2006-2310: THE EFFECT OF INCORPORATING VERBAL STIMULI IN THE ONLINE EDUCATION ENVIRONMENT: AN ONLINE CASE STUDY

Alice Squires, Stevens Institute of Technology

Alice Squires is the Associate Director of the System Design and Operational Effectiveness (SDOE) Online Program in the Department of Systems Engineering and Engineering Management (SEEM), Schaefer School of Engineering, Stevens Institute of Technology in Hoboken, NJ. Alice teaches systems engineering as a faculty at Stevens and business and management as a faculty at University of Phoenix.

Alice graduated summa cum laude with a Bachelor of Science of Electrical Engineering (BSEE) at University of Maryland in 1984 and a Masters of Business Administration (MBA) at George Mason University in 1996. She is concurrently pursuing her doctoral research at Stevens in systems engineering and intelligent / adaptive online learning systems. As the primary author of this paper, please address all related communications to her at: asquires@stevens.edu.

Early in her career Alice focused on engineering hardware design and related software development, followed by technical management and operations management, with a more recent focus on systems engineering and online education and training. She has over twenty years of experience in engineering project management and technical management primarily in the defense sector.

She has worked directly for several large defense companies including General Dynamics, Lockheed Martin and IBM. At General Dynamics, she managed the requirements and integration and testing for the vehicle electronics on the Advanced Amphibious Assault Vehicle (AAAV) built for the United States Marines. Prior to this she managed the production system and cost center for Lockheed Martin's (now BAE Systems') radiation-hardened manufacturing line. At IBM she worked as a technical lead on various defense related contracts. She has also worked for several smaller companies including Delex Systems (Navy and tactical trainers), Agere Systems (telecommunications) and ASSETT, Inc (Navy and signal processing). She received the General Dynamics Technical Achievement in Safety Award in 2002, the Lockheed Martin Outstanding Team Award in 1998, the MBA Fellowship from 1994-1995 and multiple technical and suggestion awards from IBM from 1986 to 1993.

Mike Pennotti, Stevens Institute of Technology

Michael Pennotti is Industry Professor and Director of the System Design and Operational Effectiveness (SDOE) Program in the Department of Systems Engineering and Engineering Management (SEEM), Schaefer School of Engineering, Stevens Institute of Technology. He is also a member of the faculty of the Center for Management Development at Rutgers University.

As a systems engineering leader for more than thirty years, Dr. Pennotti has broad experience with both technical and organizational systems. He spent the first twenty years of his career at Bell Laboratories, designing, analyzing and improving the operational performance of three generations of anti-submarine warfare systems for the United States Navy. From 1984 to 1990 he was Director of Advanced ASW Concepts at Bell Labs.

In 1990, Mike shifted his focus from R&D to general management, and over the next ten years, served on the senior leadership teams of three different AT&T and Lucent Technologies businesses. As Quality Director for AT&T Business Communications Systems, he led the $3.5B unit to a Baldrige site visit in 1996. As Human Resources Vice President for Lucent's Enterprise Networks Group, he helped develop and execute people strategies that supported a doubling in th e size of that business in three years. As VP Quality for Avaya, he established the initial business processes for this $8B Lucent spin-off.

Mike also has experience as an independent consultant, applying the principles of process management and performance improvement to the solution of business problems for early stage, high-tech companies. A paper on that work was published in a special issue of the Engineering Management Journal.

Since joining Stevens in 2001, Mike has taught courses in systems engineering, system architecture and design, requirements engineering and management, systems engineering for thought leadership in systems engineering, and systems thinking. His courses have been enthusiastically received by students from defense and commercial industries and government agencies, both within the U.S. and around the world. He has also developed and delivered highly successful web-based versions of two of his courses.

Dr. Pennotti is a member of the International Council on Systems Engineering, a senior member of both the IEEE and the American Society for Quality. He holds Ph.D. and MS degrees in Electrical Engineering from the Polytechnic Institute of New York, a BEE from Manhattan College, and is a graduate of the AEA/Stanford Executive Institute for the management of high-technology companies.

Dinesh Verma, Stevens Institute of Technology

Dinesh Verma received his Ph.D. and M.S. in Industrial and Systems Engineering from Virginia Tech. He is currently serving as the Associate Dean for Outreach and Executive Education, and Professor in Systems Engineering in the Department of Systems Engineering and Engineering Management (SEEM), Schaefer School of Engineering, Stevens Institute of Technology. He concurrently serves as the Scientific Advisory to the Director of the Embedded Systems Institute in Eindhoven, Holland. Prior to this role, he served as Technical Director at Lockheed Martin Undersea Systems, in Manassas, Virginia, in the area of adapted systems and supportability engineering processes, methods and tools for complex system development and integration.

Before joining Lockheed Martin, Verma worked as a Research Scientist at Virginia Tech and managed the University's Systems Engineering Design Laboratory. While at Virginia Tech and afterwards, Verma continues to serve numerous companies in a consulting capacity, to include Eastman Kodak, Lockheed Martin Corporation, L3 Communications, United Defense, Raytheon, IBM Corporation, Sun Microsystems, SAIC, VOLVO Car Corporation (Sweden), NOKIA (Finland), RAMSE (Finland), TU Delft (Holland), Johnson Controls, Ericsson-SAAB Avionics (Sweden), Varian Medical Systems (Finland), and Motorola. He served as an Invited Lecturer from 1995 through 2000 at the University of Exeter, United Kingdom. His professional and research activities emphasize systems engineering and design with a focus on conceptual design evaluation, preliminary design and system architecture, design decision-making, life cycle costing, and supportability engineering. In addition to his publications, Verma has received one patent and has two pending in the areas of life-cycle costing and fuzzy logic techniques for evaluating design concepts.

Dr. Verma has authored over 85 technical papers, book reviews, technical monographs, and co-authored two textbooks: Maintainability: A Key to Effective Serviceability and Maintenance Management (Wiley, 1995), and Economic Decision Analysis (Prentice Hall, 1998). He is a Fellow of the International Council on Systems Engineering (INCOSE), a senior member of SOLE, and was elected to Sigma Xi, the honorary research society of America. He serves an a member of the External Advisory Board on Systems Engineering at SAIC, on the Systems Engineering Advisory Council (SEAC) of the Systems and Software Consortium, and the Advisory Board of the Center for Systems Engineering at the Air Force Institute of Technology.

The Effect of Incorporating Verbal Stimuli in the Online Education Environment: An Online Case Study

Abstract

In 2005, Stevens Institute of Technology's System Design and Operational Effectiveness (SDOE) Program added audio lectures to their online *Fundamentals of Systems Engineering* course. This paper compares results from four instantiations of this online course with no audio lectures delivered in 2004 to results from three instantiations of the same online course with audio lectures delivered in 2005. The analysis addresses differences in student participation and performance, team project quality, and student survey scores between the two types of course offerings. The objective of this analysis is to better understand the contribution of audio lectures to the learning process.

1. Overview

In converting classroom-based instruction to online instruction, it is natural to try to mimic, where possible, the classroom environment. With this strategy, however, online learning is subjected to the constraints of a live classroom, without being able to leverage the advantages of the new medium. We believe the online education environment has far greater potential than the traditional classroom environment for effectively incorporating auditory, visual, and kinesthetic stimuli that address the various developed models of learning while remaining asynchronous in format. The first step toward this end is to develop a framework for online learning that can be used anywhere, at any time. We have previously defined this framework and have shown that we can provide equivalent learning with comparable student feedback and a manageable instructor course load in an asynchronous online version of our graduate course – *Fundamentals of Systems Engineering*.[1] This is a core course in the Masters of Systems Engineering degree offered at the Stevens Institute of Technology.

The next step is to provide a balance of auditory, visual and kinesthetic learning experiences in the online environment. The original online course was comprised of classroom presentations organized into weekly lecture notes, supplemental papers, a series of team assignments that culminated in a team project, and weekly online discussions. The weekly lecture notes were adopted from the presentation slides used in traditional classroom lectures and provided as softcopy presentations annotated with notes in key areas. During the course, the teams go offline to discuss the course content and work on their team project, with team assignments due each week. The instructor proactively participates in the course, engages the students in weekly discussions, answers any questions on the course material, and otherwise acts as a facilitator of the course. The instructor communicates with the students asynchronously through online discussion groups and classroom mail. While the students may communicate offline in various formats, the online course itself was devoid of verbal stimuli.

In 2004, based on student feedback and a sponsor request, we modified the *Fundamentals of Systems Engineering* course into a six week format. This modified course was taught four times in 2004 to students from the same sponsoring organization.

In 2005, again based on student feedback and requests, we added 15 to 25 minute audio lectures to the weekly course material that reviewed the weekly lecture notes. The lecture notes were then provided in three formats: a short audio lecture combined with the original classroom presentation slides, these same slides with speaker note manuscripts of the audio, and the original classroom presentation slides with no additional annotation. We delivered this course three times in 2005, with the three forms of lecture notes to allow the students a choice in the lecture delivery method based on their preferred style of learning.

This paper summarizes a comparison of the four instantiations of the *Fundamentals of Systems Engineering* course delivered in 2004 with the three delivered in 2005. As a result of this analysis, recommendations are made for evolving the framework for our online courses to incorporate the optimal blend of stimuli to effectively address all styles of learning.

2. Visual versus Verbal: Related Research

Felder and Soloman[2] group Learning Styles and Strategies into four groups:

- Active (ACT) and Reflective (REF)
- Sensing (SEN) and Intuitive (INT)
- Visual (VIS) and Verbal (VRB)
- Sequential (SEQ) and Global (GLO)

They provide an online learning style instrument that can be used to determine an individual's preference along each of the above four scales. An example of the results from this learning style instrument for the primary author of this paper is shown in Figure 1.

This paper is primarily focused on the visual versus verbal style of learning. Ground classes are, by their very nature, based on verbal interaction primarily from the instructor, but also contributed to by the students in the form of verbal questions or responses. While the base stimuli presented to the students in the ground classroom is verbal in nature, it is typically supplemented with visual stimuli such as presentation charts, writing on the board, demonstrating the concept, and so on.

On the other hand, online courses are, by their very nature, based on visual stimuli. A large base of the currently available online courses are in fact devoid of verbal stimuli, relying primarily on text-based communication possibly supplemented with hardcopy presentation slides along with tables, graphs and/or images.

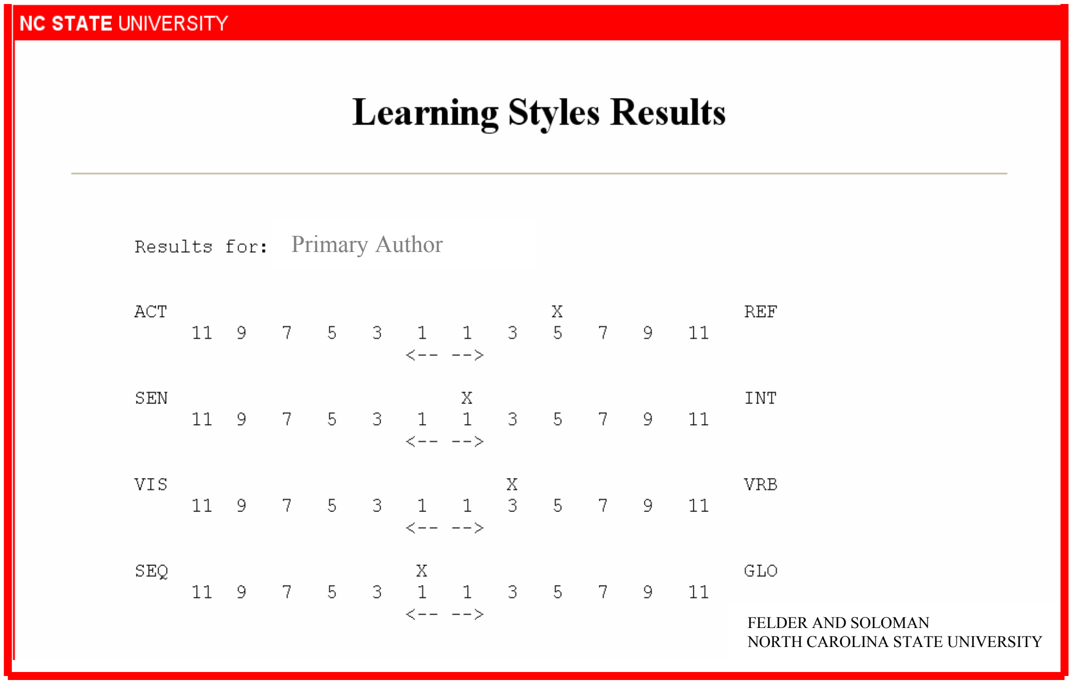

Figure 1. Example of Felder and Soloman's Learning Styles Instrument Results.

Note: The following guideline is provided along with the results in Figure 1:[3]

- *If your score on a scale is 1-3, you are fairly well balanced on the two dimensions of that scale.*
- *If your score on a scale is 5-7, you have a moderate preference for one dimension of the scale and will learn more easily in a teaching environment which favors that dimension.*
- *If your score on a scale is 9-11, you have a very strong preference for one dimension of the scale. You may have real difficulty learning in an environment which does not support that preference.*

As one example, the College of the Canyons cautions the online student:

> "Online courses are very different than traditional (on-campus courses). The material covered is delivered in a different manner, and the student is responsible for learning the material without constant "face-to-face" interaction with an instructor. Online courses are not for everybody. To be successful in online courses the student must be a better-than-average reader, with a learning style conducive to reading and visual stimuli, rather than auditory and verbal stimuli."[4]

Many other examples can be found by performing a search of online degrees. Some online courses supplement the visual material with audio, as well, or offer web conferencing sessions with the students. Stevens Institute of Technology offers examples of each of these. At Stevens, another online course in the Systems Design and Operational Effectiveness (SDOE) program offers a full suite of audio lectures. Thirty lectures of on average, 90 minutes each in duration, comprise the base set of course material for the university's online graduate Decision and Risk Analysis course. An advanced program management course includes a weekly web conference as an optional venue for students to interface to the instructor 'face-to-face' on a weekly basis. Clearly, in a world of different learning styles of learning and preferences, a combination of both verbal and visual stimuli provides the optimal learning experience. And that is how we arrive at the basic question that we address in this paper: What is the effect on the student's learning ability and performance, of adding verbal stimuli to an online course that otherwise has none?

3. Course Delivery Overview

As shown in Table 1, the course was offered four times in 2004 to a total of 91 students, and three times in 2005 to a total of 40 students.

Table 1. List of Sections of Fundamentals Course Delivered in 2004 and 2005.

Semester	Timeframe	Course	Instructor	# Students
1Q04	**Apr 19 - May 30**	**SYS630**	**A**	**21**
2Q04	Aug 9 - Sep 17	SYS630	B	21
3Q04	**Sep 13 - Oct 24**	**SYS630**	**A**	**23**
4Q04	Sep 27 - Nov 7	SYS630	B	26
				91
2Q05	**Apr 11 - May 20**	**SYS630**	**B**	**18**
3Q05	**Jul 11 - Aug 19**	**SYS630**	**A**	**12**
4Q05	**Sep 26 - Nov 4**	**SYS630**	**B**	**10**
				40

Note: Bolded sections were used for detailed analysis that compared participation data and team project quality as measures of student performance. All sections were used for the student survey analysis.

4. Detailed Data and Analysis

Analyses of data comparing the two versions of the *Fundamentals of Systems Engineering* course are presented in this section. Areas emphasized include the level of student participation in the online classroom, the quality of the final team projects, and the results of the student course survey.

Participation

The first comparison between the 2004 and 2005 course offerings is in the area of student participation. The assumption is that the availability of audio lectures should have a positive impact on student performance reflected in an increase in participation, particularly for those students who are verbal learners.

Students in the *Fundamental of Systems Engineering* course are required to contribute to a discussion that takes place five out of the six weeks of the course, starting in week two. Each week, the previous week's course material is discussed. The discussion is initiated by the instructor who posts two to four open ended questions for the students to select from and respond to. Students are encouraged to start their own discussions as well, ranging from asking questions about specific points in the course material to providing real-life examples of a particular concept reviewed in the lecture notes. Students are required to post at least three substantive comments each week to receive 'credit' for the course.

Participation was measured in two ways. In the first, the students' scores for participation were tabulated for each course in each year by each week, and an average score for the course calculated. Next, students' marks for participation in each course were tabulated by year, and an average for the courses in each year was calculated. The results are shown in Table 2. While the average participation mark was slightly higher in 2005 than 2004, there does not appear to be a significant difference by year, or by the number of students in the course, or by instructor.

The second method for analyzing participation focused on the number of substantive (value add) postings submitted by the students in the weekly discussions. Again, the number of postings were summed over each week per student and averaged by course, and also by courses in each year. The results are also shown in Table 2. We include the instructor's postings in a separate count where every instructor posting was considered substantive in nature. Again, the average number of substantive postings per student is slightly higher in 2005 than 2004. The interesting find was that the average number of instructor postings was lower in the second year. There is the possibility that the audio lectures supplemented the need for instructor clarification in the course discussions.

Table 2. Student (and Instructor) Participation Comparisons.

Semester	Instructor	# Students	Average Participation Marks	Instructor Average Weekly Substantive Posts	Student Average Weekly Substantive Posts
1Q04	**A**	**21**	2.59	40.20	5.41
3Q04	**A**	**23**	2.20	36.20	3.49
		44	2.39	38.20	4.40
2Q05	**B**	**18**	2.51	15.60	4.90
3Q05	**A**	**12**	2.64	27.20	4.68
4Q05	**B**	**10**	2.52	19.00	4.52
		40	2.42	20.60	4.51

Team Project Quality

The second comparison between the 2004 and 2005 course data is in the area of team project quality. The final deliverable for the *Fundamentals of Systems Engineering* course is a team project. Teams, typically consisting of three to five members, work on their team project throughout the course and submit them in the final week of class. The assumption is that the availability of audio lectures should result in a higher number of learning objectives met or exceeded, as evidenced by the feedback results of the final team project. For the *Fundamentals of Systems Engineering* course a feedback form was created to rate each area of the team project by whether certain learning objectives (criteria) were met, exceeded expectations, or needed additional work. Final results are shown in Table 3.

Table 3. Comparison of Team Project Feedback.

Semester	Instructor	# Students	# Teams	Total Criteria	Met	Exceeded	Needs Work
1Q04	**A**	**21**	5	40	72.5%	13.3%	14.3%
3Q04	**A**	**23**	6	40	74.6%	14.6%	10.8%
		44		40	73.5%	13.9%	12.5%
3Q05	**A**	**12**	3	40	72.5%	15.8%	11.7%
4Q05	**B**	**10**	3	40	61.7%	22.5%	15.8%
		22		40	67.1%	19.2%	13.8%

As shown, the results appear to be mixed. Although the students appear to have exceeded expectation more in 2005 than 2004, they also had more criteria that they needed to work on (more room for improvement).

Student Survey Results

The final point of comparison is the student survey scores. These surveys are completed by each student in the *Fundamentals of Systems Engineering* course. The assumption is that the student's satisfaction with the course should increase from 2004 to 2005 with the additional of audio lectures being a factor in that increased satisfaction level. A typical student course survey is shown on the following page. For this analysis, the scores were tabulated by course and by year and the results are shown in Table 4 for the average response to each survey question. In the case of every question on the survey, the 2005 ratings are higher than the 2004 ratings. While the sample set is small, the results indicate that student satisfaction with the course has improved.

STEVENS
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Course Assessment and Evaluation

Course Title: **SYS630 – Fundamentals of Systems Engineering**

Instructor: ______________ **Dates:** **July 11, 2005 – Aug 21, 2005**

Your Name (Optional): ________________________________ **Location:** **WebCT**

QUESTION					
Course Evaluation:					
Please check the box that corresponds to how much you agree (or disagree) with the statement.	**1 Strongly Disagree**	**2 Disagree**	**3 Neutral**	**4 Agree**	**5 Strongly Agree**
1. The objectives of the course were clearly explained					
2. The material was presented in an organized manner					
3. The instructor has command of the subject					
4. The subject was successfully communicated					
5. The instructor is fair and consistent					
6. The course is well structured					
7. The course material is well organized					
8. The material was adequately covered in the allotted time					
9. The course is structured to encourage student contribution and participation					
10. The subject matter has significant relevance and usefulness to my organization					
11. I can apply what I have learned in this course on projects (underway or future) in my organization					
12. The course would enable me to enhance my future career objectives					
13. OVERALL – The instructor was an effective teacher					
14. OVERALL – This was an Excellent Course					

Questions:

The thing that I liked best about this course was:

If I could change one thing about this course, I would…

General Comments:

Table 4. Average Student Survey Score Comparison Between 2004 and 2005.

	2004 Average Score	2005 Average Score
1. The objectives of the course were clearly explained	4.03	4.11
2. The material was presented in an organized manner	3.75	3.79
3. The instructor has command of the subject	4.22	4.34
4. The subject was successfully communicated	3.43	3.84
5. The instructor is fair and consistent	4.24	4.34
6. The course is well structured	3.60	3.84
7. The course material is well organized	3.50	3.74
8. The material was adequately covered in the allotted time	3.62	3.74
9. The course is structured to encourage student contribution and participation	3.81	4.08
10. The subject matter has significant relevance and usefulness to my organization	4.14	4.34
11. I can apply what I have learned in this course on projects (underway or future) in my organization	4.05	4.32
12. The course would enable me to enhance my future career objectives	3.89	4.03
13. OVERALL – The instructor was an effective teacher	3.88	4.13
14. OVERALL – This was an Excellent Course	3.45	3.68

The result of the survey comparisons are summarized in Table 5.

Table 5. Average Score and % Agree or Strongly Agree Summary.

Semester	Instructor	# Students	Average Score	% Agree or Strongly Agree
1Q04	A	21	4.14	81%
2Q04	B	21	3.75	61%
3Q04	A	23	3.58	59%
4Q04	B	26	3.86	67%
		91	3.83	67%
2Q05	B	18	3.75	68%
3Q05	A	12	4.47	68%
4Q05	B	10	4.06	81%
		40	4.02	79%

Table 5 further reflects significant improvement in student satisfaction with the online delivery of the *Fundamentals of Systems Engineering* course when supported by the audio lectures.

Figures 2 and 3 show a pictorial comparison of the 2004 and 2005 survey results. One can see that the level of satisfaction has increased overall from 2004 to 2005, and the level of dissatisfaction has decreased.

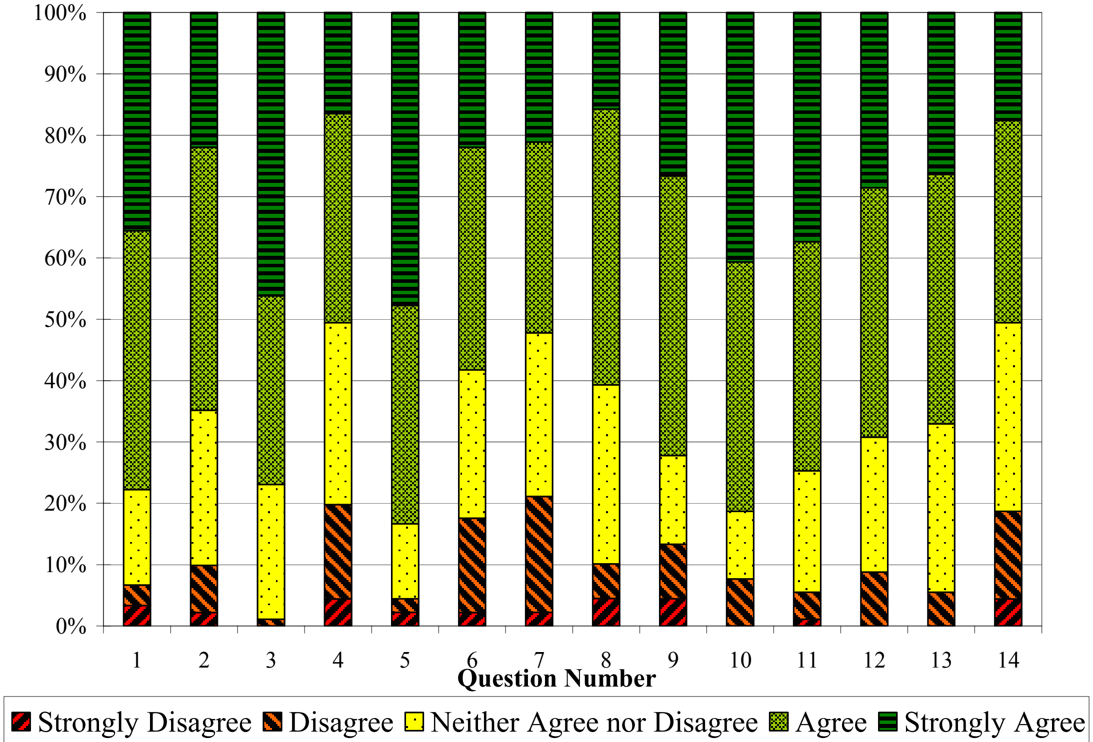

Figure 2. Graphical Representation of Satisfaction Levels in 2004.

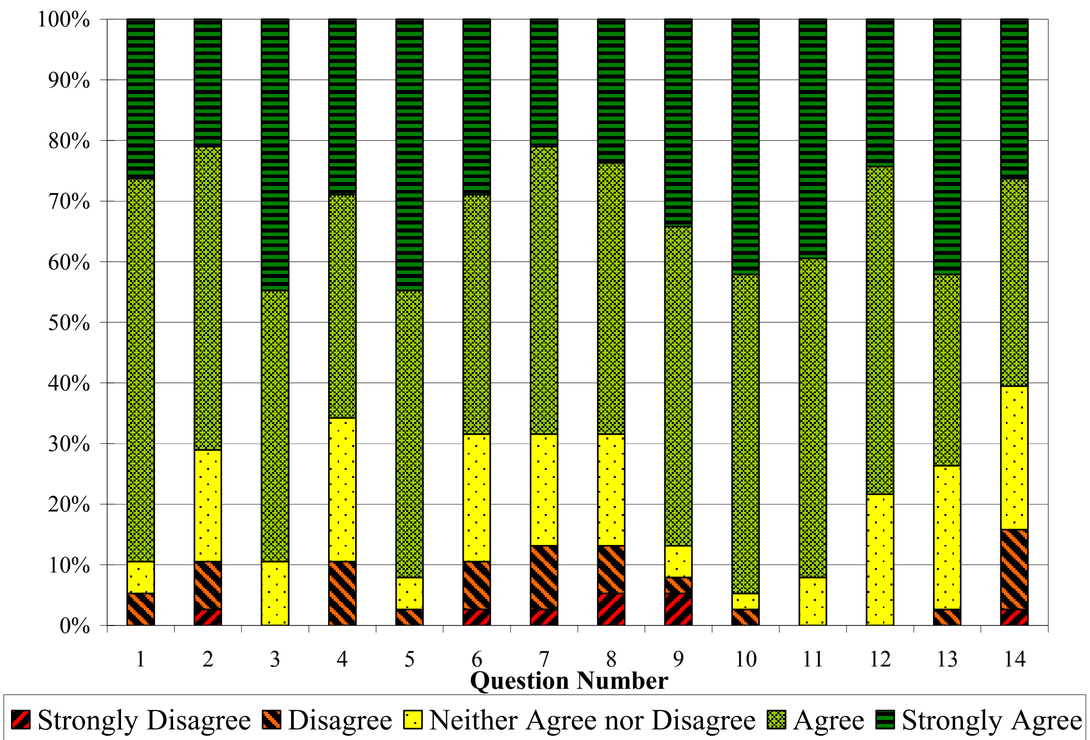

Figure 3. Graphical Representation of Satisfaction Levels in 2005.

5. Lessons Learned

The first lesson learned is that maintaining a consistent and complete record of course survey scores and student comments for all related online courses administered to date has proven invaluable in improving the course structure and format.

Second, there is a need to track who is listening to the audio lectures and for what length of time. Making audio lectures available to the students does not guarantee they were 'listened' to by the students. To better assess the value of the verbal stimuli, we need to track the access and level of use of the available audio lectures. We can assume, based on classroom and survey comments, those students who learn best through verbal stimuli did access and use the audio lectures throughout the course; however, empirical evidence of the level of use of the audio lectures would provide a more accurate analysis.

We do know from the 'Track pages' records within the classroom recorded in all three 2005 courses that, although the students are urged to download the materials locally to their own personal drive, the course material with the speaker notes that contained the audio lecture manuscripts were accessed increasingly more as the class progressed and for a greater length of time than the presentation slides alone. See Figures 4 and 5.

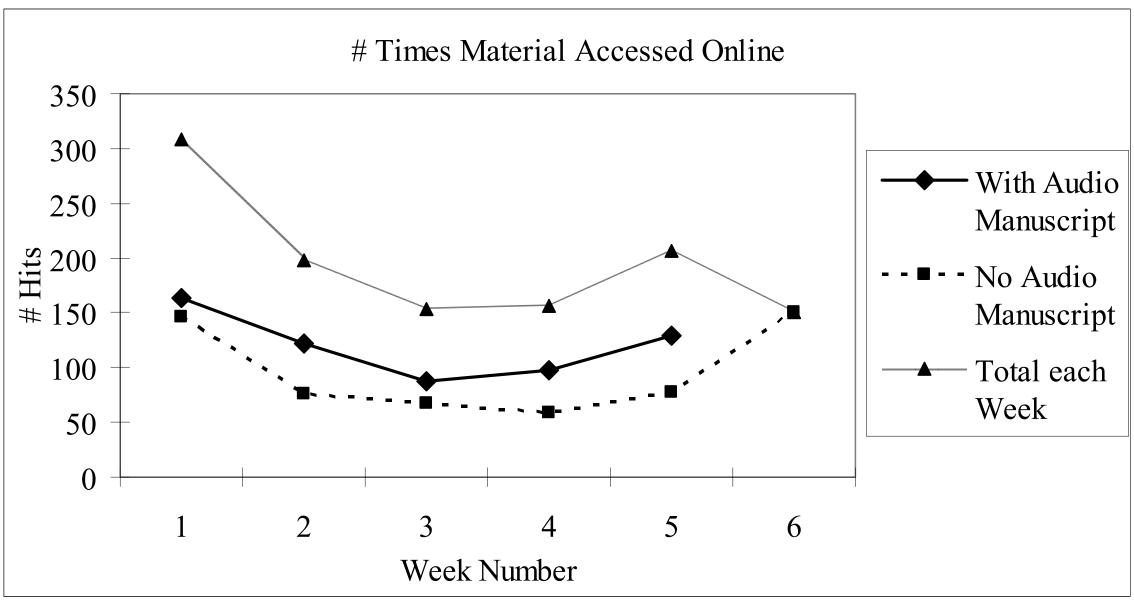

Figure 4. Total # Hits on Course Material in Weeks 1 through 6.

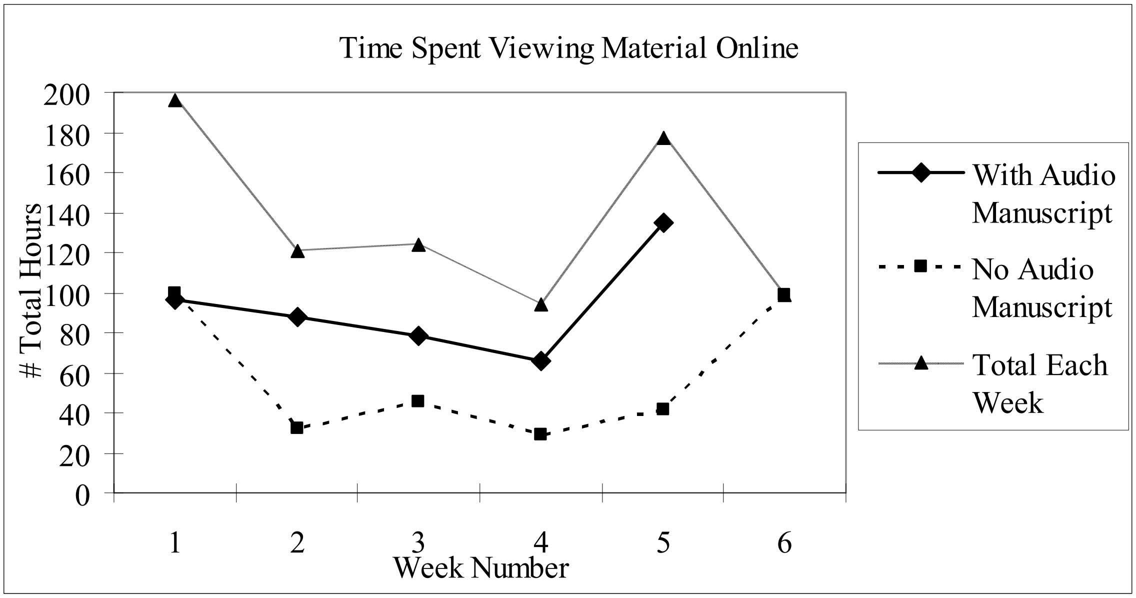

Figure 5. Total Time (Hrs) Spent Viewing Course Material in Weeks 1 through 6.

In fact, we can conclude the following from a summary of the 'Tracking Pages' data:

1. At the onset, there was about equal preference between full size slides and slides with the speaker notes containing the audio manuscript.
2. Once the students were exposed to both types of format, the preference was clearly for the smaller slides that contained the audio manuscripts in the speaker notes. These were accessed about twice as often in weeks 3 and 4, and about three times as often in weeks 2 and 5. No audio manuscript was available (or needed) for Week 6.

Another lessons learned is, based on the data available, we determined that the corporate courses were the right courses to compare for this analysis. Because these courses are for a corporate sponsor, we found that the students viewed these surveys as performance reviews and did not hesitate to provide the full depth of their feedback scores and comments.

Finally, the analyses conducted leads to the conclusion that where there is evidence that the inclusion of audio lectures in the online format increases student satisfaction, it may not necessarily improve student learning. This will be one area that we will investigate more in the future.

6. The Future

In performing a literature search on the impact of verbal stimuli in online education, we found that there is not a large database of empirical data that can be used to make comparisons. Courses are typically all visual or otherwise. The format of the courses has not evolved to a great extent from one format to another. Rather there seems to be a gap between the collegiate level conversion of a university's content to an online format and the availability of media produced by industry marketing organizations selling to the general public or niche markets. However, the technology has evolved to a level where further research in value-add expansion of currently visual only based courses will prove useful, as long as the discriminators of convenience, low cost, and content protection can be met.

Another potential area of future research is the impact of audio in online learning and culture. The impact of verbal stimuli in student performance and learning could vary according to the student's country of origin, language, sex, race or other cultural variables. In one section of the Fundamentals course, a student with English as a second language requested a fourth type of lecture note format. This student specifically requested that the audio with the presentation slides and the lectures with the speaker notes' manuscript be combined so that the student could read the words as they were being said.

But the most practical and immediate area of research is in our own backyard. For the Fall 2005 semester, we collected evaluation data on our Webcampus Systems Engineering and Engineering Management (SEEM) online courses for 85% of 115 online SEEM students. Of the courses provided in the Fall of 2005, 63% of the students had the opportunity incorporate audio into their online learning experience, either through audio lectures or weekly web conferencing sessions. Additional research will be done to compare student feedback between the two modalities – those with audio incorporated and those without – to identify any trends in student satisfaction with the online experience. Differences in student satisfaction based on the type of verbal stimuli – audio lectures versus weekly web conferencing sessions – will also be investigated.

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