 1.06$, $p = .307$). The partial η2 was .016, indicating that less than 2% of the variance in the listening comprehension scores could be attributed to treatment ($g = .25$). Two-tailed significance tests were used here and in all analyses.

Table 11: Part One Between-Group Differences in Listening Comprehension

Assigned Group	Mean	SD	N
Group One (G1) Listening	74.76	10.97	35
Group Two (G2) Tagging	70.59	21.24	34
Total	72.71	16.84	69

These results show that group differences in raw scores on the Part One Listening Comprehension test were not statistically detectible.

5.3.4 Part Two Between-Group Differences in Listening Comprehension

This section looks at the second set of listening comprehension test results compared between groups. For part two (P2) conditions were as follows; group two (G2) acted as the control group and only listened to the audio lecture, whereas group one (G1) listened and tagged.

As mentioned previously, two outlier cases were excluded from the analysis. Table 12 shows means, standard deviation, and sample size for both treatment groups on Part Two.

Analysis of variance using the listening comprehension outcome variable detected an effect due to treatment ($F1{,}67 = 8.02$, $p = .006$). The partial $\eta 2$ was .109, indicating that 11% of the variance in the listening comprehension scores could be attributed to treatment ($g = .68$).

These findings differ from those found in Part one of the study. Students in the group who first listened to audio file and then an audio file which was supported with tagging outperformed the group who tagged audio material first and then listened without tagging on a listening comprehension measure (see Table 12).

Table 12: Part Two Between-Group Differences in Listening Comprehension

Assigned Group	Mean	SD	N
Group One (G1) Tagging	74.07	21.84	35
Group Two (G2) Listening	58.37	23.66	34
Total	66.33	23.93	69

5.3.5 Listening Comprehension Within Group One

This section compares listening comprehension scores for the participants in group one obtained in Part 1 and Part 2. Therefore, this section's statistical analysis evaluates the test scores of part one (P1) and part two (P2) within group one (G1). As previously mentioned, G1 participants were assigned to the listening condition for P1. Later, G1 participants were assigned the listening and tagging condition for P2. The mean G1 scores for listening on P1 ($M = 74.76$, $SD = 10.99$, $n = 35$) were not significantly different from the tagging scores on P2 ($M = 74.06$, $SD = 21.84$, $n = 35$), $t(34) = .195$, $p = .84$ (two-tailed), $g = .04$. In addition, this paired-sample t-test was conducted using Levene's *Test for Equality of Variances.*

Table 13: Listening Comprehension Within Group One

Group One	Mean	SD	N
Part One (P1) Listening	74.76	10.97	35
Part Two (P2) Tagging	74.07	21.84	35

5.3.6 Listening Comprehension Within Group Two

This section compares both of the listening comprehension test results for the participants in group two. Therefore, this sections' statistical analysis evaluates the test scores of part one (P1) and part two (P2) within group two (G2). As previously mentioned, G2 participants were assigned to the tagging condition for P1. Later, G2 participants were assigned the listening condition for P2. The mean G2 scores for tagging on P1 (M = 70.59, SD = 21.24, n = 34) were significantly different from the listening scores for P2 (M = 58.37, SD = 23.66, n = 34), $t(33) = 2.6$, $p = .014$ (two-tailed), $g = .54$. In addition, this paired-sample t-test was conducted using Levene's *Test for Equality of Variances.*

Table 14: Listening Comprehension Within Group Two

Group Two	Mean	SD	N
Part One (P1) Tagging	70.59	21.24	34
Part Two (P2) Listening	58.37	23.66	34

The result of within group analysis shows average performance of students was greater in the part one tagging condition than in the part two audio-alone condition. This moderate drop in test performance on the second test will be explored further in the discussion section 5.3.7, as well as how this score fits within the context of the other results.

5.3.7 Discussion

This section presents important findings and then contrasts and interprets the between and within group results. In addition, this section examines and rebuts several possible confounds in the lab study.

Statistical analyses examined results on two parts of a comprehension test between and within groups for the conditions of listening alone, or listening with tagging. The order of these two conditions varied between the two groups. The main question addressed by the analyses was "does annotating audio files by inserting topic headings and notes improve recall as measured by a multiple-choice comprehension test?"

To summarize, comprehension scores for participants who listened first, then tagged, were not significantly different for the two parts of the test. However, for participants who tagged first, then listened, comprehension scores in the listening-only condition dropped considerably. Several confounds need to be ruled out before attempting to explain this outcome.

First, it may be argued that the second audio segment was somehow more difficult to comprehend than the first audio segment. However, a pilot study with three participants showed no substantial difference in test scores using audio-only or audio-and-tagging for both sections. In addition, the supplied audio and test materials from McKinneys' (2009) podcast study are reported by that author to be of equal quality throughout. Therefore, we can reasonably assume that the audio content and the test measures for both P1 and P2 are of equal difficulty for learners.

Second, it may be argued that learning to use the *Audio Re-Searcher* for tagging was too challenging, and thus had an impact on test scores. However, if the *Audio Re-*

Searcher was burdensome to learn and use, one would have expected to see poorer test results in the tagging condition, and for both groups this was not the case.

Third, it may be argued that participants experienced a novelty effect using the *Audio Re-Searcher* tool that positively affected their test scores in the tagging condition. Although the *Audio Re-Searcher* tool was a novelty for all participants, the second group, who tagged, then listened had comprehension scores on the first test that were not statistically different from those of the first group (listen, then tag). Therefore, it is reasonable to surmise that the novelty effect did not have a significant positive effect on test scores in the tagging condition.

These arguments still leave us with the mystery of the poor performance of group two (tag, then listen) on the second test, in the listening-only condition. Two plausible explanations are explored, followed by what I believe to be the most likely explanation.

First, perhaps the second group's experience of tagging during the first test crippled their subsequent performance on the second test, during the listening condition. McLuhan (1967, p. 26) suggests, "[a]ll media are extensions of some human faculty - psychic or physical." Further, with each media-related extension comes an amputation (McLuhan, 1964). Therefore, perhaps a "digital amputation" (Greenfield, 2011, [audio index 00:37:05]) occurred for the second group when they no longer had the ability to tag during the second half of the lecture. Put another way, learning a new way to work with audio may have had the "unanticipated [negative] consequence" (Rogers, 1995, p. 419) of poor performance when this new affordance (the ability to tag) was removed.

A second explanation for G2's drop in performance is that G2 participants experienced a "reverse novelty effect" when tagging was disabled for P2. In effect, they might have been put off by being forced to merely listen to audio for P2.

Both the first and second explanations seem somewhat plausible, and could have played a role in the G2's poor test results on P2. However, the combined effects of fatigue and cognitive load may also have played a significant role. By the time the participants started the second portion of the lab study, they had been working for a total of one hour. During that first hour, they listened or listened and tagged and completed survey questions and test questions. At the start of the second hour of the lab study, participants in both groups would have likely been fatigued.

Prior multi-media learning studies have investigated short media between 140 seconds (Mayer & Moreno, 1998) and 6 minutes (Moreno & Mayer, 1999) in duration. More specifically, podcast studies have investigated short audio segments between 5 and 15 minutes in length (Abt & Barry, 2007; Evans, 2008). Yet podcasts of actual lectures are virtually never this brief: the present study came closer to simulating real-world pedagogical applications of podcasts.

Overall, while the results of the lab study are somewhat ambiguous, they suggest an intriguing possibility. For the second test, perhaps participants who listened, then tagged far out-performed participants who tagged, then listened because tagging, through the process of generative learning, sustained their engagement in a lengthy process that required significant concentration and effort. Another way to say this is that, for participants who had been required to concentrate for over an hour, perhaps "tagging prevented flagging" (O'Neill, 2011, April 20, personal communication).

6: CONCLUSION

This chapter provides a summary of the survey, usability study and lab study results, as well as discussion of their implications and limitations. I will conclude with recommendations for future research on audio tagging.

6.1 Summary and Implications

Educators are recognizing the value of providing students with recording of lectures in audio format, as either a supplement to or replacement for in-person attendance. However, compared to text, the temporal nature of recorded audio makes identifying and reviewing main concepts in an audio file tedious and intrinsically difficult. Finding relevant audio segments for review is easier if a student has notes that provide a time index, or if the audio file contains cue points. Student learning benefits when cue points are provided for podcasts or in-class lectures. As well, notetaking in a multimedia environment provides learning benefits similar to those found in traditional notetaking scenarios. Although, "Moreno and Mayer's (2002) reverse redundancy effect" (Sweller, 2005, p. 164) explains how audio learning is reinforced when cue points are used for review, perhaps the cognitive acts of self-selecting audio segments, tagging them, and constructing notes based on associations with prior knowledge are more important to focusing and engaging learners when learning from lecture podcasts.

The *Audio Re-Searcher* was designed to allow the learner to "select, organize and/or integrate" (Mayer, 1996, p. 368) audio-recorded lecture content in a way that parallels pen-and-paper notetaking. This tool allows the learner to review and listen to audio content associated with tags and notes created by the listener. Through the process of creating tags and notes, the learner creates an enhanced podcast. This self-selection and discovery - of important content - is consistent with Wittrock's (1974, 2010) central premise of generative learning, "people tend to generate perceptions and meanings that are consistent with their prior learning". As Proust argued over 50 years ago,

> We are not provided with wisdom, we must discover it for ourselves, after a journey through the wilderness which no one else can take for us, an effort which no one can spare us, for our wisdom is the point of view from which we come at last to regard the world (1957, p. 1035).

The creation of self-selected tags and notes on an audio timeline in *Audio Re-Searcher* likely plays an important role in generative learning - or self-discovery, as Proust puts it.

The investigation of SFU students in the current online survey found them to be similar to other university students discussed in the literature in terms of how and where they use podcasts: regardless of the popularity of iPod devices or MP3 players for entertainment purposes, SFU students most frequently listen to audio lectures at home on either a laptop or desktop PC.

Knowing this, and that synchronizing images and text can improve learning outcomes (Griffin, Mitchell, & Thompson, 2009; Kennedy, Hart, & Kellems, 2010; McKinney et al., 2009), it made sense to provide a vehicle for delivering educational podcasts that can take the greatest advantage of stationary hardware. The *Audio Re-*

Searcher, a web-based multimedia tool, matches student preferences for listening to audio at home on stationary hardware.

The design rationale for the *Audio Re-Searcher* hypothesizes specific benefits for learning, which were tested in a lab study. Overall, the results from this lab study are somewhat surprising. From the data available, we cannot know exactly why performance was so much higher for the first group (listen, then tag) than for the second group (tag, then listen) on the second half of the comprehension test. However, we do know empirically that, from a student perspective, the *Audio Re-Searcher* is highly usable. Therefore, it is unlikely that difficulties with the interface caused the differences in performance between the two groups on the second test. In addition, prior research on notetaking clearly establishes both the benefits of external storage and generative learning for study.

The lab study results suggest the fascinating possibility that the listen-then-tag group group (G2) fared better on the second part (P2) of the test than the tag-then-listen group because the added task of tagging sustained their engagement, despite their mental fatigue.

Had they been taking notes from a text, this would have been the equivalent of taking away their pens and notepaper. This line of thought suggests that there may be unintended consequences to using *Audio Re-Searcher,* as there have been with other educational technologies (Nworie & Haughton, 2008).

The affordances of a technology can supplant our innate abilities, as for instance the reliance on the technology of print has diminished our capacity to remember (Illich & Sanders, 1988). In the context of the *Audio Re-Searcher*, one might wonder if even a short exposure to the practice of tagging-audio-in-a-multimedia-environment encourages a lack of attention to listening. On the other hand, perhaps this is a *post hoc ergo propter hoc* logical fallacy. Clearly, the benefits and detriments of tagging audio need to be investigated further.

6.2 Limitations and Recommendations for Future Research

This section explores possible limitations of the lab study, survey, and *Audio Re-Searcher* application.

6.2.1 Lab Study

The two-hour lab study resulted in what is interpreted as a flagging phenomenon. Ideally, the lab study would have had longer separations - one week verses the current 10 minutes - between treatments (notetaking or listening only), review and testing. This might be useful in isolating the effects of (1) notetaking, (2) reviewing notes, and (3) fatigue. With a longer separation between treatment and testing, the participants would be "fresh" for testing. However, if repeating the current two hour lab study procedure, another way to investigate fatigue would be to measure fatigue by direct observation (video tape and rate for tiredness and posture changes) and/or by self-report (self-rating of fatigue every five minutes). A future study might be able to clarify the finding that tagging sustains engagement despite fatigue.

For the lab study, only 69 of the 78 participants provided usable data. A larger number of homogeneous participants might provide more convincing results. Future research studies might screen for age, gender, GPA and prior knowledge. During the pilot, it was discovered that some of the lecture content supplied by McKinney - on sensation and perception - is covered in the British Columbia grade nine science curriculum. Therefore, future studies using McKinney's lecture content might consider limiting participants to those that have not been exposed to the British Columbia grade nine science curriculum. Further, the prior knowledge questionnaire was a self-report of exposure to previous learning. A pre-test would have been a better method of gauging prior knowledge. Alternatively, neutral or non-science content could be used. Future studies might also investigate the quantity and quality of the tags and notes taken in relationship to both recall and transfer. However, this would require changing the test question format to get at deep versus shallow learning, and rote learning versus meaning-making. Finally, the *Audio Re-Searcher* application could be evaluated within the context of a SFU course that offers recordings of lectures.

6.2.2 Survey

In this survey, students self-reported the frequency of attending lectures when audio lectures are provided. The score for "attend class when audio is also available" by SFU survey participants seems to be lower than the results of several other podcast studies. Lane's (2006) study found that 79% of student responses indicated the availability of lecture audio as having no impact on attendance.

With regard to another portion of the survey, the wording of the System Usability Scale question #8 (see Appendix 8) called for clarification by several participants in this study. Specifically, the word "cumbersome" was not part of some participants' vocabulary. Finstad (2006) has suggested that to help non-English speakers, the word "awkward" can be substituted for the word cumbersome.

Further, when building an online multimedia tool, one ought to consider the available hardware and the current audience practices. Unfortunately, the survey did not include questions about Internet connection speed. This could be an important design consideration for multi-media designers. However, based on both students' current preferences for listening to educational podcasts on their laptop or desktop computers and the positive research on enhanced podcasts, the use of web-based multi-media audio applications such as the *Audio Re-Searcher* should be further explored.

6.2.3 Audio Re-Searcher

Participants in the lab study suggested several new features that would further minimize the cognitive effort required to use the *Audio Re-Searcher*. The most promising suggestion might be the addition of a variable playback speed control. Further supporting this suggestion by several participants are Carver's (1973) findings that (1) increasing audio playback speed does not necessarily negatively affect comprehension, and (2) individuals have differing audio playback-speed comprehension thresholds.

Currently Guloy (2011) is using the Audio Re-Searcher in a doctoral thesis focused on online mentoring. Initial responses from participants indicate that the tool is easy to use. One mentor and mentee in a pilot group stated that they would like to be able to share notes privately (Guloy, 2011, May 30, personal communication). Adding the capacity to privately share notes with another selected user could make the Audio Re-Searcher a useful tool for "telementoring - also called e-mentoring or online mentoring" (O'Neill, Weiler, & Sha, 2005, p. 111). Further, sharing notes between friends or classmates opens the possibility of the Audio Re-Searcher being used as a tool to facilitate “collaborative learning” (Pea, 1994, p. 285) or “computer-supported collaborative learning - CSCL” (Weinberger & Fischer, 2006, p. 71).

It is hoped that the *Audio Re-Searcher* application can continue to evolve, with new versions incorporating user comments and suggestions. However, the addition of new features should integrate the design features put forward in section 3.5, including: (1) high availability - web based - with a consistent interface, (2) minimal interface, (3) learner control - self-selection of important information, (4) learner ownership of tags and notes, (5) minimize instructional effort, and (6) privacy control.

In addition, I plan for newer versions of the *Audio Re-Searcher* application to include the SUS questionnaire. In this way, the usability of newer versions can be compared against the baseline 80% SUS rating. Perhaps this would answer the most basic software development question, "Is the *Audio Re-Searcher* application improving (version to version)?"

7: REFERENCES

Abt, G., & Barry, T. (2007). The quantitative effect of students using podcasts in a first year undergraduate exercise physiology module. *Bioscience Education e-Journal, 10* doi:10.3108/beej.10.8

Apple Inc. (2008). *Apple - education - iTunes U - overview.* Retrieved July 30, 2008, from http://www.apple.com/education/itunesu_mobilelearning/itunesu.html

Apple Inc. (2011). *Apple - iTunes U - learn anything, anywhere, anytime.* Retrieved June 21, 2011, from http://www.apple.com/education/itunes-u/

Austin, J. L., Lee, M., & Carr, J. P. (2004). The effects of guided notes on undergraduate students' recording of lecture content. *Journal of Instructional Psychology, 31*(4), 314-320.

Baddeley, A. (1992). Working memory. *Science, 255*(5044), 556-559. Retrieved from http://www.jstor.org.proxy.lib.sfu.ca/stable/2876819

Bangor, A., Kortum, P. T., & Miller, J. T. (2008). An empirical evaluation of the system usability scale. *International Journal of Human-Computer Interaction, 24*(6), 574. doi:10.1080/10447310802205776

Bongey, S. B., Cizadlo, G., & Kalnbach, L. (2006). Explorations in course-casting: Podcasts in higher education. *Campus-Wide Information Systems, 23*(5), 350-367. doi:10.1108/10650740610714107

Brittain, S., Glowacki, P., Van Ittersum, J., & Johnson, L. (2006). Podcasting lectures. *Educause Quarterly, 29*(3), 8. Retrieved from http://www.educause.edu/ir/library/pdf/EQM0634.pdf

Brock, R. (2007). How to podcast campus lectures. *The Chronicle of Higher Education, 53*(21), A32-5.

Brooke, J. (1996). SUS: A 'quick and dirty' usability scale. In P. W. Jordan, B. Thomas, B. A. Weerdmeester & I. L. McClelland (Eds.), *Usability evaluation in industry* (pp. 189-194). London: Taylor & Francis.

Bruner, J. S. (1990). *Acts of meaning*. Cambridge, MA, US: Harvard University Press.

Carrier, C. A., & Titus, A. (1981). Effects of notetaking pretraining and test mode expectations on learning from lectures. *American Educational Research Journal, 18*(4), 385-397. Retrieved from http://www.jstor.org.proxy.lib.sfu.ca/stable/1162628

Carver, R. P. (1973). Effects of increasing the rate of speech presentation upon comprehension. *Journal of Educational Psychology, 65*(1), 118-126. doi:10.1037/h0034783

Chandler, P., & Sweller, J. (1991). Cognitive load theory and the format of instruction. *Cognition and Instruction, 8*(4), 293. doi:10.1207/s1532690xci0804_2

Clark, D., & Walsh, S. (2004). iPod-learning.[white paper]. *Brighton, UK: Epic Group,*

Coghlan, E., Futey, D., Little, J., Lomas, C., Oblinger, D. & Windham, C. (2007). *ELI discovery tool: Guide to podcasting.* Retrieved June 2, 2011, from http://www.educause.edu/GuideToPodcasting

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Hillsdale, N.J.: L. Erlbaum Associates.

Copley, J. (2007). Audio and video podcasts of lectures for campus-based students: Production and evaluation of student use. *Innovations in Education and Teaching International, 44*(4), 387-399. doi:10.1080/14703290701602805

Crawford, C. C. (1925). The correlation between college lecture notes and quiz papers. *The Journal of Educational Research, 12*(4), 282-291. Retrieved from http://www.jstor.org.proxy.lib.sfu.ca/stable/27523171

Cuban, L. (1986). *Teachers and machines: The classroom use of technology since 1920*. New York: Teachers College Press.

Dewey, J. (1916). *Democracy and education: An introduction to the philosophy of education.* Macmillan Publishing. Retrieved from http://www2.hn.psu.edu/faculty/jmanis/johndewey/dem&ed.pdf

Di Vesta, F. J., & Gray, G. S. (1972). Listening and note taking. *Journal of Educational Psychology, 63*(1), 8-14. doi:10.1037/h0032243

Di Vesta, F. J., & Gray, G. S. (1973). Listening and note taking: II. immediate and delayed recall as functions of variations in thematic continuity, note taking, and length of listening-review intervals. *Journal of Educational Psychology, 64*(3), 278-287. doi:10.1037/h0034589

Edirisingha, P. (2007). The" double life" of an i-pod: A case study of the educational potential of new technologies. Paper presented at the *Online Education Conference,* Berlin: Germany.

Evans, C. (2008). The effectiveness of m-learning in the form of podcast revision lectures in higher education. *Computers & Education, 50*(2), 491-498. doi:10.1016/j.compedu.2007.09.016

Finstad, K. (2006). The system usability scale and non-native english speakers. *Journal of Usability Studies, 1*(4), 185-188. Retrieved from http://www.usabilityprofessionals.org/upa_publications/jus/2006_august/finstad_sus_non_native_speakers.pdf

Greenfield, A. (2011). In Young N. (Ed.), *Spark 147 – digital impermanence [audio index 00:37:05]*. Vancouver: CBC Radio. Retrieved from http://podcast.cbc.ca/mp3/podcasts/spark_20110508_14370.mp3

Griffin, D. K., Mitchell, D., & Thompson, S. J. (2009). Podcasting by synchronising PowerPoint and voice: What are the pedagogical benefits? *Computers & Education, 53*(2), 532-539. doi:10.1016/j.compedu.2009.03.011

Guloy, S. (2011). *Virtual mentoring for volunteer leadership development.* (Unpublished Doctor of Philosophy). Simon Fraser University, Simon Fraser University.

Guloy, S. (2011, May 30). In Zander F. O. (Ed.), *Initial feedback on audioresearcher*. Burnaby BC, Canada: SFU.

Gump, S. E. (2004). Keep students coming by keeping them interested: Motivators for class attendance. *College Student Journal, 38*(1), 157-160.

Hedges, L. V., & Olkin, I. (1985). *Statistical methods for meta-analysis*. Orlando: Academic Press.

Heuer, T. (2009a). *Introduction to WCF RIA services.* Retrieved June 13, 2010, from http://www.silverlight.net/learn/videos/all/net-ria-services-intro/

Heuer, T. (2009b). *New silverlight media experience for WindowsClient.net.* Retrieved June 16, 2011, from http://timheuer.com/blog/archive/2009/02/26/new-silverlight-media-experience-on-windows-client.aspx

Hew, K. (2009). Use of audio podcast in K-12 and higher education: A review of research topics and methodologies. *Educational Technology Research and Development, 57*(3), 333-357. doi:10.1007/s11423-008-9108-3

Holbrook, J., & Dupont, C. (2011). Making the decision to provide enhanced podcasts to post-secondary science students. *Journal of Science Education & Technology, 20*(3), 233-245. doi:10.1007/s10956-010-9248-1

Howe, J. (2006, June). The rise of crowdsourcing. *Wired, 14.06*(July 24, 2006) Retrieved from http://www.wired.com/wired/archive/14.06/crowds.html

Illich, I., & Sanders, B. (1988). Memory. In *ABC: The alphabetization of the popular mind* (pp. 14-28) London: Penguin Books.

Jackson, H. J. (2001). *Marginalia: Readers' writing in books*. New Haven: Yale University Press.

Jairam, D., & Kiewra, K. A. (2009). An investigation of the SOAR study method. *Journal of Advanced Academics, 20*(4), 602-629. Retrieved from http://search.ebscohost.com.proxy.lib.sfu.ca/login.aspx?direct=true&db=tfh&AN=48074289&site=ehost-live

Jensen, M. (2007). Lecture is dead: Take 3. *American Biology Teacher, 69*(3), 138-138. doi:10.1662/0002-7685(2007)69[138:LIDT]2.0.CO;2

Kennedy, M. J., Hart, J. E., & Kellems, R. O. (2010). Using enhanced podcasts to augment limited instructional time in teacher preparation. *Teacher Education and Special Education: The Journal of the Teacher Education Division of the Council for Exceptional Children,* doi:10.1177/0888406410376203

Kiewra, K. (1989). A review of note-taking: The encoding-storage paradigm and beyond. *Educational Psychology Review, 1*(2), 147-172. doi:10.1007/BF01326640

Kiewra, K. A. (1985). Learning from a lecture: An investigation of notetaking, review and attendance at a lecture. *Human Learning: Journal of Practical Research & Applications, 4*(1), 73-77.

Lakhal, S., Khechine, H., & Pascot, D. (2007). Evaluation of the effectiveness of podcasting in teaching and learning. Paper presented at the *Proceedings of World Conference on E-Learning in Corporate, Government, Healthcare, and Higher Education 2007,* 6181-6188. Retrieved from http://www.editlib.org.proxy.lib.sfu.ca/p/26770

Lane, C. (2006). *UW podcasting: Evaluation of year one.* Retrieved April 30, 2011, from http://www.washington.edu/lst/research_development/papers/2006/podcasting_year1.pdf

Lee, M. J. W., & Chan, A. (2007). Pervasive, lifestyle-integrated mobile learning for distance learners: An analysis and unexpected results from a podcasting study. *Open Learning, 22*(3), 201-218. doi:10.1080/02680510701619810

Lee, M. J. W., McLoughlin, C., & Chan, A. (2008). Talk the talk: Learner-generated podcasts as catalysts for knowledge creation. *British Journal of Educational Technology, 39*(3), 501-521. doi:10.1111/j.1467-8535.2007.00746.x

Levinson, P. (2009). *New new media*. Boston: Allyn & Bacon.

Liberty, J. (2009). *Extending the SMF for the HVP.* Retrieved June 16, 2011, from http://jesseliberty.com/2009/12/17/extending-the-smf-for-the-hvp/

Likert, R., Roslow, S., & Murphy, G. (1934). A simple and reliable method of scoring the thurstone attitude scales. *The Journal of Social Psychology, 5*(2), 228-238.

Mayer, R. E. (1984). Aids to text comprehension. *Educational Psychologist, 19*(1), 30. Retrieved from http://search.ebscohost.com.proxy.lib.sfu.ca/login.aspx?direct=true&db=aph&AN=6370673&site=ehost-live

Mayer, R. E. (1989). Models for understanding. *Review of Educational Research, 59*(1), 43-64. doi:10.3102/00346543059001043

Mayer, R. E. (1996). Learning strategies for making sense out of expository text: The SOI model for guiding three cognitive processes in knowledge construction. *Educational Psychology Review, 8*(4), 357. doi:10.1007/BF01463939

Mayer, R. E. (2001). *Multimedia learning*. New York: Cambridge University Press.

Mayer, R. E. (2005). Principles for reducing extraneous processing in multimedia learning: Coherence, signaling, redundancy, spatial contiguity and temporal contiguity principles. In R. E. Mayer (Ed.), *The cambridge handbook of multimedia learning* (pp. 183-200). New York: Cambridge University Press.

Mayer, R. E., & Moreno, R. (1998). A split-attention effect in multimedia learning: Evidence for dual processing systems in working memory. *Journal of Educational Psychology, 90*(2), 312-320. doi:10.1037/0022-0663.90.2.312

McKinney, D. (2010, November 30). In Zander F. O. (Ed.), *Re: ITunes university and the classroom: Can podcasts replace professors? (McKinney, dyck, & luber, 2009)*. Fredonia, NY: fredonia.edu.

McKinney, D., Dyck, J. L., & Luber, E. S. (2009). iTunes university and the classroom: Can podcasts replace professors? *Computers & Education, 52*(3), 617-623. doi:10.1016/j.compedu.2008.11.004

McLoughlin, C., & Lee, M. J. W. (2007). Listen and learn: A systematic review of the evidence that podcasting supports learning in higher education. Paper presented at the *Proceedings of World Conference on Educational Multimedia, Hypermedia and Telecommunications 2007,* Chesapeake, VA: AACE. 1669-1677. Retrieved from http://www.editlib.org.proxy.lib.sfu.ca/p/25596

McLuhan, M. (1964). *Understanding media:The extensions of man* (2d ed.). New York: New American Library.

McLuhan, M., & Fiore, Q. (1967). *The medium is the massage*. New York: Random House.

Microsoft. (2010a). *Microsoft visual studio 2010*. Redmond, WA: Retrieved from http://www.microsoft.com/visualstudio/en-ca/

Microsoft. (2010b). *SilverLight* (4th ed.) Retrieved from http://www.silverlight.net/

Microsoft. (2011). *Microsoft DreamSpark.* Retrieved June 15, 2010, from https://www.dreamspark.com

MIT OpenCourseWare. (2008). *Free online MIT course materials | Audio/Video courses | MIT OpenCourseWare.* Retrieved July 30, 2008, from http://ocw.mit.edu.proxy.lib.sfu.ca/OcwWeb/web/courses/av/index.htm

Moreno, R., & Mayer, R. E. (1999). Cognitive principles of multimedia learning: The role of modality and contiguity. *Journal of Educational Psychology, 91*(2), 358-368. doi:10.1037/0022-0663.91.2.358

Moreno, R., & Mayer, R. E. (2002). Verbal redundancy in multimedia learning: When reading helps listening. *Journal of Educational Psychology, 94*(1), 156. doi:10.1037//0022-0663.94.1.156

Noble, D. F. (2002). *Digital diploma mills: The automation of higher education*. New York, NY: Monthly Review Press.

Nworie, J., & Haughton, N. (2008). Good intentions and unanticipated effects: The unintended consequences of the application of technology in teaching and learning environments. *TechTrends: Linking Research & Practice to Improve Learning, 52*(5), 52-58. doi:10.1007/s11528-008-0197-y

O'Neill, D. K. (2011, April 20). In Zander F. O. (Ed.), *Perhaps tagging prevents flagging*. SFU:

O'Neill, D. K., Weiler, M., & Sha, L. (2005). Software support for online mentoring programs: A research-inspired design. *Mentoring & Tutoring: Partnership in Learning, 13*(1), 109-131. doi:10.1080/13611260500040617

Oxford English Dictionary. (2010). *"Podcast, n."*. Retrieved January 29, 2011, from http://www.oed.com.proxy.lib.sfu.ca/viewdictionaryentry/Entry/273003

Paivio, A. (1978). The relationship between verbal and perceptual codes. In E. C. Carterette, & M. P. Friedman (Eds.), *Handbook of perception. vol. IX: Perceptual processing* (pp. 113-131). New York: Academic Press.

Pauk, W. (1997). *How to study in college* (6th ed.). Boston, MA, US: Houghton, Mifflin and Company.

Pea, R. D. (1994). Seeing what we build together: Distributed multimedia learning environments for transformative communications. *Journal of the Learning Sciences, 3*(3), 285-299. doi:10.1207/s15327809jls0303_4

Peper, R. J., & Mayer, R. E. (1986). Generative effects of note-taking during science lectures. *Journal of Educational Psychology, 78*(1), 34-38. doi:10.1037/0022-0663.78.1.34

Proust, M. (1957). *Within a budding grove.* Chatto & Windus. Retrieved from http://www.nalanda.nitc.ac.in/resources/english/etext-project/proust/vol2.pdf

Read, B. (2005). Lectures on the go. *Chronicle of Higher Education, 52*(10), A39-A42.

Rickards, J. P., & August, G. J. (1975). Generative underlining strategies in prose recall. *Journal of Educational Psychology, 67*(6), 860-865. doi:10.1037/0022-0663.67.6.860

Rickards, J. P., & Friedman, F. (1978). The encoding versus the external storage hypothesis in note taking. *Contemporary Educational Psychology, 3*(2), 136-143. doi:10.1016/0361-476X(78)90020-6

Robinson, F. P. (1946). *Effective study (rev. ed.)*. Oxford, England: Harper.

Rogers, E. M. (1995). Consequences of innovations. In *Diffusion of innovations* (4th ed ed., pp. 405-442). New York: Free Press.

SFU. (2011). *podCasting @ SFU.* Retrieved May 21, 2011, from http://podcast.sfu.ca.proxy.lib.sfu.ca

Silverstein, S. (2006, January 17). The iPod took my seat. *Los Angeles Times,* Retrieved from http://articles.latimes.com/2006/jan/17/local/me-noshow17

Stranger, M. (2011, July 8). In Zander F. O. (Ed.), *podCasting @ SFU statistics*. Burnaby, BC Canada: Simon Fraser University.

Sweller, J. (2005). The redundancy principle in multimedia learning. In R. E. Mayer (Ed.), *The cambridge handbook of multimedia learning* (pp. 159-167). New York: Cambridge University Press.

Titsworth, B. S., & Kiewra, K. A. (2004). Spoken organizational lecture cues and student notetaking as facilitators of student learning. *Contemporary Educational Psychology, 29*(4), 447-461. doi:DOI: 10.1016/j.cedpsych.2003.12.001

Traphagan, T., Kucsera, J., & Kishi, K. (2010). Impact of class lecture webcasting on attendance and learning. *Educational Technology Research and Development, 58*(1), 19-37. doi:10.1007/s11423-009-9128-7

Vaughan, D. (2009). *Clog: Client logging for .NET.* Retrieved January 29, 2010, from http://clog.codeplex.com/

Walls, S. M., Kucsera, J. V., Walker, J. D., Acee, T. W., McVaugh, N. K., & Robinson, D. H. (2010). Podcasting in education: Are students as ready and eager as we think they are? *Computers & Education, 54*(2), 371-378. doi:10.1016/j.compedu.2009.08.018

Weinberger, A., & Fischer, F. (2006). A framework to analyze argumentative knowledge construction in computer-supported collaborative learning. *Computers & Education, 46*(1), 71-95. doi:10.1016/j.compedu.2005.04.003

Willmore, D. J. (1966). *A comparison of four methods of studying a college textbook.* (Unpublished doctoral dissertation). University of Minnesota, Minneapolis, MN.

Winne, P. H. (2006). How software technologies can improve research on learning and bolster school reform. *Educational Psychologist, 41*(1), 5-17. doi:10.1207/s15326985ep4101_3

Wittrock, M. C. (1974). Learning as a generative process. *Educational Psychologist, 11*(2), 87-95.

Wittrock, M. C. (2010). Learning as a generative process. *Educational Psychologist, 45*(1), 40-45. doi:10.1080/00461520903433554

Zander, F. O. (2008). *The audio re-searcher: A learning resource to enhance deep learning via audio content.* Unpublished manuscript.

Zander, F. O. (2011). *The audio re-searcher: A learning resource to enhance deep learning via audio content* (version 2011.1.29 ed.). Surrey, BC: Retrieved from http://www.audioresearcher.org

Zander, F. O., & Nesbit, J. (2008). *Marzieh EDUC 892.* Retrieved August 27, 2008, from http://marzieh.corbmite.com/

APPENDICES

Appendix 1a: Consent Form - Online Survey

Simon Fraser University
Faculty of Education
8888 University Way
Simon Fraser University
Burnaby, BC V5A 1S6

Informed Consent By Participants In A Research Study

Title: The Audio Re-Searcher: examining the effects of audio note taking in a multi-media, web-based environment.
Primary Investigator: Frank Zander, email: foz@sfu.ca
Supervisor: Dr. Kevin O'Neill
Department: Faculty of Education. Phone: 778 782-3476

1) PRIMARY INVESTIGATOR
Frank Zander is the primary investigator conducting research under the auspices of SFU. Frank is a graduate student at Simon Fraser University in the Masters program in Educational Technology and Learning Design.

2) PURPOSE
The purpose of this Masters' thesis research project is to evaluate the effects of learning via Audio. Your participation in this audio-lecture survey will supply important background information on how students use podcast lectures.

3) VOLUNTARY PARTICIPATION
The following information is provided to help you decide whether you wish to volunteer as a participant in this research project, "The Audio Re-Searcher: a study of comprehension using audio and note taking." Please be aware that you can decide not to participate and that you can withdraw at any point and have the record of the session destroyed.

4) CONFIDENTIALITY
Collected data will be kept confidential and anonymous. Your name will not be associated with research findings in any way. Only the researchers will know your identity. No reference will be made in verbal or written form that could link your name to the project. Survey and note data entered by the participant will be stored on a password protected computer or server - in Canada - to which only the research team members have access. Participants will only be able to see their own data and not data other participants.

5) BENEFITS OF THE STUDY
Survey data will aid in creating a snapshot of current student practices in note taking and audio usage.

6) RISKS TO THE PARTICIPANT
There are no known risks and/or individual discomfort associated with this study. The online survey as well as the lab activities in the study are non-threatening and non-invasive. Any participant who feels uncomfortable may choose to stop participating at any time.
7) PERMISSION
The University and those conducting this study subscribe to the ethical conduct of research and to the protection at all times to the interests, comfort, and safety of participants. This study is being conducted under permission of the Simon Fraser University Research Ethics Board.
8) OBTAINING RESEARCH RESULTS
A copy of the results of this study, upon completion, may be obtained by contacting Frank Zander at foz@sfu.ca
9) CONCERNS OR COMPLAINTS
If you have any questions or concerns about the study or the procedures at any time, you may contact Dr Hal Weinberg, Director, Office of Research at hal_weinberg@sfu.ca or 778-782-6593
PROCEDURES
Participants are asked to take a twenty minute online survey. The online survey focuses on current note-taking, audio and lecture practices.
PARTICIPANT CONSENT
I agree to participate in the research study named above. In addition, I certify that I have read and understand the procedures and personal risks to me in taking part in the study. I understand that I may withdraw my participation at any time. I also understand that I may register any complaint with the Dr Hal Weinberger, Director, Office of Research at hal_weinberg@sfu.ca or 778-782-6593

Print Last Name ______________________________ Print First Name ______________________

Participant Contact Information

Participant Signature

____

Date: (mm/dd/yyyy)

Appendix 1b: Consent Form - Lab study

Simon Fraser University
Faculty of Education
8888 University Way
Simon Fraser University
Burnaby, BC V5A 1S6

Informed Consent By Participants In A Research Study
Title: The Audio Re-Searcher: examining the effects of audio note taking in a multi-media, web-based environment.
Primary Investigator: Frank Zander, email: foz@sfu.ca
Supervisor: Dr. Kevin O'Neill
Department: Faculty of Education. Phone: 778 782-3476

1) PRIMARY INVESTIGATOR
Frank Zander is the primary investigator conducting research under the auspices of SFU. Frank is a graduate student at Simon Fraser University in the Masters program in Educational Technology and Learning Design.
2) PURPOSE
The purpose of this Masters' thesis research project is to evaluate the effects of learning via the *Audio Re-Searcher* software. The *Audio Re-Searcher* is a web-based multi-media tool for listening to audio and adding notes. Your participation in this lab study will provide valuable feedback in how participants use the *Audio Re-Searcher* software as an educational tool. As well, your participation will add to an understanding how learners can effectively annotate an audio lecture.
3) VOLUNTARY PARTICIPATION
The following information is provided to help you decide whether you wish to volunteer as a participant in this research project, "The Audio Re-Searcher: a study of comprehension using audio and note taking." Please be aware that you can decide not to participate and that you can withdraw at any point and have the record of the session destroyed.
4) CONFIDENTIALITY
Collected data will be kept confidential and anonymous. Your name will not be associated with research findings in any way. Only the researchers will know your identity. No reference will be made in verbal or written form that could link your name to the project. Survey and note data entered by the participant will be stored on a password protected computer or server - in Canada - to which only the research team members have access. Participants will only be able to see their own data and not data other participants.
5) BENEFITS OF THE STUDY
The information obtained will help to improve the researcher's understanding of the effects of audio instruction and note taking in a web-based, multi-media environment.

6) RISKS TO THE PARTICIPANT
There are no known risks and/or individual discomfort associated with this study. The online survey as well as the lab activities in the study are non-threatening and non-invasive. Any participant who feels uncomfortable may choose to stop participating at any time.

7) PERMISSION
The University and those conducting this study subscribe to the ethical conduct of research and to the protection at all times to the interests, comfort, and safety of participants. This study is being conducted under permission of the Simon Fraser University Research Ethics Board.

8) OBTAINING RESEARCH RESULTS
A copy of the results of this study, upon completion, may be obtained by contacting Frank Zander at foz@sfu.ca

9) CONCERNS OR COMPLAINTS
If you have any questions or concerns about the study or the procedures at any time, you may contact Dr Hal Weinberg, Director, Office of Research at hal_weinberg@sfu.ca or 778-782-6593

PROCEDURES
Participants are asked to come to a two hour lab session. The two hour lab session will include an online prior knowledge survey as well as a brief training on the *Audio Re-Searcher* web application. Next, each lab participant will use a web browser to access the *Audio Re-Searcher* web application. After using the Audio Re-Searcher, lab participants will be asked to fill out a short online software usability questionnaire as well as an online survey. In addition, lab participants will take two online multiple choice tests. Lastly, the lab computer screen may be videotaped and audio recorded, subject to the participant's approval.

PARTICIPANT CONSENT
I agree to participate in the research study named above. In addition, I certify that I have read and understand the procedures and personal risks to me in taking part in the study. I understand that I may withdraw my participation at any time. I also understand that I may register any complaint with the Dr Hal Weinberger, Director, Office of Research at hal_weinberg@sfu.ca or 778-782-6593

Print Last Name ______________________________ Print First Name _____________________

Participant Contact Information

Participant Signature

____

Date: (mm/dd/yyyy)

Appendix 2: Survey Questions

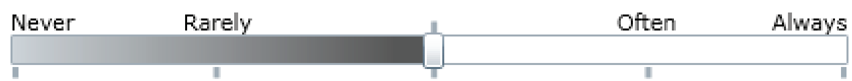
Student background questions

1. Age
2. Gender
3. How many semesters have you attended university?
4. What is your current grade point average (GPA)?
5. What is your area of study?
   e.g. Education, Psychology, General Studies, Science, Undecided (etc. …)

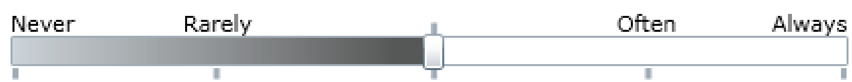
Note taking questions

6. How many hours per week do you review (study from) your lecture notes?

7. How often do you make hand written notes (on paper) during class?

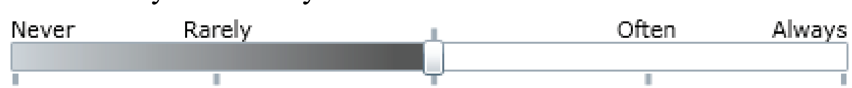


8. How often do you type notes (using a computer or laptop) during class?

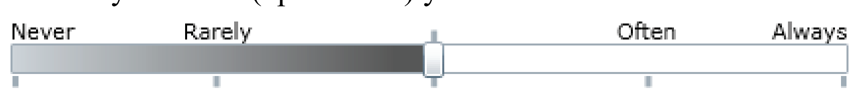


9. How detailed are your notes?

10. How often do you review your notes?

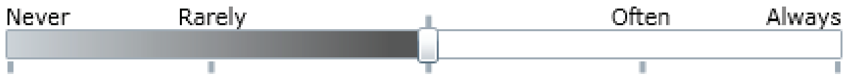


11. How often you revise (update/edit) your notes?

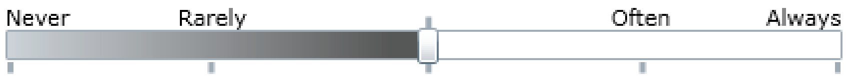


12. How often do you take notes on:

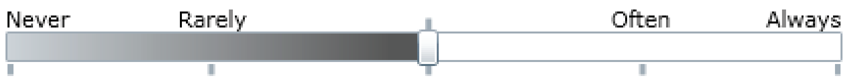
a. What the professor/TA says:



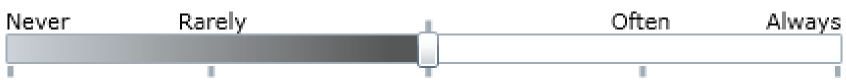
b. What other students say:



c. The material you find interesting:



d. Material you find confusing:



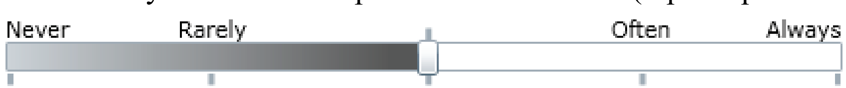
e. Other:

Audio lecture (podcast) questions

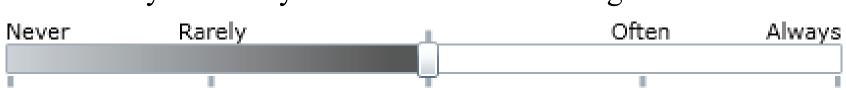
13. How many hours per week do you listen to course lectures?

14. How many hours per week do you listen to mp3 music?

15. How often do your instructors provide course audio (mp3 or podcasts)?

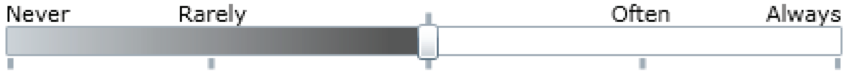


16. How often do you make your own course recordings?



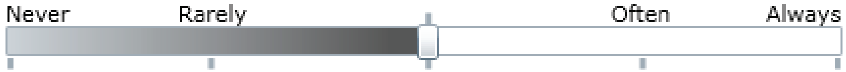
17. How often do you re-listen to course lectures?

18. How often do you attend lectures when audio is also available?

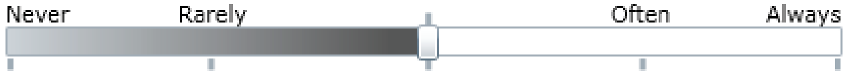


19. How often do you listen to audio lectures:

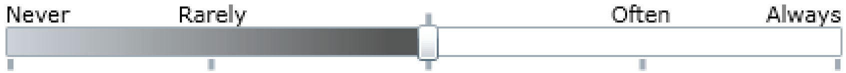
a. At home



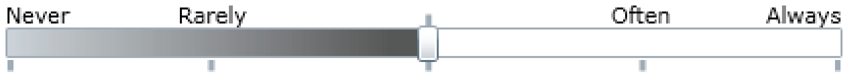
b. At the gym



c. On my commute



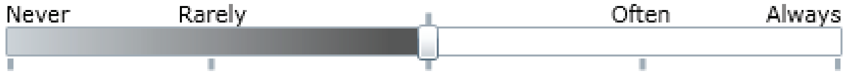
d. At school



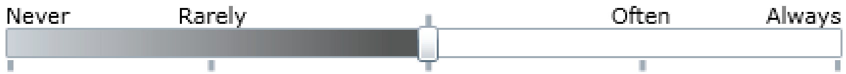
e. Other

20. What hardware do you use to listen to audio lectures:

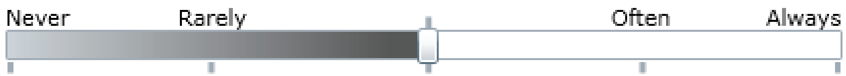
a. Ipod (nano, shuffel, etc.)



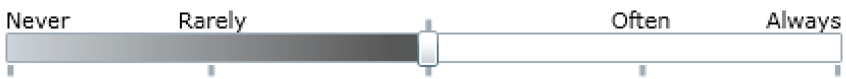
b. Iphone



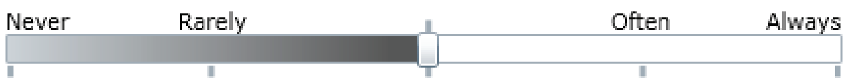
c. MP3 player (generic brand)



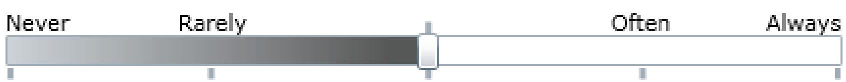
d. Cell phone (non Iphone)



e. Laptop



f. Computer (desktop)



g. Other

General

21. Tell us about something important, or something that we should have asked about

Appendix 3: System Usability Scale *Online Version*

System Usability Scale © Digital Equipment Corporation, 1986.

1. I think that I would like to use this system frequently — Strongly disagree … Strongly agree

2. I found the system unnecessarily complex — Strongly disagree … Strongly agree

3. I thought the system was easy to use — Strongly disagree … Strongly agree

4. I think that I would need the support of a technical person to be able to use this system — Strongly disagree … Strongly agree

5. I found the various functions in this system were well integrated — Strongly disagree … Strongly agree

6. I thought there was too much inconsistency in this system — Strongly disagree … Strongly agree

7. I would imagine that most people would learn to use this system very quickly — Strongly disagree … Strongly agree

8. I found the system very cumbersome to use — Strongly disagree … Strongly agree

9. I felt very confident using the system — Strongly disagree … Strongly agree

10. I needed to learn a lot of things before I could get going with this system — Strongly disagree … Strongly agree

Source Brooke (1996). Brook states " The System Usability Scale (SUS) is a simple, ten-item scale giving a global view of subjective assessments of usability."

Appendix 4a: Online Test Questions - Part One

When light strikes the cells in the retina of the eye, and those receptor cells send neural impulses to the brain, _______ has occurred.

- perception
- sensation
- recognition
- visual awareness

The study of the relation between physical events and the corresponding experience of those events is called

- perception
- sensation
- psychophysics
- signal detection

_________ is the founder of Psychophysics

- Wundt
- Helholtz
- Fechner
- Weber

Sensitivity and bias refer to

- just noticeable differences
- electromagnetic radiation
- signal detection theory
- dark adaptation

People's ability to detect a signal amongst noise is dependent upon

- the absolute threshold of the stimulus
- the implementation of Weber's law
- the size of the JND
- sensitivity

An absolute threshold is the

- largest amount of stimulus needed in order to notice that the stimulus is present at all
- smallest amount of stimulus needed in order to notice that the stimulus is present at all
- exact amount of stimulus needed in order to notice that the stimulus is present at all
- point where a physical stimulation becomes strong enough to be noticed

Weber's Law states

- a constant percentage of a magnitude change is necessary to detect a difference
- a varying percentage of a magnitude change is necessary to detect a difference
- a varying percentage of a magnitude change is necessary to detect a similarity
- a constant percentage of a magnitude change is necessary to detect a similarity

Light is a form of

- magnetic radiation
- electric radiation
- electromagnetic radiation
- magnoelectric radiation

Fill Signal Detection Theory Grid with the following: Hit, Miss, Correct Rejection, or False Alarm

	HIT	MISS	FALSE ALARM	CORRECT REJECTION
Signal Present & Reported Signal :	●	●	●	●
Signal Present & NO Reported Signal :	●	●	●	●
NO Signal Present & Reported Signal :	●	●	●	●
NO Signal Present & NO Reported Signal :	●	●	●	●

Appendix 4b: Online Test Questions - Part Two

In what ways do colours vary?

- brightness, saturation, and hue
- sensation and perception
- just noticeable differences
- accommodation and transduction

Surrounding the pupil is a circular muscle called the

- iris
- cornea
- eye
- sensory neuron

The process where sensory neurons in the eye converts physical energy into neural impulses is called

- transformation
- transduction
- transfillation
- transfiguration

What chemical is produced by rods that responds to light?

- rhododendron
- rhodopsin
- opsin
- melanin

Where is the concentration of cones most dense?

- far from the fovea
- cones are equally spread out throughout the retina
- near the fovea
- where the optic nerve exits the retina

Increased sensitivity to light is due in part to:

- an increase in the number of rods
- a decrease in the number of cones
- the enlarging of the pupils
- a decrease in the blind spot

The purity of the input produces the perception of ____ ?

- brightness
- density
- hue
- saturation

Match the definition to the eye part

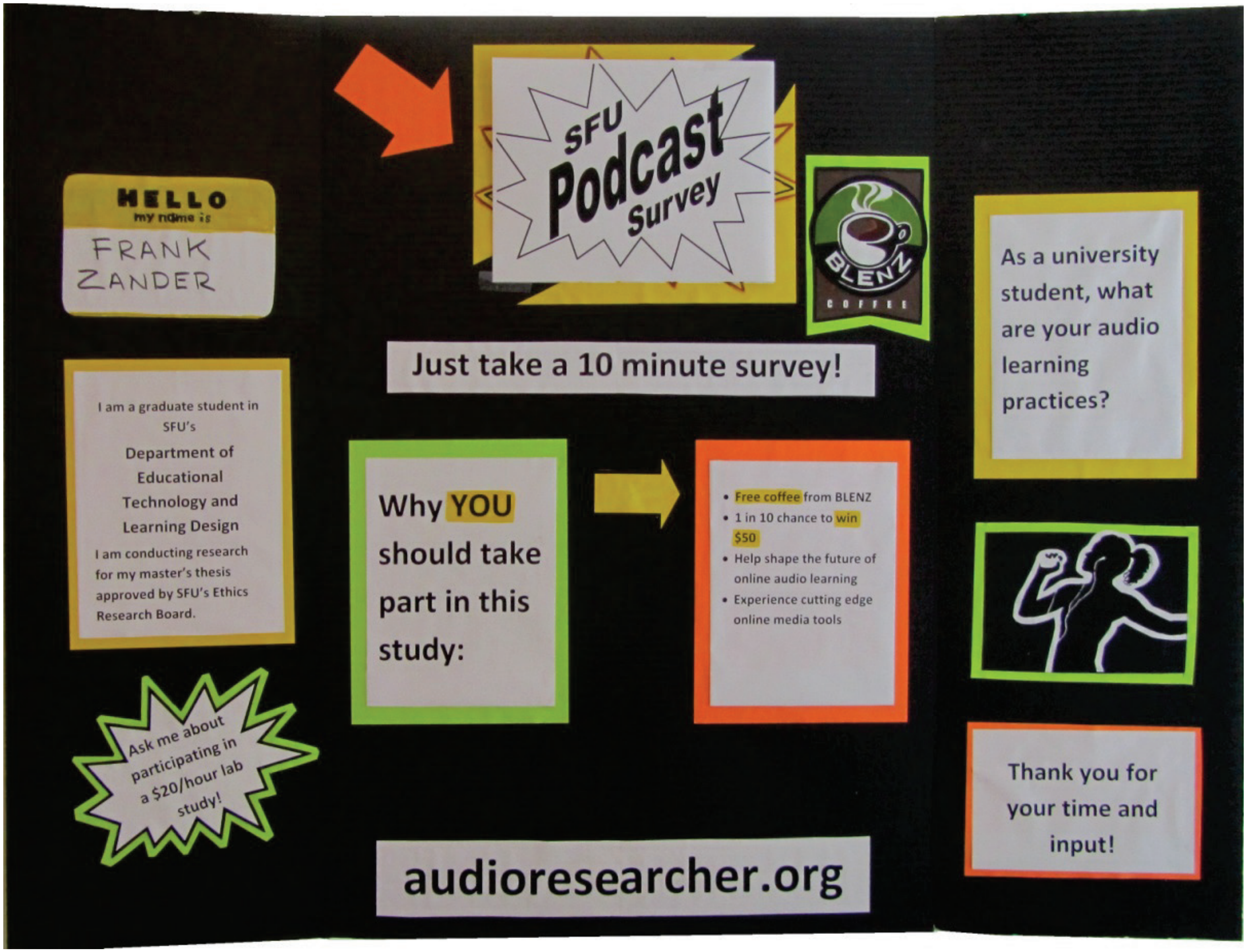
	IRIS	CORNEA	RETINA	LENS	OPTIC NERVE	PUPIL
The opening in the eye through which light passes. :	●	●	●	●	●	●
The part of the eye involved in accommodation, the automatic adjustment of the eye to see at different distances. :	●	●	●	●	●	●
Changes the size of the pupil to let in more or less light :	●	●	●	●	●	●
A sheet of tissue at the back of the eye containing cells that convert light to neural impulses. :	●	●	●	●	●	●
The transparent covering over the eye, helps with focusing light :	●	●	●	●	●	●
Axons from retinal cells in each eye are gathered into this single large cord. :	●	●	●	●	●	●

Appendix 5: Prior Knowledge Questions

What is the highest level course you have taken where the following topics were discussed?

	never	in high school	introductory course (100 or 200 level)	in an upper level course
How people or animals, see or interpret images :	●	●	●	●
How light waves are like particles :	●	●	●	●
Dissection of an animal eye :	●	●	●	●
Experiments with light or sound:	●	●	●	●

Appendix 6a: Survey Recruitment Poster Board



Appendix 6b: Survey Recruitment Poster

AudioReSearcher.org

Take a 10-minute online podcast survey!

As a university student, what are your podcast (or MP3 audio) learning practices?

Why YOU should take part in this study:

- Receive a $5 coffee card from BLENZ
- 1 in 10 chance to win $50
- Help shape the future of online audio learning
- Experience cutting edge online media tools
- Survey takes less than 10 minutes
- Study approved by SFU's Office of Research Ethics (ORE)

Participate/Login @ http://www.AudioReSearcher.org

Ask me about participating in a $20/hour lab study!
Contact: foz@sfu.ca

www.AudioReSearcher.org

For more information contact Frank Zander – SFU graduate student in the Faculty of Education
call : 604 591-1140 or email: foz@sfu.ca

* Printed on 8.5" X 11" paper

Appendix 7: Lab Study Recruitment Poster

* Printed on 11" x 17" paper

Appendix 8: System Usability Scale Questions and Responses

Question	N	Mean	SD
1. I think that I would like to use this system frequently	68	6.21	2.687
2. I found the system unnecessarily complex	68	8.34	2.053
3. I thought the system was easy to use	68	8.59	1.621
4. I think that I would need the support of a technical person to be able to use this system	68	8.97	2.018
5. I found the various functions in this system were well integrated	68	6.97	2.033
6. I thought there was too much inconsistency in this system	68	8.04	1.952
7. I would imagine that most people would learn to use this system very quickly	68	8.73	1.621
8. I found the system very cumbersome to use	68	7.13	2.505
9. I felt very confident using the system	68	8.00	2.320
10. I needed to learn a lot of things before I could get going with this system	68	9.09	1.678
Overall SUS Rating	68	80.12	12.129

Appendix 9: Sample of Participant Usability Comments

In addition to the standard System Usability Scale questionnaire, participants had the option to leave comments and suggestions on the usability web form. A sample of positive comments include:

"I've never used/seen this program before however I thought it was a great way to do research. The program was extremely easy to use."

“I loved being able to stop and take notes while I was listening, it not only helped me retain the information better but actually kept me engaged as well"

" Interesting system, very easy to use. Easy to repeat those important parts. I think if my prof uses this system, there is no need to attend the class"

“I liked how I can tag the audio and review the notes in my own wording at real time."

Suggestions for Improvement to the *Audio Re-Searcher* tool include:

"I found it annoying when the system would pause the audio while adding a note. I would much rather have it keep playing or at least have the option to be able to pause it when taking notes or keep playing while taking notes."

“It would be a good idea to specify a point A - point B for each audio tag (a beginning and end), so the person using the system could tell where the important info are."

" The system is good however if there were a way to view the tags without bringing the audio to that point all the time such as double clicking the tag to make the audio follow it so that you can view other tags without losing your spot."

"... Another thing that might help improve the system would be adding a [playback] speed modifier button"

"A place to store lecture notes in categories"

"I think it would be a good idea to add a visual of the person who is actually talking; I find it much easier to listen to people when I can actually see them."

Appendix 10: Lab Study Timelines

Part One Timeline

	Intro (5 min)	Test Prior K (5 min)	Train (5 min)	Part One **(P1)** (24 min)	Wash (10 min)	Review (5 min)	Test Part A (5 min)
Group One (G1)	5 min	5 min	5 min	Listen to 12 minute audio twice	Participant Survey 5 min + 5 min Break	5 min	5 min
Group Two (G2)				Listen and Tag Audio			
	6 pm	6:05 pm	6:10 pm	6:15 pm	6:40 pm	6:50 pm	6:55 pm

Part Two Timeline

	Train (5 min)	Part Two **(P2)** (24 min)	Wash (10 min)	Review (5 min)	Test Part B (5 min)	Survey (5 min)	Debrief (5 min)
Group One (G1)	5 min	Listen and Tag Audio	Break 10 min	5 min	5 min	5 min	5 min
Group Two (G2)		Listen to 12 minute audio twice					
	7 pm	7:05 pm	7:30 pm	7:40 pm	7:45 pm	7:50 pm	7:55 pm

Appendix 11: Default Microsoft (2010b) SilverLight Media Player Interface and Layout

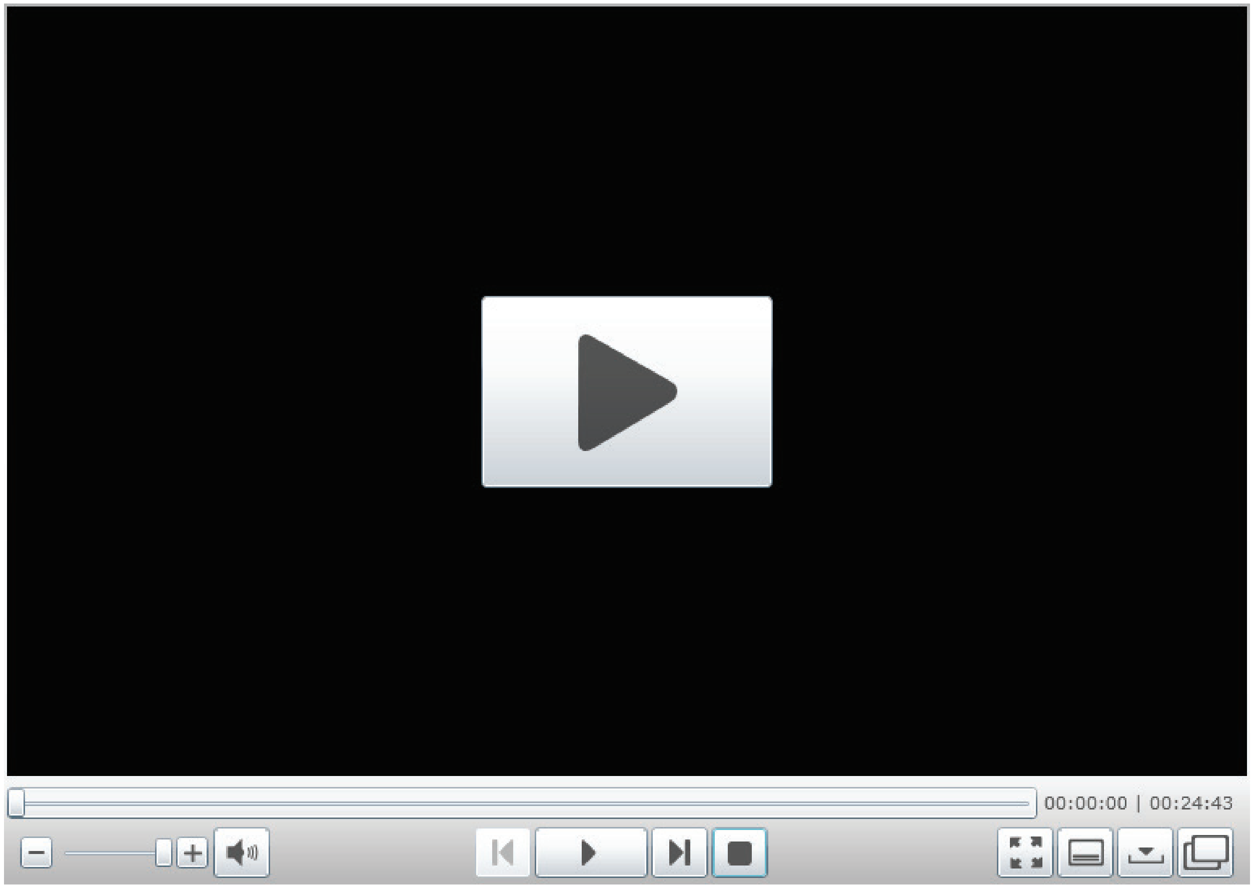


Figure 15: Default Microsoft (2010b) **SilverLight Media Player Interface and Layout**