# USING STUDENT-GENERATED NOTES AS AN INTERFACE TO A DIGITAL REPOSITORY

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# USING STUDENT-GENERATED NOTES AS AN INTERFACE TO A DIGITAL REPOSITORY

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This Dissertation is Dedicated to

The Memory of My Father

***Lester Colon Harvel***

And the Honor of My Mother

***Laura Roberts Harvel***

*Joshua 24:15*

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# SUMMARY

A recent survey of studies related to digital libraries concluded that "[b]oth faculty and students use and like electronic resources and most readily adopt them if the sources are perceived as convenient, relevant, and time saving to their natural workflow" [86]. However, the results of access studies show that actual use of online content is relatively low, with only 10-20% of students making regular use of the content [24, 41, 60, 71]. This is because navigation to the online content in these collections is not convenient, requires multiple steps in order to reach relevant content, and is not integrated into a student's natural workflow.

In our research, we have designed, deployed, and evaluated a method for making content available to students that targets the content to their current need and is designed as an alternative yet cooperative method of access to a well-structured set of course content. Since notes are both integral to lecture classes and generally ubiquitous, it is a natural target for connecting the student with available content. Pen technologies and mobile devices make it possible for us to capture student notes and enhance them with embedded access links to relevant content. In our initial interface, NoteNexus, instead of delivering content as the result of a student search query or browsing activity, we embedded links to the content into the student's notes. NoteNexus did not produce a change in the student use of online content. C-Nexus was designed and developed from the results of the NoteNexus study. C-Nexus was successful in increasing the student use of online content.

# CHAPTER ONE

# INTRODUCTION

With the advent of the World Wide Web and the expansion of the Internet in the early 1990's, more colleges began making course content available online. There were several reasons behind this trend. Economics was one factor, the belief that providing content online would save printing and copying expenses. Another reason was to provide the content in a more convenient medium for the students. For many courses, "online content" refers to a digital representation of the handouts that instructors previously provided on paper. However, a growing number of instructors have begun to extend both the quantity and quality of online content available in their courses. This ranges from providing copies of previous homework and tests all the way to the development of interactive environments designed to aid students in the exploration and expanded understanding of concepts within the course. In some instances, these collections are connected with digital libraries, large collections of organized and indexed materials. More often, they are the work of individuals or small groups who maintain dedicated sites for that purpose. With so much content in existence, entities like MERLOT [97] and Connexions [40] have sprung into being with the goal of cataloguing what content exists for a variety of subjects, and making that content available to instructors and students around the world.

The move towards providing online content has continued with the majority of courses providing some kind of online content and a significant number now providing content that goes beyond the classroom. The following is an indication of the growth of

online course content in traditional, lecture based undergraduate courses in U.S. colleges: [25, 34]

- 53.1% of classes provide online presentation handouts
- 18.9% provide simulations/exercises
- 28.3% are using purchased instructional resources online
- 40.1% use course management tools to provide online resources
- 40.3% provide web pages with class materials and resources

Though it is problematic to estimate the amount of money spent creating online content for courses, given the difficulties of assessing instructor time and other institutional resources, most numbers are in the order of millions of dollars each year [7, 17, 25, 35, 88]. Though significant time and money are spent developing and providing online course content, student use is low.

### *1.1 Low Use of Digital Repositories of Educational Content*

That "online content is not well used by students," is a generally held populist view, but one that has few definitive studies to support or discount it. Though the general studies on digital libraries show a dismal picture of use [60], these do not necessarily extend to the specific case of online content provided for a particular course or curriculum:

> There is consensus that high quality knowledge should be freely available when possible. Almost every American research university has made significant investments in digitizing its intellectual and cultural resources. Recent discussions, however, have identified a general lack of

> knowledge about use of these resources. We do not know how these resources are being used for educational activities. [41]

This quote, taken from the description of an ongoing study at Berkeley, is a clear statement of the current situation. However, some studies provide limited insight into usage.

In 2002, researchers concluded a study of the Perseus project at Tufts University [60]. This is one of the oldest online libraries of educational content, focused primarily on classical history and the humanities [95]. The Perseus Digital Library (PDL) is available to the public, and is actively promoted by university programs and even in many high schools. The PDL, now over 17 years old, is one of the most successful Digital Library projects, averaging over 300,000 HTTP requests per day. Though a significant number, it is relatively low given the broad collection of students and other users that have been directed to this site. Given the number of unique users identified in the report, just over 37,000, the general level of access is roughly equivalent to what we report in Chapter 2. Other important results from this large study show that 66% of users were first time users, and only 11% used the resource on a regular basis (on the order of weekly).

A recent evaluation study of the MIT OpenCourseWare project showed that return visitors accounted for only 25% of users [71]. Of those users, 8% claimed to use the site on a regular basis. Data on the role of the return users shows that 31% of the users were actual students, and 52% of the users were non-students, or more appropriately, self-learners. An interesting finding from their survey data is that “[s]tudents most frequently use the site to find subject matter and materials for use in conjunction with a course they were currently taking (43%), and secondarily to enhance their personal

knowledge (39%).” Finally, over 80% of users reported a positive or extremely positive impact on their learning experience.

Carol Tenopir at The University of Tennessee, with a team of collaborators, produced an overview and analysis of recent research studies on digital libraries and their use [86]. This summary of research includes over 200 recent publications from eight large-scale and ongoing research projects, as well as over 100 smaller studies and targeted projects. Below are some conclusions from that study that are relevant to our research:

- Both faculty and students use and like electronic resources and most readily adopt them if the sources are perceived as convenient, relevant, and time saving to their natural workflow.
- Students exercise some quality judgments about materials they retrieve from the Internet, but those quality judgments may not exactly match faculty members’ criteria for quality content.

The University System of Georgia is engaged in a system-wide study (which includes Georgia Tech) to examine the use and impact of digital content in online courses [24]. Their findings are still preliminary, but the researchers recently presented the results to date. An important finding, which supports the general belief of educators, is the positive correlation between the use of content and success in a given course, Figure 1.

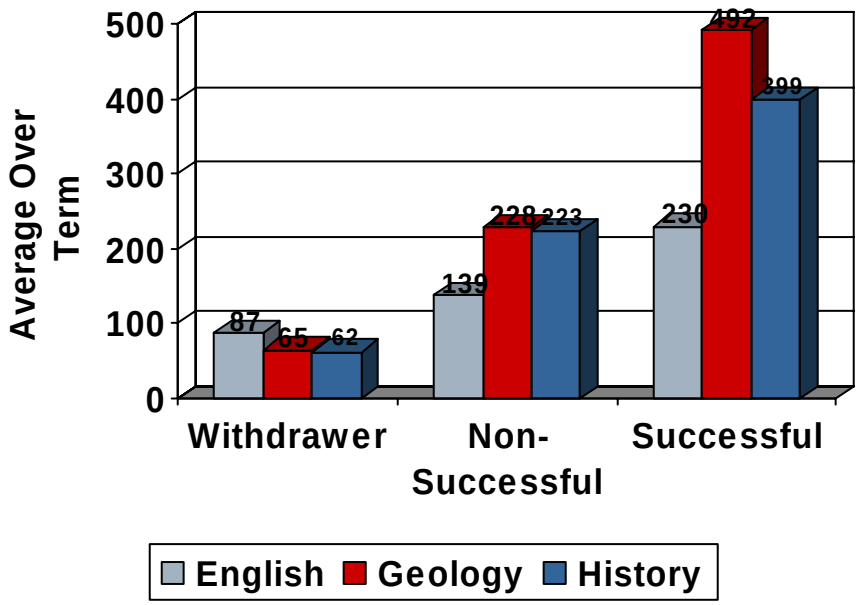



Figure 1 : Correlation of content use on success. Withdrawer students dropped the course before completion, Non-Successful students received a grade lower than a C, and Successful students received a C or higher. The Y-axis is average content interactions. The courses were online-only courses [24].

In summary, this data indicates the overall use of online resources in education, even for successful sites, is relatively low when the number of possible users is considered. The majority of students are generally occasional (or one-time) users, with only around 10% of students using the content on a regular basis. Ongoing research, however, shows that substantial use of online content may produce a significant positive impact on student success.

Given students' positive opinion of online content, and the growing evidence that use has a positive impact on performance, the generally low use of content contradicts the expectations of content developers and providers.

### *1.2 The Idea of Convenient Access*

As the Tenopir summary study showed, the idea that a "convenient" access system would improve student use is common in many usage studies and interface designs [17, 31, 39, 41, 57, 60, 61, 86, 88, 92]. However, there is no consistent definition of the concept of convenience, and in many cases, no definition at all. Fundamentally, the idea behind the convenient-interface theory is "make it easy and they will use it." It is important to understand that this concept is not without foundation. Consistently, students rate the value of online collections of educational content very highly. Likewise, they consistently respond positively towards "ease of use" and "time-saving" applications and interfaces. Finally, students also report that they believe the content was important to their success (as clearly indicated in the OIT OpenCourseWare study) [71].

If the available body of evidence shows that students want to use the online content, perceive the content to be valuable, and believe that the content assists them in achieving good performance, it is reasonable to assume that low content use is due to some factor impeding student access to content. In other words, some factor or factors related to the interface between the students and the content may inhibit the students' ability to use the content. Every year, dozens of new interfaces are presented at JCDL (Joint Conference on Digital Libraries) [46], ICDL (International Conference on Digital Libraries), and at other conferences related to digital libraries and in conference tracks related to online educational content and use.

With the purpose of increasing student use of online content, our research began with this idea of producing a more convenient interface. More specifically, based upon the Tenopir survey and other previously cited studies, our goal was to design an interface

that was *convenient*, *relevant*, and *time saving to the students' natural workflow*. In our approach, we interpreted the interface as a tool used by the students in order to achieve a goal. That goal is, to some degree, unique to each student, but our functioning assumption is that those individual goals include factors of intrinsic and extrinsic motivation, specifically, some desire to gain proficiency in the material, as well as a strong desire to succeed on performance measures in a course [5, 51, 22]. We designed our exploration of convenient interfaces specifically to assist students in meeting this broadly defined goal of success within a course.

### *1.3 Purpose of Research and Thesis Statement*

The purpose of this research was to explore whether a well-designed, convenient interface will change the student use of online content in an undergraduate engineering course. Therefore, our goal was to ***increase student use of online content*** by designing, developing, and deploying an interface that would be convenient, provide relevant content, and be timesaving within the students' work practice. We proposed to accomplish this by ***embedding relevant content links into student-generated notes***. By doing so, we use the students own framework of understanding as a basis for targeted delivery of supporting material. We provide both a quantitative and qualitative evaluation of access to explore ***how a student's perceived value of the online content changes,*** and, in what ways, if any, ***student practice and perception of their own note-taking changes***.

Research supports the idea that note-taking is an important activity in the learning experience. The ability to select important terms from a lecture, assign meaning to those terms and accurately transcribe them, is a major factor in academic success for a large number of students [12, 13, 14, 21, 28, 36, 50, 52, 53, 54, 55, 58, 59, 62, 75, 77, 93]. The

review of notes is also an important activity that serves to improve understanding and recall of the originally presented material. We selected the practice of note-taking as a place to embed access to content because of the value of note-taking in the learning process and the general use of notes by students.

In our work, instead of delivering content as the result of a student search query or browsing activity, we embed access to the content into the student-generated artifact, and thus deliver it within a representation of that student's learning context. By doing so, we have better control over content relevance and reduce the number of steps necessary to access the content.

**Our thesis is:**

*Using student-generated notes as an access interface will increase the use of captured and authored digital content for undergraduate students.*

We looked for three specific changes to signify a positive impact from the intervention. Since our desire was to increase content use, the level of use before and after the insertion of our technology into the environment is an important indicator. Both log file and student surveys were sources of data to determine changes in the quantity of use. We were also interested in the students' perception of how valuable the content was in terms of meeting their goal of success within a course. We used a series of student surveys as well as information gained from focus groups and discussions with subjects in the deployment studies to track perceived value. Finally, as we evaluated the student use of online content over the previous three years, we separated the content into two categories: performance-oriented and proficiency-oriented (we discuss this division of content in Section 2.5). The final focus of our intervention was to increase the use of

proficiency-oriented content. However, we continued to monitor the overall use of online content in order to determine if use of one form of content affected the other.

### 1.3.1 Research Contributions

Our research provides three contributions.

- Use quantitative and qualitative data to understand how students are using online content in a course.
- Design and evaluate access interfaces for students that will make the available content: *Convenient*, *Relevant*, and *Time-saving to their natural workflow*.
- Evaluate the impact of these interfaces on how students use the available online content.

Designing a tool for student note-taking requires an understanding of the current student practice, including an analysis of current access. As referenced earlier, few studies provide a clear picture of how students use online content in classes. Our final analysis includes four years of access data and survey data from several hundred students. The design process explores issues related to deploying technology in real classroom settings, and the evaluation of these interventions provides valuable information about designing for these environments. Finally, our evaluation of the impact of our intervention raises questions about the convenient-interface theory and demonstrates the successful use of student motivation in an interface design.

### *1.4 Study Design*

Understanding the impact of technology intervention in classroom environments can be difficult. The ability to constrain factors that may affect the outcomes and analysis of data is often not possible. However, we believed that it was important for our study to be conducted in as natural a context as possible without attempting to artificially constrain the myriad variables inherent in the environment. Our research study, therefore, takes a similar approach to the *design-based research* methods employed by the late Dr. Ann Brown and others in the learning sciences [9, 16, 19]. Though our work is fundamentally related to ubiquitous computing, interface design, and digital libraries, the situation of the exploration, in the context of the classroom and learning experience, necessitates the adoption of research techniques appropriate to the domain.

Many variables may affect how students use online content. Variables related to individual instructors, demographics of the students in a given semester, student course load, and changes in semester length are some major factors. In order to consider these factors in a situation where we are not able to control them directly, it was necessary to generate a set of baseline data that includes these factors. The availability of past data was a priority in the selection of a target course. Another requirement was the availability of a rich set of online content. Other factors in selecting a target course for this study included: a stable presentation of the course material in order to minimize differences in instructor presentation, a course with content use at least as high as other successful collections of online content, and a course with significant enrollment in order to have a large population set for analysis. ECE 2025, a sophomore level course met these

requirements. A detailed description of the course, the content, and the demographics of the student population are available in Sections 2.1 and 2.2.

We provide an overview of the components of this study in Figure 2. The numbers to the right show the number of students enrolled in ECE 2025 for that semester. The colored bars on the timeline show the duration of that study component.

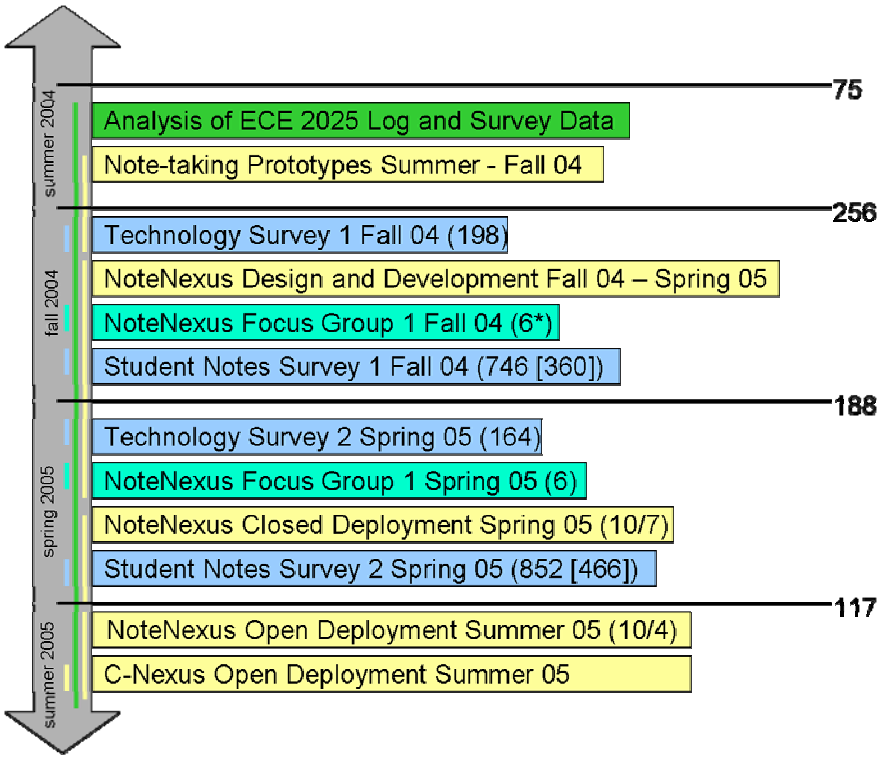



Figure 2 Overview of the design-based research study.

The numbers in parenthesis are the number of students involved in that component, if known. In the case of the Student Notes Survey, the numbers in square brackets indicate the number of student responses to the questions added to the survey for this study. The divided numbers in NoteNexus Deployments show the number who participated and then the number of students completing the final survey. The following

sections provide an overview of these components, which we then discuss throughout this dissertation.

### 1.4.1 The Target Course

*ECE 2025 Introduction to Signal Processing* is a sophomore course in the School of Electrical and Computer Engineering at the Georgia Institute of Technology. The course is a required course in electrical, computer, and biomedical engineering, and as such, maintains high enrollment. It is also an elective in other engineering and science disciplines. Over the past decade, Dr. James H. McClellan, Dr. Ron W. Schafer, and Dr. Mark A. Yoder have developed a significant collection of digital content that they have integrated into both the course text and syllabus [67]. They maintain this content on a collection of servers at GT, with a subset of the content available on the CDROM that comes with the text. Their goal in producing this content was to provide students with a variety of ways to approach the same concept. With the intent of supporting a variety of learners and learning styles, their content uses all of the multimedia capabilities generally available in computers today. The book and collected materials have met with a great deal of success, not only in wide adoption, but also in a general appreciation from students.

### 1.4.2 Analysis of Log and Survey Data

We began our study with the analysis of three years (nine semesters) of past access log data and survey results. 1,614 students enrolled in the course during those nine semesters. The students' interaction with the content consisted of 57,679 sessions (a set of page views from a single IP address with no more than a 30 minute gap in activity).

Over the original nine semesters analyzed, the average number of sessions per student was 36, with a standard deviation 8.42 between semesters. A summary of our findings from the analysis of the log data is in Section 0. Students also reported a high use of content, as well as a positive perception of the content. A discussion of students' perceived value, taken from the survey results is in Section 2.4. These results were significantly higher than results reported in other content use studies. To understand why, we looked at the nature of the content itself. In our evaluation of the data, it was apparent that two distinct types of content were available. Though the use of the online content in ECE 2025 was extremely high; almost all of that use related to *performance-oriented* content (past quizzes, exams, and homework solutions). The other content type, *proficiency-oriented* content (guided exercises, animated and MATLAB demonstrations, and lab tutorials), represents the content more commonly presented in online course materials. The use of this content type was in keeping with previous studies. We present the difference in these content types and their significance to our study in Section 2.5.

The students' reported perception of the available online content in ECE 2025 was very positive. However, the use of all the online content is moderate, and low when considering only the proficiency-oriented content, as with the other studies reported. With an established baseline for student content use and an understanding of the students' perceived value of the content, we were able to explore a series of designs and platforms with consideration for social and environmental factors.

### 1.4.3 Initial Design Prototypes

Many technological, social, and environmental issues obstruct technological intervention in real-world classrooms. There is rarely a standard computing platform, and

often the physical environment has not been designed to support a broad range of technologies. The lack of table space and power inhibits the use of laptops. Availability and implementation of wireless access often interferes with the use of network access for mobile devices. Many instructors now ban the use of cell phones in class, so developing for that platform is problematic. Students resist the requirement to purchase additional technology for courses, and in the context of a design study, their resistance might be higher. With these factors in mind, we developed five initial prototypes that allowed us to explore, in a laboratory setting, the viability of inserting these technologies into an actual classroom. In Chapter 3, we discuss the design of these technologies and the results of our evaluation. In conjunction with the prototype development, we conducted a survey to understand student opinion with respect to the intervention of a technology into note-taking. We also discuss these results in Chapter 3.

### 1.4.4 Target Design: NoteNexus

The NoteNexus system was a result of our exploration of prototype designs and our technology surveys. NoteNexus is a note-taking tool, based on laptop or pen-tablet technology, which connects student notes to available content based on keyword identification. As part of the formative evaluation of the NoteNexus design, we conducted two focus groups. Each focus group consisted of six students recruited from the current semester of ECE 2025. The focus group studies resulted in revisions to the NoteNexus design. Our discussion of the focus group studies is in Section 3.5.1. During the last six weeks of Spring semester 2005, we conducted a closed deployment of NoteNexus, involving 10 students from the target course (188 total students in the class).

The results of this study indicated a positive response for the note-taking technology, but no change in the use of the proficiency-oriented content.

We conducted a second deployment study in the Summer of 2005. In this deployment, we made the software available to all of the students. Again, 10 students participated (that we are aware of) out of 117 total students. Given the technological, environmental and social obstacles to adoption, a low percentage of voluntary adoption was expected. Again, the study results showed a positive response towards the note-taking tool, but no change in the use of proficiency oriented content. We discuss the results of the two deployment studies in Section 4.1.

### 1.4.5 Design Iteration: C-Nexus

The results of the NoteNexus studies raised doubts about a strong relationship between convenient access and student use of online content. However, we still had the anomaly that students expressed value for the online content, yet use that content rarely. The ECE 2025 context provided us with two kinds of content, performance-oriented and proficiency-oriented. Though the use of the proficiency-oriented content is in keeping with other studies, the performance-oriented content has much higher evidence of use. Considering this, along with the results of our study to date, we determined that the convenient-interface theory, evident in the digital library and educational content communities, was not sufficient to increase the student use of online content. Turning to the student motivation literature in the learning and education communities, we hypothesized that a convenient interface built to leverage student motivation would produce a better tool for helping students achieve their goals, specifically, the goal of achieving good performance grades in the course [Section 4.3].

To test this hypothesis, we designed and deployed C-Nexus. C-Nexus leverages the students' desire to access the online capture of the classroom lectures, provides a keyword filter to present a subset of concepts, and upon selection of an individual concept, presents the set of proficiency-oriented content relevant to the topic. Use of the C-Nexus tool was significant, and not surprisingly, peaked at times just prior to performance measures. The use of content in C-Nexus began with mostly captured lecture access, but the use of the other proficiency-oriented content grew over time. The result was a significant increase in the use of the proficiency-oriented content. Our discussion of the C-Nexus study is in Sections 4.2 - 4.4.

### *1.5 Summary and Overview of Dissertation*

Through a series of design prototypes, interventions and iterations, we test the idea that a convenient interface will improve content use. Our results challenge this idea and suggest that convenience alone is not sufficient. By coupling student motivation with convenience in our final design iteration, we are successful, on a small scale, in increasing the student use of online content.

In Chapter 2, we describe the content available to students in ECE2025 and how that content is structured. The chapter includes our analysis of student use and a description of the baseline use of content for the three years prior to our experiments. We then describe the collection of prototypes explored in our design process in Chapter 3, including a description of the *embedded access* architecture. We describe the final embedded access prototype, NoteNexus, at the end of Chapter 3. Chapter 4 discusses the deployment of NoteNexus, evaluates the results from the deployment, and presents C-Nexus and its deployment. We based our design of C-Nexus on the negative results from

the NoteNexus study. The new application was designed to provide the requested keyword-based retrieval, but in an interface that better fit the student work practice and motivation. We close in Chapter 5 with our conclusions and a discussion of future work.

# CHAPTER TWO

## Understanding Student Use of Online Content in ECE 2025

We selected the subject course in this study, *ECE 2025 – Introduction to Signal Processing*, for a variety of important reasons. The course is well structured and engaging. In this chapter, we look at the nature and delivery method of content available in the *ECE 2025 Introduction to Signal Processing* course at Georgia Tech. The faculty and instructors involved in this course have developed the content over the last ten years [6, 66, 67, 68, 18, 80, 83, 49, 96, 65, 69]. The primary content developers and the authors of the textbook are Dr. James H. McClellan and Dr. Ronald W. Schafer from the Georgia Institute of Technology, and Dr. Mark A. Yoder from Rose-Hulman Institute of Technology.

The authors were "guided by the premise that signal processing is the best starting point for the study of both electrical engineering and computer engineering" [67]. Motivating students by introducing core mathematical concepts in the context of audio, video, and digital music was a key reason for making this course the first in the electrical and computer engineering core curriculum. In 1993, they began to gather content, produce MATLAB demonstrations, and outline the course material and structure. The first version of the book, *DSP First: A Multimedia Approach*, was published in 1998. The most recent version of the book, *Signal Processing First*, was published in 2003. To date, over 100 institutions worldwide have adopted this text and the overall approach. The "visual learning demonstrations, MATLAB laboratories, and a bank of solved problems," have become an essential part of the learning experience for this course [66].

Georgia Tech teaches the course as a sophomore-level course over a 15-week period. The course comprises two 1-hour lectures, a 1.5-hour recitation, and a 1.5-hour laboratory session per week. Significant emphasis is placed on the lab work since it is the belief of the authors that “it is essential for motivating our students to learn the mathematics of signal processing, and because it introduces our students to the use of powerful software in engineering analysis and design” [66, 67].

## *2.1 The Student Population in ECE 2025*

ECE 2025 is the first course in the undergraduate core curriculum for both Electrical Engineering and Computer Engineering students. Individuals in these programs usually constitute the majority of students enrolled in the course. It is also required for undergraduate students in Biomedical Engineering. ECE 2025 also serves as an engineering elective in other engineering disciplines. We show the distribution of majors in ECE 2025 in Figure 3.

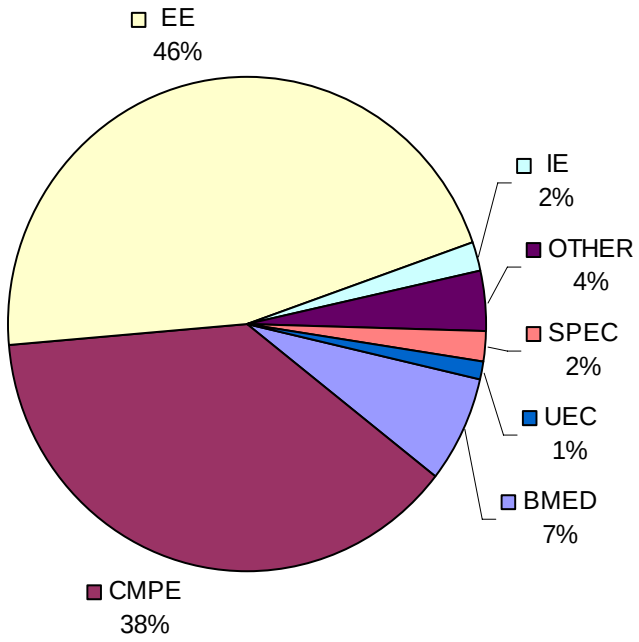



Figure 3 : Distribution of students in ECE 2025 by major from Fall Semester 1999 through Summer Semester 2005. “OTHER” reflects the set of majors with representation below 1%.

The prior academic performance of students entering ECE 2025 is fairly distributed. The graph in Figure 4 shows that 42% of students have GPAs over 3.0, and 23% of students have GPAs below 2.0. The distribution of grades in the course is similar; 52% of students earn grade points of 80% or higher and only 19% of students earn grade points of 70% or lower.

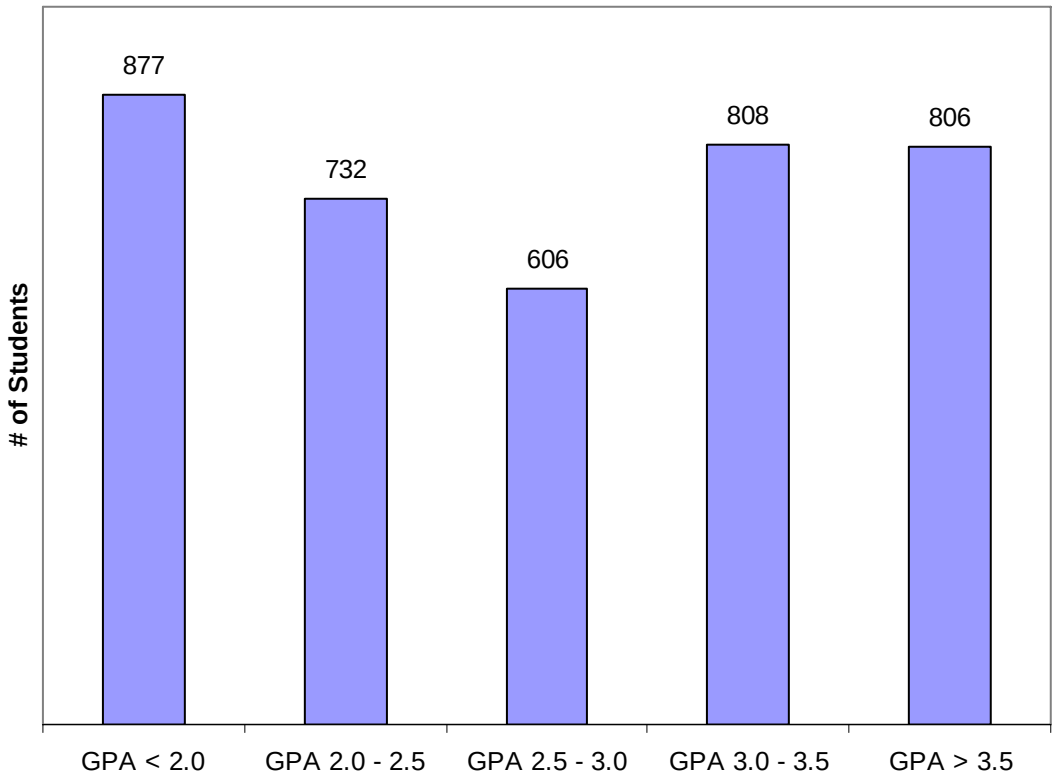



Figure 4 : Distribution of students in ECE 2025 Fall Semester 1999 through Summer Semester 2005, by overall GPA.

ECE 2025 is designed as a sophomore level course. In practice, 52% of the students enrolled in the course were sophomores; 29% of enrolled students were juniors; 11% were seniors, and 4% were freshmen. The remaining students were graduate students or special classifications. Over the eighteen semesters, the average percentage of female students was 14%.

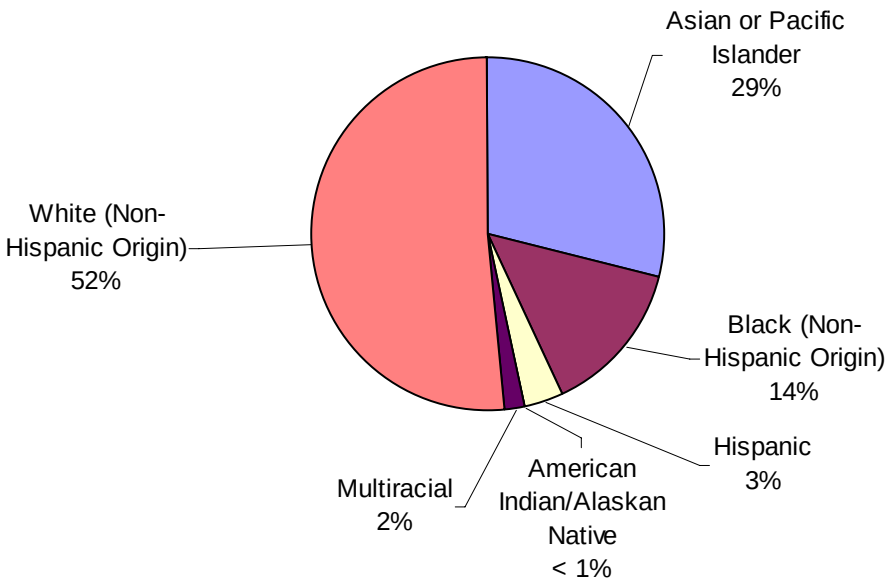



Figure 5 : Distribution of students in ECE 2025 by race from Fall Semester 1999 through Summer Semester 2005.

## *2.2 Signal Processing First – Course Content*

The course materials are interconnected and are comprised of the textbook, *Signal Processing First* [67], the accompanying CD of demonstrations [68], the online collection of worked problems and quizzes, and the collection of streaming video lectures. We will describe each or these collections, and how students currently use them.

### 2.2.1 The Book

The book is a traditional textbook that begins with simple continuous-time sinusoidal signals, moves into discrete-time signals and systems, and ends by mixing the two to explore many real-world engineering systems. Each chapter begins with an

introduction to the fundamental theory and mathematics. A set of sections follow the introduction and provide a more detailed explanation of the concepts and related ideas. The authors have augmented the chapter sections with demonstrations from CDROM and exercises. The solutions to the exercises are also available on the CDROM.

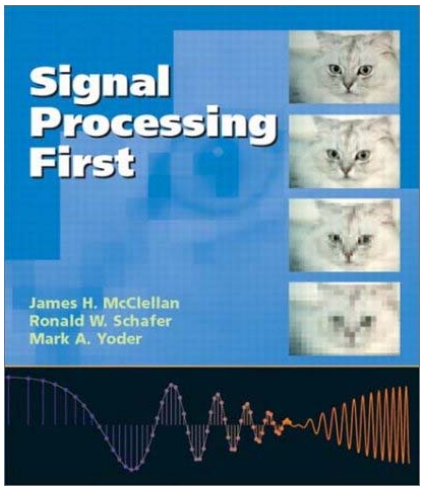



Figure 6 : The Signal Processing First textbook

### 2.2.2 The CDROM

The authors and developers organized the accompanying CDROM to follow the same structure as that of the book. For each chapter, the CDROM provides the following information [68]:

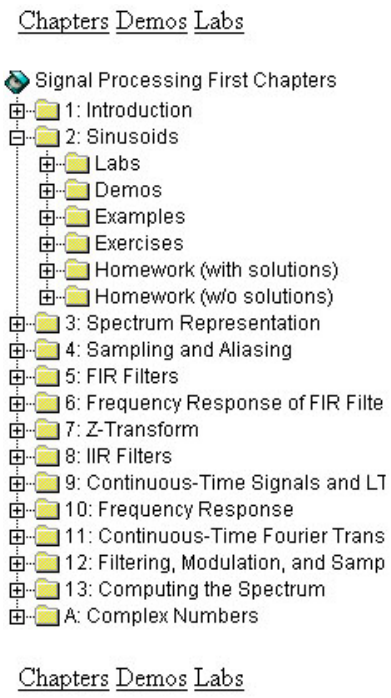



Figure 7 : Index of the CDROM

- Demos - QuickTime movies, MATLAB-based demos, sound files, etc. that help reinforce the concepts introduced in the text,
- Labs - Over 20 MATLAB based laboratory exercises for in-depth study of concepts and ideas introduced in the text,
- Exercises - Solutions to the exercises in the text,
- Examples - Examples given in the text,
- Homework - A large collection of homework problems, provided with and without solutions.

The MATLAB based demos require, for the most part, MATLAB 5.1, which the students purchase separately from the book and CDROM. They have provided the homework and exercises as Adobe PDF files.

The developers of the content felt that the previous CDROM was difficult to navigate, and based on student feedback, decided that there was some difficulty involved in locating material outside of the linear navigation developed to support the text and

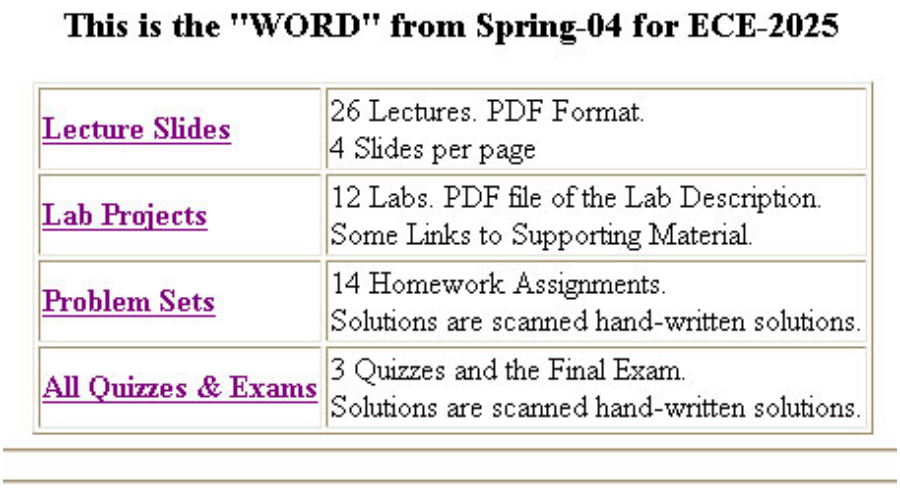
course. Therefore, in the new edition, developed in 2003, the authors added a search engine to assist the students in finding relevant content.

### 2.2.3 The WebCT Site

The course instructors use the WebCT site for administering quizzes and surveys and to provide a reference link to the main WORD site (Section 2.2.4) and to streaming videos of the course lectures. Students are able to access their current homework assignments, homework solutions after grading, lab assignments, pre-lab quizzes, and administrative information related to the course. There is also a class message board used by students for asking questions and by the instructors to announce adjustments in the assignments or the course.

### 2.2.4 The “WORD” Site

In student vernacular, “WORD” for a course or subject is past assignments, tests and quizzes, usually with solutions. The practice, viewed by many as a form of cheating, began within the Greek societies. Over the last few years, instructors have begun to support the practice, making it available to all students by providing the material themselves. The WORD files for ECE 2025 go back, through the various versions of the course, to 1993. There is a link from the WebCT site to a single page that provides connections to the entire collection, including material from the current semester. Figure 8 shows a segment of the collection for Spring of 2004.



**This is the "WORD" from Spring-04 for ECE-2025**

| | |
|---|---|
| Lecture Slides | 26 Lectures. PDF Format.<br>4 Slides per page |
| Lab Projects | 12 Labs. PDF file of the Lab Description.<br>Some Links to Supporting Material. |
| Problem Sets | 14 Homework Assignments.<br>Solutions are scanned hand-written solutions. |
| All Quizzes & Exams | 3 Quizzes and the Final Exam.<br>Solutions are scanned hand-written solutions. |

Figure 8 : HTML page for access to the Spring 04 WORD collection.

### 2.2.5 The Captured Lectures

Since the Fall of 2000, we have been providing a streaming video capture of the ECE 2025 lectures. We currently have 210 lectures available with 156 as Real Media files and 54 as QuickTime files. The DLPE (Distance Learning and Professional Education) group at Georgia Tech produces the videos as part of their support of the GTREP (Georgia Tech Regional Engineering Program) in South Georgia. However, the course instructors make the videos available to all of the ECE 2025 students via the WebCT site and the WORD collection.

The section of the web page, shown in Figure 9, provides links to the PDF of the lecture slide, a link to the captured lecture, as well as a link to the *permanent* version of the lecture slides. The permanent representations of the slides are those without announcements specific to that semester or to ECE 2025 in general. The web page also provides a reference to the date of the lecture capture, the associated reading from the textbook, and any extra materials such as related demos and examples.

| Lecture | File(s) | Date | Topic | Reading | Extras |
|---|---|---|---|---|---|
| 1 | PDF Video *perm* | 05 Jan 04 | Sinusoids | Ch. 2, Sects 2-1 to 2-2, Appendix B | |
| 2 | PDF Video *perm* | 09 Jan 04 | Time and phase shift Complex Exponentials | Ch. 2, Sects 2-3 to 2-5, Apps. A & B | ZIP file for Sine Drill: find cos() formula from a plot. updated from DSP First CD. |
| 3 | PDF Video *perm* | 12 Jan 04 | Phasor Addition Theorem | Ch. 2, Sect 2-6 | ZIP file for Z-Drill: complex number manipulations. |
| 4 | PDF Video *perm* | 16 Jan 04 | The Spectrum | Ch. 3, Sect 3-1, App. A | |

Figure 9 : Slice of WORD HTML page providing lecture materials.

### *2.3 Student Use*

In order to get a broad picture of the students' use of the online content, we analyzed their use of each of the four main components. For two of these components, the WORD site and the Captured Lectures, we used access log data from the web and streaming server, respectively. Analyzing web log data is problematic, since the log does not record student identity, but it suffices to provide an understanding of general use. We used the WebTrends program to perform the basic data analysis from the log files [43]. For the WebCT site, we were handicapped by the limitations of the file tracking provided by the CE version of the application [Section 2.3.2]. The final component is the CDROM. Given current security practices, and restrictions placed on browser technologies, it is not feasible to track CDROM use directly. We do have information from student surveys that pertain to use; and relied upon those to give us an understanding of how the CDROM fits into the overall picture of online material use in ECE 2025. A recent study, done by the Advanced Learning Technologies (ALT) group at the University System of Georgia Board of Regents, suggests that students' self-reported use of online content closely relates to their actual, logged use of that content [24].

### 2.3.1 Use of the WORD Site

Our log files for the WORD site go back several years. For the purpose of this analysis, we have limited our data range to twelve semesters, from Fall 2001 through Summer 2005. This provides four full years of data. As discussed in Section 1.4.2, the initial analysis used the first three years. The subsequent year is part of the actual study. Within this subset of the data, we have 1,407,301 *hits*, 327,128 *views*, and 87,645 *sessions*. For the purpose of this analysis, we define these terms in a manner similar to the definitions used in the Classroom 2000 study:

- Hit - An action on the Web site, such as when a visitor views a page or downloads a file
- View - Hit to HTML pages only (access to non-HTML documents are not counted)
- Session - A session of activity (all hits) for one visitor of a web site. We determine a unique visitor by the IP. By default, a visitor session is terminated when a visitor is inactive for more than 30 minutes [1, 15].

The twelve semesters includes 2,175 students, 141 of which withdrew from the course prior to completion. The highest enrollment was the Fall of 2001, with 299 students enrolled in two sections of the course. The lowest enrollment was the Summer of 2004 with 75 students. The average number of sessions per student from the Fall of 2002 until the Summer 2004 held between 23 and 44, with a standard deviation of 7.94. A significant drop occurred in the Fall of 2003 and the Summer of 2004. This general level of access for the WORD content held through the initial phases of our study in the Fall of

2004 and the Spring of 2005. The final phase of our study resulted in a marked increase in the use of online content in the Summer of 2005 (Section 4.3).

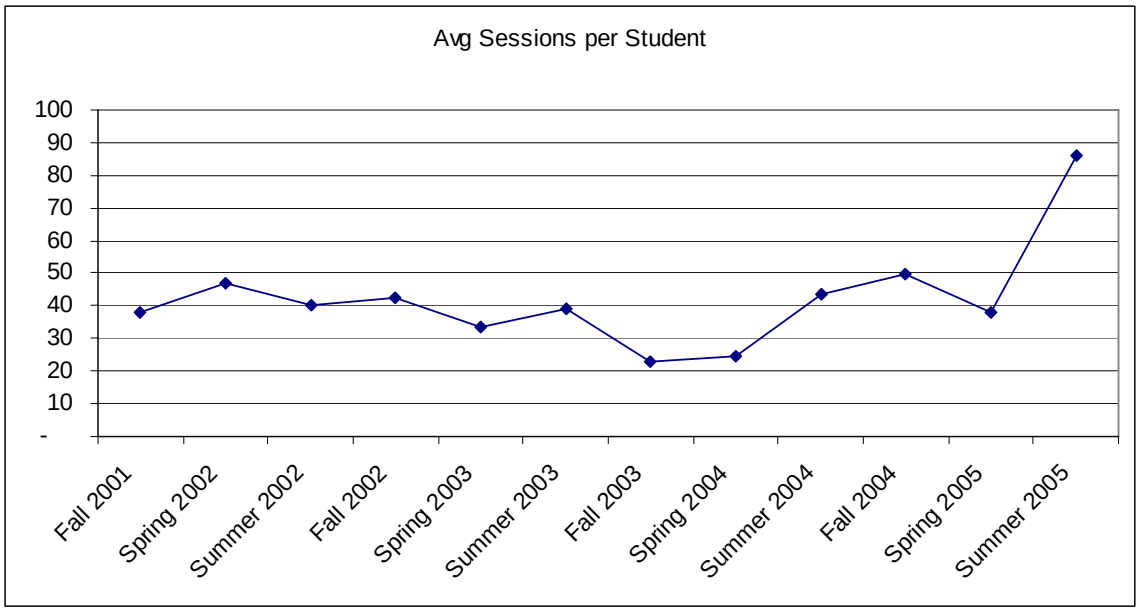



Figure 10 : Average number of Sessions per Student from Fall 2001 through Summer 2005.

The graphs of average hits [Figure 11] and views [Figure 12] show a similar pattern. In all three of these series, there is a decline in use towards the Fall 2003 and Spring 2004 with a resurgence in content access in the Summer of 2004. As in the case with average sessions, they also increase significantly in the final phase of our study.

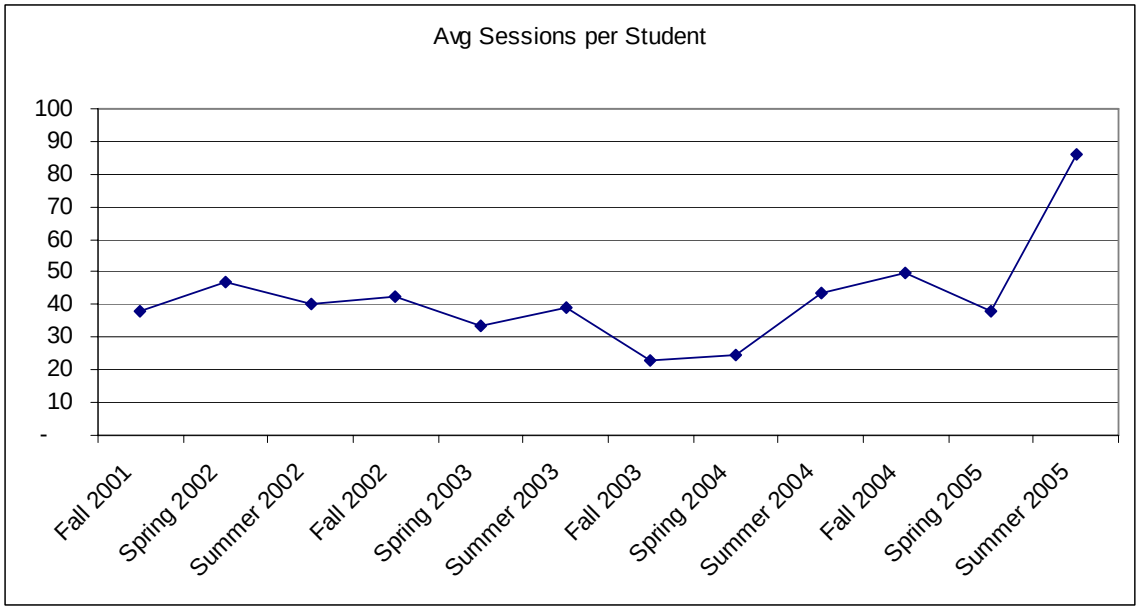



Figure 11 : Number of Hits for the WORD site per student.

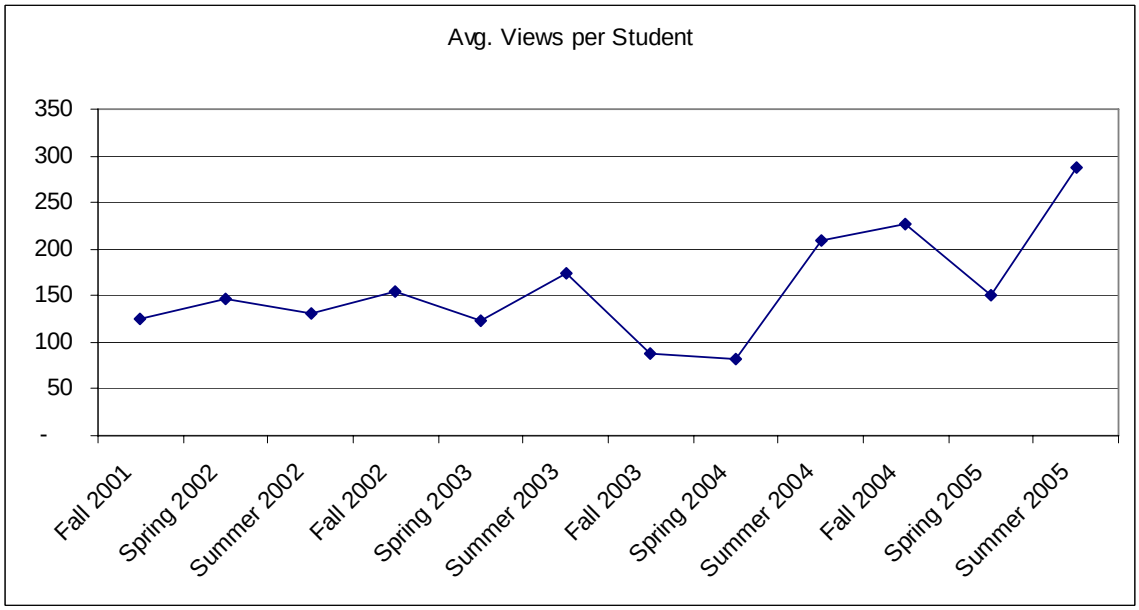



Figure 12 : Number of Views for the WORD site.

The summarized data is available in Appendix A. Peak days generally occur at the end of the semester, as finals draw close. The general activity rises and falls through a semester, with peaks appearing to occur as term tests approach. The average session time held steady for the first nine semesters, at about 7:30 minutes; as our study progressed in the last three semesters, the average session length increased. Likewise, the percentage of sessions that last less than a minute holds around 60%, and the percentage of sessions that exceed 19 minutes holds around 10%.

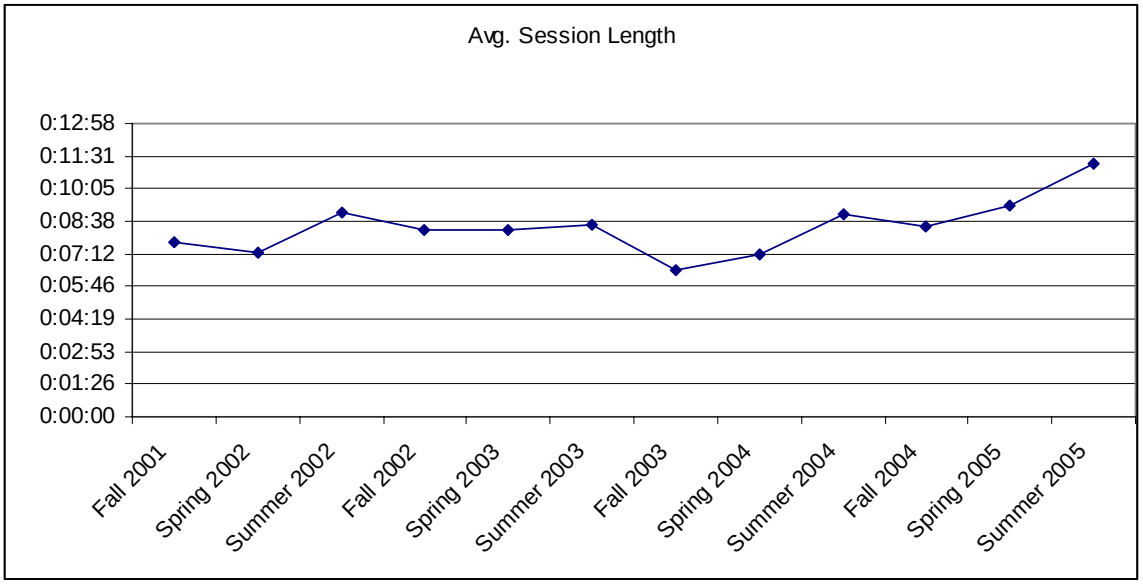



Figure 13 : Average length of access sessions of the WORD content.

Another set of ratios that held steady over the nine semesters relates to the number of pages viewed during a session. Roughly 83% of students view fewer than five pages per session, with the largest segment around 33%, viewing just two (traversing one link). Less than 1% of students view more than 12 pages in a single session. A review of the common paths shows that this reflects the students' clear goal, and a straightforward way of reaching it. The two primary paths go from the main entry page to the past homework

assignments or to the past quizzes. Since the current homework assignments are on the WebCT site, the access on the WORD site is directed at previous assignments. Students tend toward starting with the most recent past semester, and working backwards. This holds true with the exception that a large number of students tend to skip summer semesters.

Our interpretation of this data, including an examination of navigation data from the WebTrends reports, is that the majority of the students' use of the WORD content is a targeted selection of past homework files and past quizzes.

### 2.3.2 Use of the WebCT Site

Though WebCT is intended to track student usage of content, their definition of content in the outdated version (CE) being run at Georgia Tech is extremely limited and does not include individual content files. Instead, faculty are expected to group content together into modules and track only content module access. The instructors did not do this with the ECE 2025 course content. With this limitation, the only quantitative information we have regarding student access of WebCT content is general access data for the navigational pages. In addition, due to space limitations, the systems does not retain past semesters of courses. A request for the archived semesters was not able to produce a consistent set of data. Though we do not have the historical information in line with the rest of the information presented in this chapter, we were able to get the limited data available for Fall 2004 through Summer 2005. It is too small of a sample set to designate a trend, but it does show a consistent use by students, with average navigational hits from 582 to 767 per student per semester.

Though we do not have detailed information about specific files accessed by students, we can deduce the majority of use from other data. From our Apache log files, we know that the majority of content use for those sites is from the link provided on the WebCT site. This constitutes a significant portion of the hits on WebCT. Also, there are required lab quizzes and assignments provided on the WebCT site. These also account for a significant number of hits. Finally, there are discussion groups (bulletin boards) maintained on the WebCT site. Posting and reading articles on these are included as access hits in the WebCT data. These constitute more than half of the recorded accesses.

### 2.3.3 Use of the CD

Though student survey data exists for ECE 2025 going back several semesters, we currently only have access to information from Fall 2003 through Summer 2004. In our initial study, we used the data from the first two semesters to understand the relationship between the CDROM and available online content.

In general, the CDROM is used mostly for the demos (predominantly MATLAB demos) and not for review of the past homework assignments or worked problems.

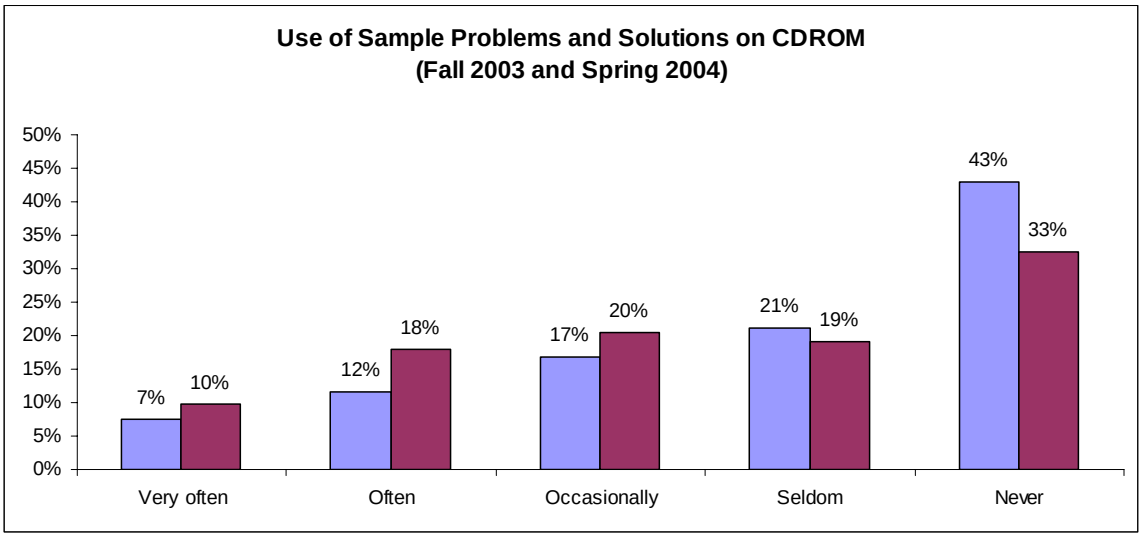



Figure 14 : Limited use of CDROM content.

Figure 14 shows 70-80% of students occasionally or never use the CDROM to access the practice problems (exercises). Though the CDROM contains much of the same data, students seem to prefer using the WORD files on the Web.

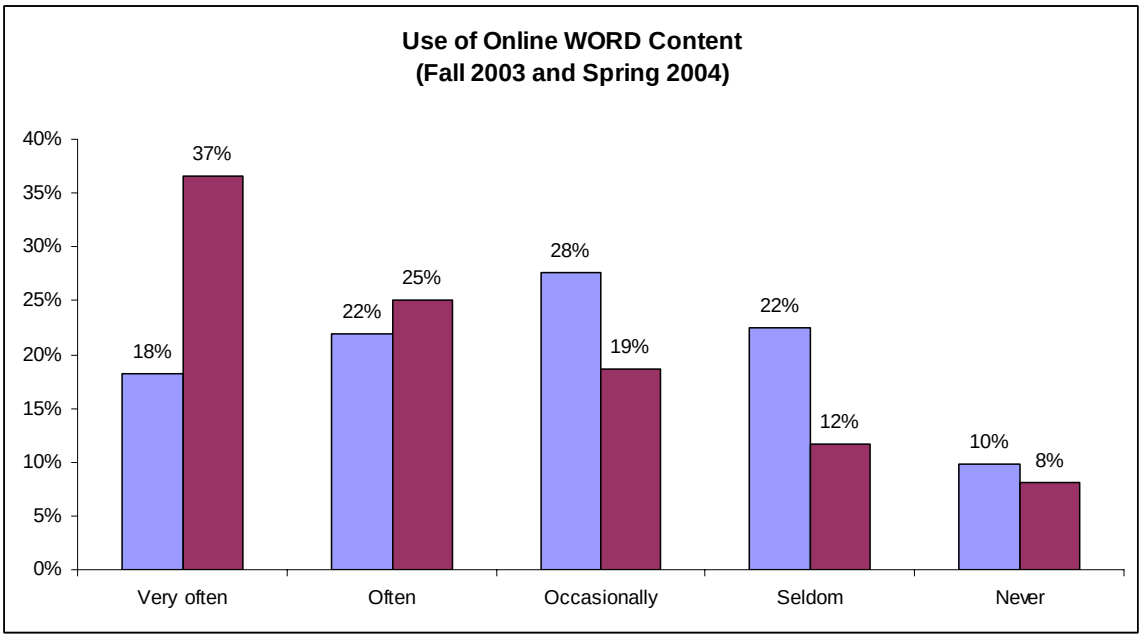



Figure 15 : Web vs. CDROM use.

In contrast, the students' reported use of Web content, Figure 15, shows a strong preference for this medium over that of the CDROM, Figure 14. This may reflect the location and time of use, when they may not have the CDROM available, or a lack of motivation to find and insert the CDROM, or perhaps even a perception that the information on the WORD site is better in some way. Few comments on this were included in the students' general comments, and we did not ask the question specifically. One available comment indicated a belief that the resale value of the book would be greater if the CDROM packet was unopened.

### 2.3.4 Use of Captured Lectures

Our look at the Helix (Real Media Streaming Server) log files showed evidence of student use of prior lectures from other semesters and instructors, as well as use of current semester recordings if they were available. Unfortunately, there is a gap in the access log from 6/19/2002 through 9/4/2003. The information we do have gives us some understanding of the general use of captured videos. Looking at Table 1, we see that students use the archive of past lectures even when no lectures from the current semester are available. Our data also shows that students use the captured lectures from the current semester (90%), if the lectures are available.

Table 1 : Number of video requests by semester of request. Captures field lists the number of lectures captured during that semester. No lectures were captured in the Summer of 2002 or 2004. There is missing data in the Summer 2002 log.

| *Capture Use by Semester* | *Requested* | |
|---|---|---|
| *Semester* | *Requests* | *Captures* |
| Spring 02 | 417 | 27 |
| Summer 02 * | 257 | 0 |
| Fall 03 | 1301 | 26 |
| Spring 04 | 1582 | 26 |
| Summer 04 | 639 | 0 |

Table 2 : Number of capture requests by semester of creation. Content field designates if lectures were captured. Y = yes, N = no, P = partial. Data is missing for Summer 02 and Fall 02.

| *Capture Use by Semester of Creation* | | |
|---|---|---|
| *Semester* | *Requests* | *Content* |
| Fall 00 | 188 | Y |
| Spring 01 | 835 | Y |
| Summer 01 | 0 | N |
| Fall 01 | 51 | Y |
| Spring 02 | 28 | Y |
| Summer 02* | 0 | N |
| Fall 02* | 0 | P |
| Spring 03 | 80 | Y |
| Summer 03 | 0 | N |
| Fall 03 | 1276 | Y |
| Spring 04 | 1745 | Y |
| Summer 04 | 0 | N |

Table 2 shows the number of requests for lectures based on the semester in which the lecture was captured. There were 1745 requests for lectures captured in Spring 2004. However, there were only 1582 requests actually made during that semester. The difference reflects the use of captured lectures from earlier semesters, even when the current semester is being captured. We gained the information above by using shell scripts to segment the log files into individual semesters and then count the number and source locations of video requests.

### *2.4 Students' Perceived Value of the Online Content*

The results shown in Figure 16 reflect a positive student perception of the content, with 65% believing that the content aided their understanding of the course material.

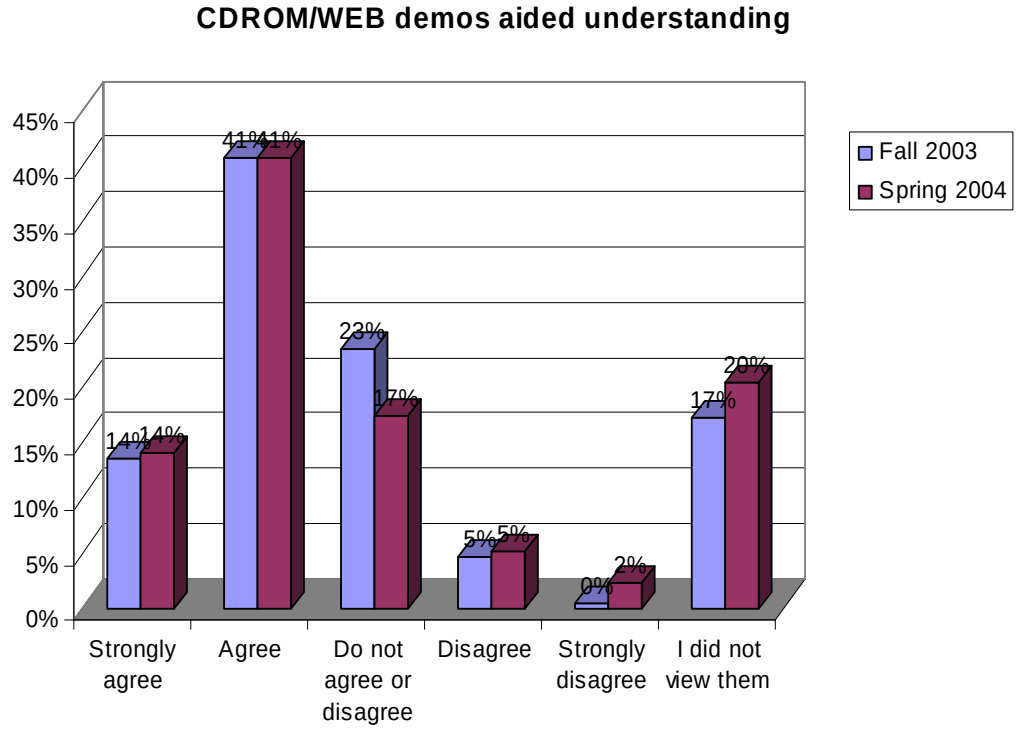



Figure 16 : Student perception of content value.

From all of the surveys, 56% of students reported that the demos aided understanding, 18% were neutral, 7% disagreed, and 20% said they never used them. This contrasts with the students' low reported use of this content (7-10% regular use), and the extremely low use logged on the servers. We summarize the survey questions related to student perception in Appendix B.

### 2.4.1 "Most Helpful" Comments

One of the open questions on the class survey asks the students "what helped most." In response to this question, 17% of students referred to the online material. Specifically (and in some cases these overlap), 13% of students referenced the WORD files as most valuable, 6% referenced the CDROM, and both the WebCT portal and the

captured videos were referenced by 5% of students. This survey data is from Spring 04, and 172 students responded (out of 173 students still enrolled when the instructor gave the survey).

### *2.5 Performance-oriented and Proficiency-oriented Content*

There is a great deal of content available for this course. There are also a significant number of students making use of that content. The content is generally well organized and the students seem able to find what they intend to find. The amount of data makes it possible for us to see stable patterns in student use. This makes it possible for us to determine if our embedded access technologies had an impact, either positive or negative, and to evaluate the magnitude of that change. Beyond identifying increases in use, we also looked for changes in the pattern of use. We discuss these changes in Section 4.5.

Though the use of online content is relatively high in ECE 2025, compared to the general use of online content discussed in other studies, the majority of the content requests were for past quizzes, past homework assignments, and past lab assignments. We refer to this as *performance-oriented* content. We interpret the students' use of performance-oriented content to be motivated by the desire to do well on a specific performance measure, like a quiz or a homework assignment. The repository of online content for this course also has *proficiency-oriented* content in the form of lab reviews and discussions, practice exercises for key procedures, and demonstrations that provide examples of key concepts. Instructors and authors designed the proficiency-oriented content to aid the students in mastering the concepts and procedures necessary to accomplish the learning objectives of the course. When we contrast the use of past

homework assignments (the most used content) with the use of past practice exercises (some of the least used content), we gain an insight into student motivation and its impact on the use of the available content.

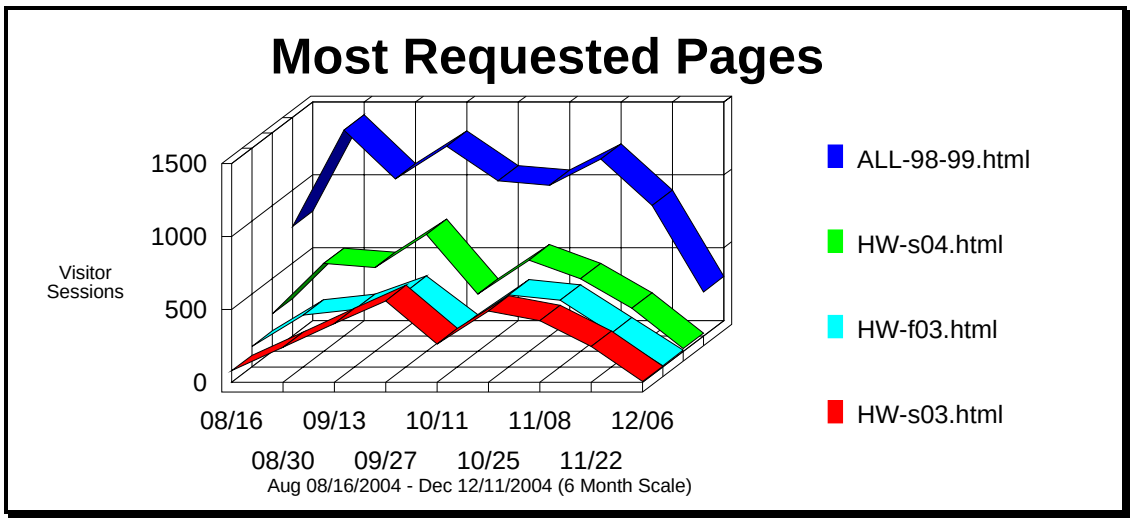



Figure 17 : Graph of most requested pages. The entry page into the WORD site is the most requested followed by the navigation pages for the homework solutions from the previous three semesters. Quiz solutions and past lab solutions are behind these.

The designation of proficiency and performance oriented content is derived mostly from the intent of the authors or creators. However, there are times when the perceived intent of the student makes this designation more difficult. Captured lectures and lecture slides are examples of this problem. The clear purpose of the authors and presenters is to transfer concepts and build proficiency. The use of the content, however, varies. Student responses to the questions of what helped them understand the material reflect the use of the content as proficiency-oriented, with comments like: “lecture/lecture slides[;] I used the slides/notes/book to go through each week and fully understand all the material for that week.” However, students also express a belief that concepts covered in

lecture are more likely to appear on a test than those that instructors did not cover in lecture [4, 12, 13, 53, 58]. This use would be performance-oriented.

In our study, artifacts that are past performance instruments (homework, quizzes, tests, and past labs exercises) are classified as performance-oriented content. Artifacts that instructors and authors developed in order to transfer concepts (worked exercises, demonstrations, expanded lab materials, and lectures) are classified as proficiency-oriented. Following the example of Kiewra [52, 53, 54], we treat lecture slides as an extension of note-taking practice.

In this research, we focused our efforts on increasing the students' use of the proficiency-oriented content. Specifically, we designed our interface applications to provide embedded links to the demos, labs, and exercises provided to deepen the students' knowledge of the material and provide a fuller understanding of how to use that knowledge. The original technology intervention did not result in an increased use of the proficiency or performance-oriented content. The second intervention, however, resulted in a modest increase in the use of proficiency-oriented content. We attribute the significant increase in the use of performance-oriented content to other factors, as discussed in Chapter 4.

# CHAPTER THREE

## Design and Evaluation of a Convenient Access Interface

In our design experiment, our goal was to test the idea that a convenient interface would improve access to online content. Motivated by the Tenopir summary, our intent was to develop an interface that would be "convenient, relevant, and time saving to their natural workflow" [86]. We believed it was important to situate our research within the real context of the classroom and learning environment. Our design approach involved an evaluation of current student practice regarding online content through an analysis of access logs and survey data. Because of the multiple dependent variables involved in real classroom settings, we generated a model of student content use that included multiple instructors, different semesters, and a broad population of students. The target course, ECE 2025, though taught by multiple instructors, uses a standard presentation that they follow from semester to semester. Changes in instructor and the differences between individual semesters did not have a significant affect on the use of online content by students. As discussed in Chapter 4, there were demographic shifts in the student population that affected the volume of content use in the final semester of the study. This shift, however, did not impact the pattern of content use.

Our next step was to determine a definition for convenience. Based upon that definition, we evaluated the existing methods of content access by the students. From our definition and evaluation, Section 3.1, we determined to develop an interface that would provide direct access to relevant content without the need for extensive navigation. In considering a context for developing our interface, we decided to use the common activity of note-taking. We discuss our reasons for this decision in Section 3.2.

We built our series of designs for different media over a common architecture, which we called *embedded access.* We then subjected the resulting target design for deployment, NoteNexus, to a formative evaluation including two focus group studies. The series of prototypes, the formative studies, and the final design are all presented in Sections 3.3 - 4.2.

### *3.1 Convenient Access*

The concept of convenience is not well defined in most of the studies cited. Our definition of convenience has two parts. First, a convenient interface should require little if any change in the work practice of the student. Second, the number of steps necessary to reach content should be low. Our design objective, therefore, was to develop an interface that would fit with current work practice and reduce the number of steps necessary to access online content.

In our analysis of the current paths used to access content on the server, 78% of access began with the entry page for the site.; 7% went to the entry page for one of the past homework sections (separated by semester), 4% went to the entry page for one of the past quiz section, 3% went directly to the entry page for past lab exercises, 1% went to an entry page for captured lectures, 5% of access were not categorized, 2% were incorrect requests, and 1% were direct access to actual content without navigation. In getting to the site, 44% of site access was direct, that is, no referring site or URL. We interpret this to be either a bookmarked connection or the user remembered the correct URL; 42% of access to the site came via the WebCT website for the course; and 14% of accesses were made via Dr. McClellan's faculty website (there was a small group of accesses, less than 1%, referred by various search engines.). Finally, our analysis of paths show that most

students proceed from the entry site, through the navigation links for semesters, down to specific content pages, Figure 18.

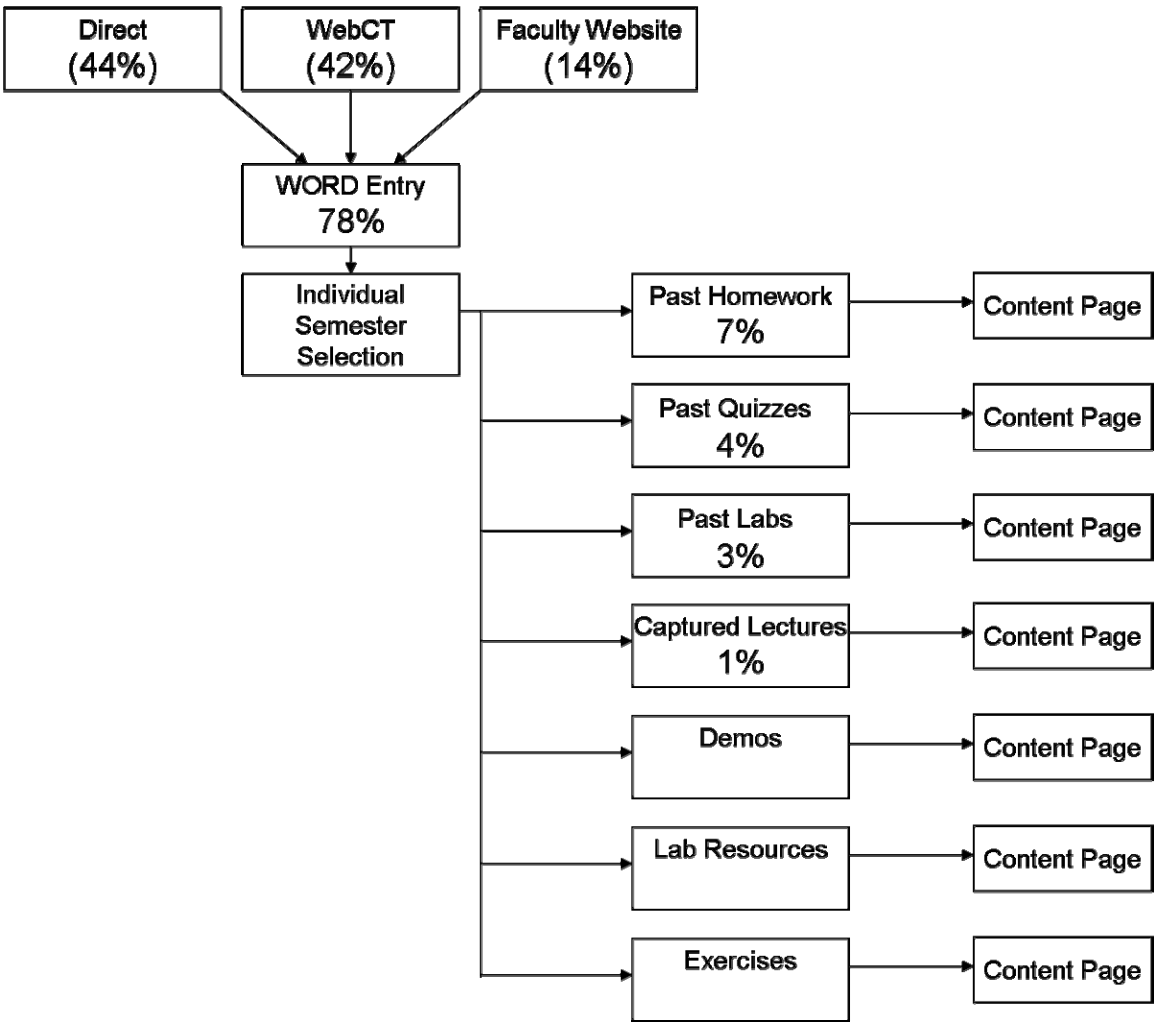



Figure 18 : Access paths for content on the server. The numbers in parenthesis in the top boxes refer to the percentage of accesses referred from that category. The other numbers reflect the percentage of entries into the content server at those points. These are aggregate numbers for all navigational pages of that type under each individual semester.

### *3.2 The Use of Notes as a Context for Access*

Class notes are an integral part of our educational experience. There are many methods and practices for taking notes, and the vast majority of students at least try to take notes. Not surprisingly, there is a correlation between good note-taking and good grades [58], though there is debate over what that relationship is. Since notes are both

integral to lecture classes and generally ubiquitous, it is a natural target for connecting the student with available content.

### 3.2.1 Notes and Recall

Studies show that the review of class notes improves recall, and retention of lecture material [28, 36]. The improvement in recall occurs with notes created by the students as well as those provided by faculty [53, 59]. In his 2001 study, Boyle describes a number of stages in the note-taking process [14]. The first of these, “Listening During Note-taking,” describes the focusing of attention on the topic and material presented by the lecturer. During the listening stage, students must “attend to the important points of the lecture” and assign meaning to those points. The cognitive stage involves the personalizing and paraphrasing of the information. The cognitive stage also involves distinguishing between essential and nonessential lecture information, identifying unknown vocabulary, accurately storing bits of information in short-term memory prior to recording it, and elaborating on lecture points [54]. Difficulty with any of these tasks may result in fewer or less complete lecture points recorded [4]. The ability to select the important ideas from the lecture, and then supplement the ideas with details is one key to creating effective notes [52]. The recording phase is when students must inscribe their notes in “a succinct yet usable format”. The notes must be organized and contain enough detail that the student is able to understand them when read later [52].

The creation of notes is a beneficial process, but the review of notes increases the understanding and recall of the information. The more complete the notes, the more benefit is gained from the review process [36, 52, 58, 13, 23, 55, 59]. According to Boyle:

> "In addition to listening, writing and processing skills, the ability to review notes is also an important, yet overlooked step in note-taking. Whether it is a review of notes immediately after class, or studying notes for a test, the review process is an important one. Here too, the task of reviewing notes can have potential pitfalls for students. Reviewing notes often means looking over notes immediately after class to fill in gaps, clarify poorly understood concepts, or correcting the spelling and legibility of handwriting. For many students, reviewing notes is often the step missing from their note-taking repertoire of skills. Yet, this step could allow poor note-takers to compensate for note-taking inadequacies. The key during this step is to review notes immediately after class. In this way, the topic is still fresh in mind and it becomes part of a routine for students. "[14]

Note-taking studies in the 1960's and 70's show that students fail to record 40% of important lecture ideas presented in a typical lecture [30, 37]. This capture of critical ideas drops to 11% for the first year students. In the 1977 study by Locke, even successful students failed to note many of the important points; students who received a grade of "A" generally recorded 62% of key points [58]. More recent studies show that students record more of the information written on a board than what is verbally communicated. The use of digital display technologies, like PowerPoint, does not generate the same level of note-taking as board writing, but it is, in general, better than verbal only, which can result in less than 10% of important points captured by students [50, 20]. Limits on short-term memory (STM), combined with the volume and pace of

information presented by the lecturer are also factors in a student's ability to identify, process, and record an important point in a lecture. This is compounded by the introduction of technologies into the classroom designed to make it possible for teachers to convey more information than previously possible in traditional classrooms [15].

The student's attention span also influences the process of note-taking. After the first 5-10 minutes of a lecture, a student's attention begins to waiver. Likewise, the ability to recall the presented material declines as the attention declines [87, 12]. As attention waivers, the quality and accuracy of the note-taking also drops. Finally, errors in student notes occur most frequently when students are attempting to record complex or dense items like diagrams or equations [50].

### 3.2.2 Capturing Notes

Several projects have explored ways of using technology to enhance, or in some cases replace, the process of note-taking. Work at Xerox Corporation's Palo Alto Research Center (PARC) focused on capturing technical meetings to support summarization by a single scribe, who was often not well versed in the subject of the meetings [78, 84]. The Tivoli work done at Xerox PARC [78], Stifelman's Audio Notebook [56], and Georgia Tech's eClass (originally Classroom 2000) [1, 15],stand out as capture system research intended for live use and evaluated over an extended period of time. The Tivoli system observed the use of capture to support specialized meetings to discuss patent applications, and the study lasted two years. Stifelman conducted two separate studies with different versions of her Audio Notebook and each study consisted of a small number of sessions both capturing and accessing personal notes from a variety of situations (class lectures, reporter interviews). Neither of these two projects has

reported the scale of use reported by the eClass system, mainly because they did not engineer their systems to facilitate the automated collection and postproduction of materials, as was the case for eClass.

Projects, like the eClass, that are related to the educational application of automatic capture, include the MANIC system at the University of Massachusetts [72], the DEPEND (Distance Education for People with Different Needs) system at the University of Oslo [74], the Chitra project at Virginia Tech [3], and the Lecture Browser system in the Project Zeno effort at Cornell University [47]. Other work includes the provision for more or less automated support to the capture of audio and video of the live sessions in order to have the presentation available for later review. This is the case of the ADEPT Project at Stanford [27] and the AutoAuditorium Project [11]. In such implementations, however, the information generated is mostly a linear video-based document. The *Authoring on the Fly* system [8] provides an elaborate capture infrastructure that implements the "linking by capturing" paradigm, a timestamp based system for interconnecting multiple capture streams. The implementation, which emphasizes support for broadcasting the presentation live, captures a fair number of applications running on Unix-only environments.

The StuPad project [89, 90], which was an extension of the Classroom 2000/eClass project, was an important look at a capture system designed specifically to support students' personal (private) notes in combination with the faculty (public) notes being captured by the classroom capture system. The Classroom 2000 system captured the notes presented by the instructor and broadcast them to the students' systems. StuPad integrated the lecturer's notes and the student's notes into a combined representation for

later review by the students. The DEBBIE system is similar to StuPad in many ways [10]. Their system broadcast an instructor's presentation to computers at students' desks and incorporated into their electronic notebooks. Both StuPad and DEBBIE have separate areas for private and public annotation, but StuPad also allows students to add their own annotations on top of the instructor's slides.

Tegrity Notes is a new, commercial system recently on the market [42]. Like the earlier StuPad project, Tegrity Notes interconnects students' notes, taken with the Tegrity Pen, into the captured lecture and notes presented by the instructor and captured with the Tegrity system. The annotations are associated with the lecture in which they were taken and time stamped. Using this information, the review interface integrates playback of the lecture and instructor annotations with the notes inscribed by the student.

### 3.2.3 Anticipated Benefits of Use

At first glance, it is apparent that an embedded access, note-taking technology will benefit students who take good notes more than those who take poor notes. Students who take fewer notes, or less accurate notes, however, will still benefit from this system. Embedded access to the available materials, even for a few terms, will increase a student's access and exposure to that content. Students who have trouble keeping up in lecture, who only manage to get the "high points," will be able to review that material, use it as an entry point into related material, and even go back through the lecture in order to pick up more detail. The more key points students acquire, the better their overall performance will be in the course [30, 37, 50, 52, 58].

Beyond the increased access to the content, we believe that our system may motivate students to use their notes more and to increase their note-taking. By changing

notes from a static artifact to an interactive one, we hope to increase the value of the notes to the students. If the notes are more valuable, and are a better tool for "performing well" in the course, regardless of the basis for that motivation, we believe that students will review their notes more often, and produce notes that are geared towards the selection and transcription of key points in the lecture. If this proves to be true, then imbuing static notes with the interactive capabilities of embedded access will provide an important tool for less gifted students, and motivate them to improve their note-taking skills.

### *3.3 Prototype Designs*

To determine the viability and efficacy of embedded access in course notes, we developed and evaluated five related note-taking systems [33]. We based one of our test systems on the use of *digital pens*, which capture student pen-strokes and produce a digital representation of those notes. The slow, but steady increase in laptops, coupled with wireless connectivity, provides the opportunity for keyboard based note-taking. Therefore, we developed four keyboard based note-taking systems. These five systems are:

- Logitech® io™ Personal Digital Pen [44]
- Microsoft PowerPoint Notes
- Adobe PDF Notes
- Text Notes
- Web Notes

### 3.3.1 Embedded Access Architecture

We built all of the prototypes and the target applications over an architecture that we developed for this study [32] .We based the design on the architecture we created for the CNT application in an earlier content access project [63]. The content is stored on a server running the Linux operating system. References to the content, including keywords, are stored in a MySQL database. Access to the database is then provided via a PHP script. Words that match keywords in the database generate an actual link. The links are queries that access the MySQL database of online content via another PHP script.

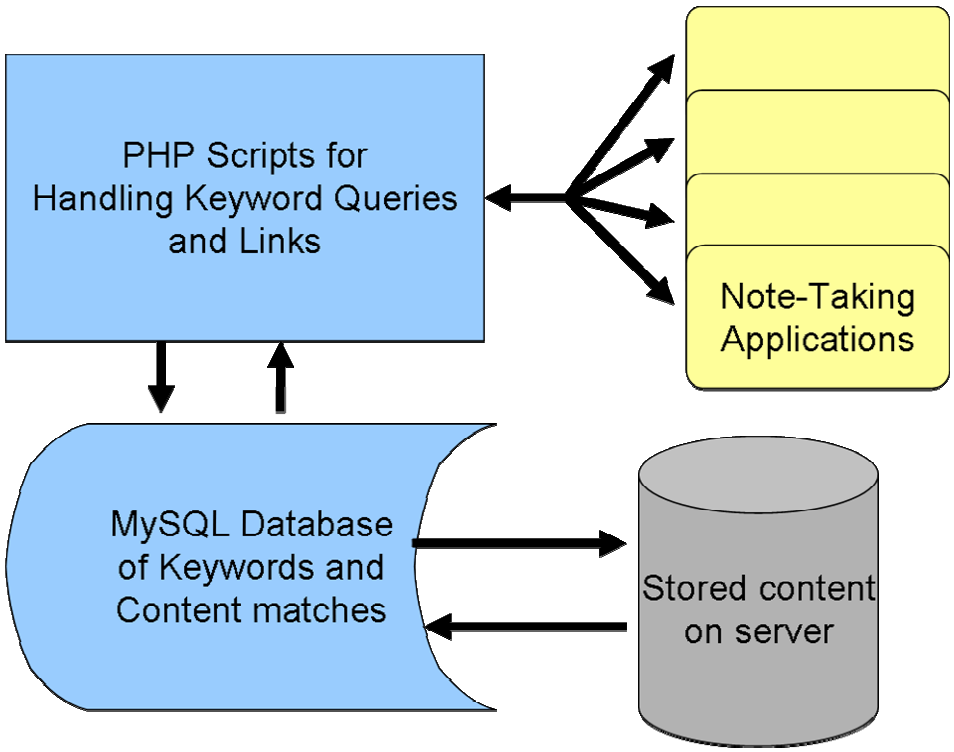



Figure 19 : Embedded Access Architecture

Though we developed the following prototypes in a variety of languages, each makes use of the embedded access architecture to handle the interconnection of student

notes with the available content. The embedded access architecture provides the content metadata to the applications.

### 3.3.2 Logitech io Personal Digital Pens

Figure 20 Logitech Pen, Docking Station and Note Pad

The Logitech® io™ digital pen is designed to replicate the affordances of a ballpoint pen and to be used in the same way. Users activate the pen by removing the cap and deactivate it by replacing the cap. The main parts of the digital pen are a digital camera, an advanced image-processing unit, and a communication unit. It also contains an ink cartridge so that you can also see what you have written or drawn. The digital pen requires special paper provided by Anoto [38], which they produce by printing a proprietary pattern of very small dots on ordinary paper. The dots have a nominal spacing of 0.3 mm (0.01 inch).

#### *3.3.2.1 Design*

The purpose of this implementation was to provide students with a system as close to traditional pen-and-paper note-taking as possible. Students used the Logitech pen when taking notes, and the special Anoto paper. After note-taking, students “docked” the pen in the USB cradle in order to transfer the digitized data to the computer. An application built around MyScript Notes [45] and Microsoft Word converted the content

into an HTML text based version. An implementation of embedded access, which we developed in Java, identified key terms and converted them to links. The result is a web page version of the notes with embedded access links to the ECE 2025 content. Figure 21 shows the output of the *prototype* on a sample of notes from a class lecture.

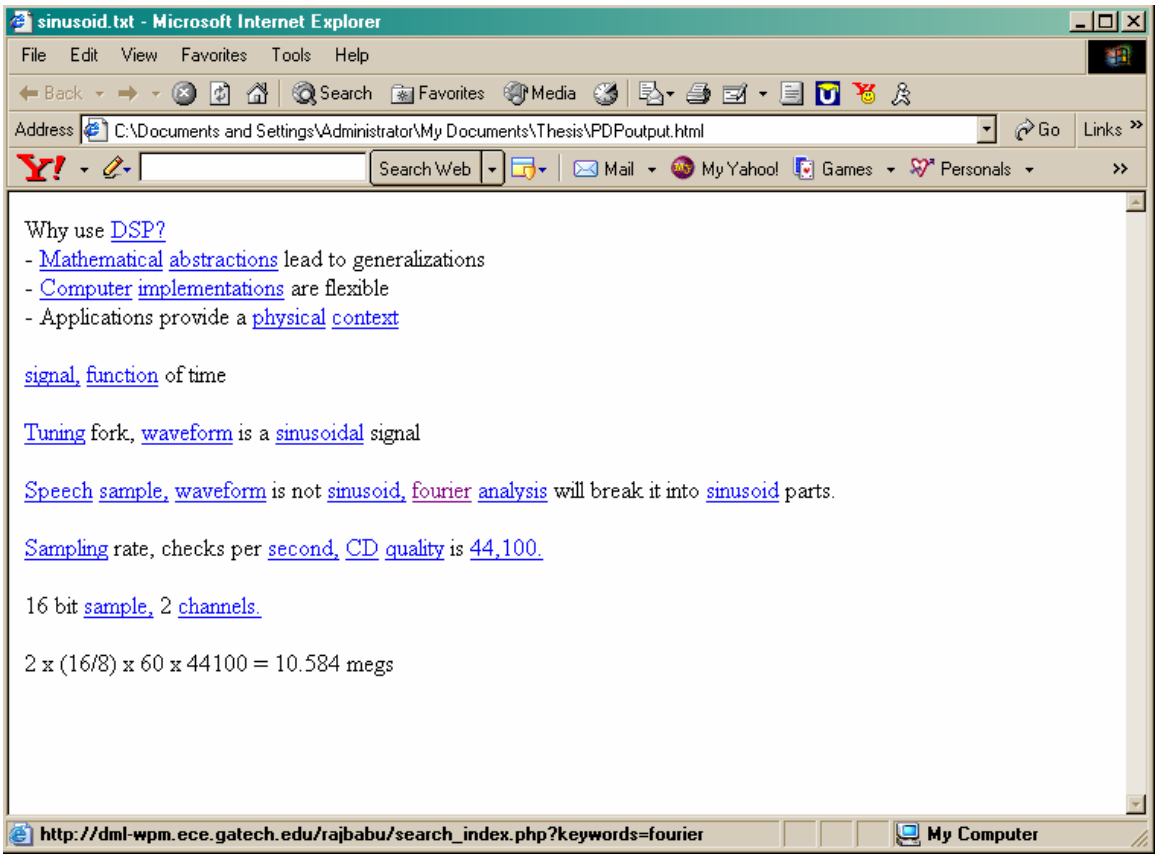



Figure 21 : Example of web page notes created from the Logitech digital pen prototype. The link in the status bar shows the PHP query for the term “Fourier”.

The application bases term selection on a set of keywords extracted from the ECE 2025 repository. Selection of a term opens another window and displays a list of suggested content.

#### *3.3.2.2 Evaluation*

Members of the design team tested the initial prototype in the lab. The pens proved to have too short of a battery life to support a full day of note-taking. Logitech reports that their pen can generate 25 pages before recharging. They provide no definition of a *page*. Our participants had fewer pages between charges, partially because the uncapped pen, poised to take notes, also burns battery life. The pens may be sufficient for students who took only a few notes, but lacked battery capacity for significant note-taking. Also,the resulting website interpretation did not handle equations very well. Finally, survey results from students reflected a lack of interest due to the cost of the pen. This prototype was set aside, but may be revisited with the new Tegrity Notes system now available using Pegasus Pens as well as the Logitech io pens [42].

### 3.3.3 Microsoft PowerPoint Notes

The Microsoft application, PowerPoint, provides the ability to associate notes with individual slides in a presentation. Since many faculty now provide copies of their PowerPoint slides prior to class, students with laptops are able to use this feature to associate their own notes with the slides. The lecture notes for ECE 2025 are available in PowerPoint format for the students. Our surveys show that 52% of students use the notes more than half the time, and only 8% of students never use the provided lecture notes. Also, 56% of students report owning laptops, and 89% of those express a willingness to bring those laptops to class if this service was available.

### 3.3.3.1 Design

Like the digital pen prototype, Section 3.3.1, we used an implementation of the embedded link method to identify keywords in the student-produced notes and create access links to the ECE 2025 online content. Since the students produced these notes via a keyboard, in machine-readable text, no conversion was necessary. There is, however, a second content source available to support embedded access in this implementation. We also selected keywords from the lecture slides and provided links to the online content.

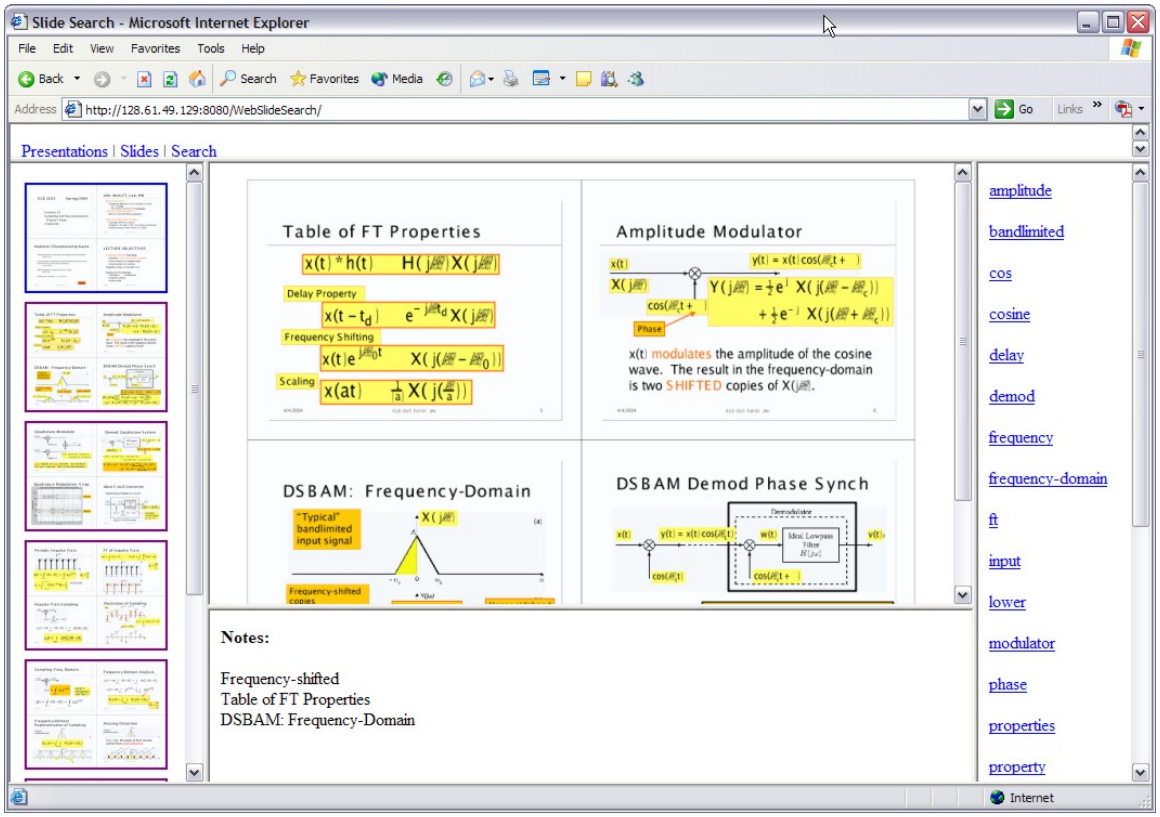



Figure 22 : HTML Page from PowerPoint notes.

This prototype, Figure 22, also represents the enhanced student notes as an HTML page. In the right-hand frame, thumbnails of the lecture slides are displayed. The instructor provided the slides in a 4-up format during this semester. The center-top frame shows the current selected slide. The frame below it shows the student notes. The layout of these

three frames matches the layout of PowerPoint in the note-taking mode. The list on the left-hand is a listing keyword links to the available content.

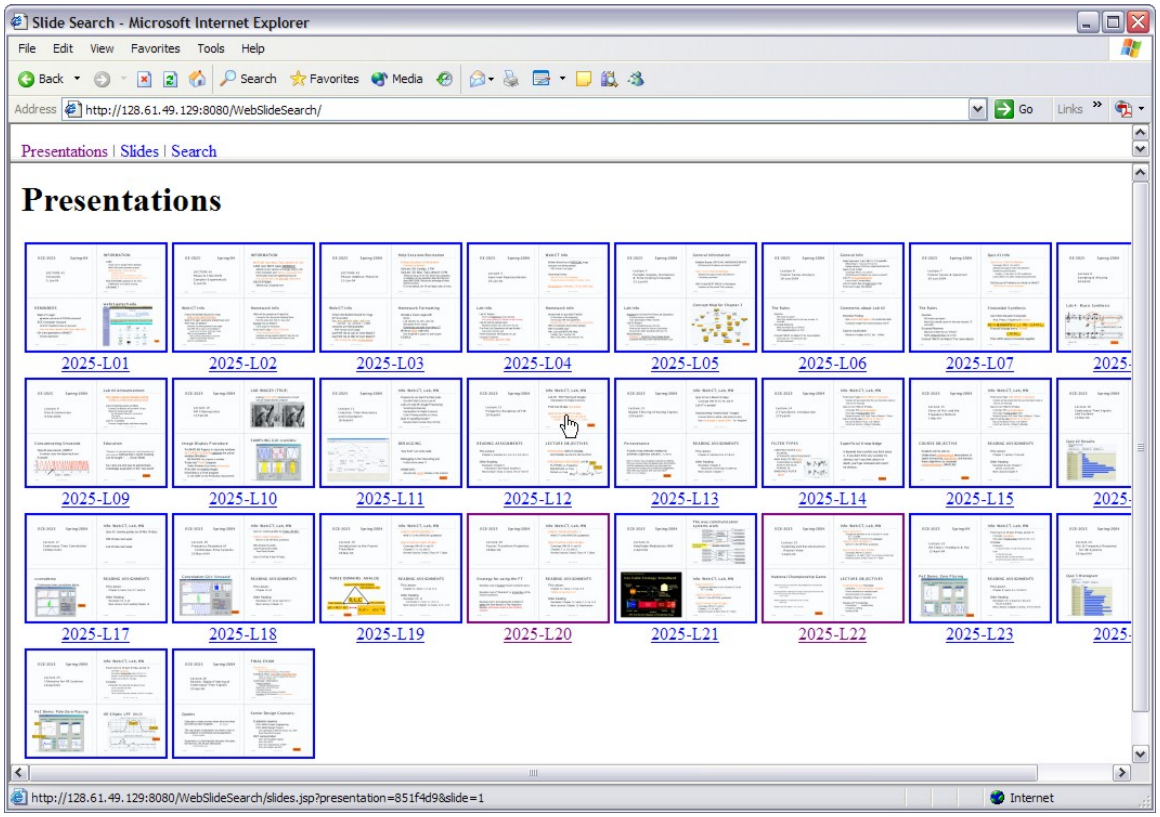



Figure 23 : Students may select which of their annotated lectures they wish to view.

Figure 23 shows a simple web interface that allows students to select an annotated lecture from their personal repository. We evaluated this prototype with the Adobe Acrobat prototype, and we present our conclusions in Section 3.3.4.

### 3.3.4 Adobe Acrobat Notes

Like Microsoft PowerPoint, Adobe Acrobat provides the ability to add notes to an existing PDF file. There are two keyboard options for adding notes: “Note Tool” and “Free Text.” They can be accessed from the toolbar, or by the hotkeys “Shift+S” and “S,” respectively. Acrobat also provides a pencil tool that works with Table PCs and other pen

based devices. The lecture notes for ECE 2025 are available in PDF format for the students.

#### 3.3.4.1 Design

We used an embedded access function to produce access links for the student notes. We also used the OCR available in the Adobe Acrobat SDK to make the text on the PDF slides available for linking. The resulting representations of the enhanced notes were presented as a web page identical to the Microsoft PowerPoint Notes.

#### 3.3.4.2 Evaluation

During development, we identified the most significant issues relating to the use of PowerPoint or Acrobat as the base technology for an enhanced note-taking application. The overhead of the systems was one of those problems. They both do a great deal more, and the interface is not optimal for the note-taking application. This leads to another difficulty: these applications are not significantly configurable. The Acrobat prototype has more functionality because it does allow for pen-based note-taking. However, both applications require a separate viewer application in order to have all of the linking capability. Though most students have PowerPoint, they do not all have Acrobat. The cost of acquiring these applications is relatively high.

Given the limitations imposed by the two products, we decided to develop our own interface that pulled on the best properties of the two applications. Based on the results of our experiments with the PowerPoint and Acrobat applications, we designed the NoteNexus tool (Section 3.5).

### 3.3.5 Digital Text Notes

There are several methods available for students to create machine text notes. Some students currently use laptops, PDAs, and even cell phones for this purpose. As the latter two are far more ubiquitous among the existing student body than either laptops or digital pens, it is important that we consider support for this note-taking method. This would also provide some support for *ad hoc* note-taking outside of the lecture environment, such as the library or serendipitous group session in hallways, buses, or elsewhere.

#### *3.3.5.1 Design*

Whatever method a student uses to produce the text notes, the student still needs to transfer those notes to a different system for processing. Once the notes are available, the embedded access application can convert the text file to an HTML representation with embedded access links to the online ECE 2025 content.

#### *3.3.5.2 Evaluation*

Students referenced this kind of application multiple times in their comments. When asked for alternatives to laptops and pens, students expressed a significant interest in cell-phone and other mobile communication devices. However, display and input limitations made it difficult to develop a system with capabilities we believed necessary. However, after reviewing student notes, an interesting application may be possible that allows for the creation of short notes or reminder/reference notes that integrate into a broader learning environment.

### 3.3.6 Web Notes

Our goals in developing a Web-based note-taking system included broad platform support as well as greater mobility. However, issues relating to storage became a problem. Limitations in Internet browsers make it difficult to load files from the local system disk into the application or to save application data onto the local filesystem. At the time of this study, we were not prepared to provide a server based system that provided secure storage capabilities for student files. In addition, our desired level of system logging would be prohibited by a browser based application. For these reasons, we chose to take our earlier design for a Web implementation of an embedded access system and develop it as a local application on a PC platform called NoteNexus [Section 3.4].

We have continued to develop a Web-based implementation in parallel with our primary effort on the NoteNexus system. The Web prototype system, which we named Scribbler, is being developed using Python/Zope over our PHP/MySQL repository.

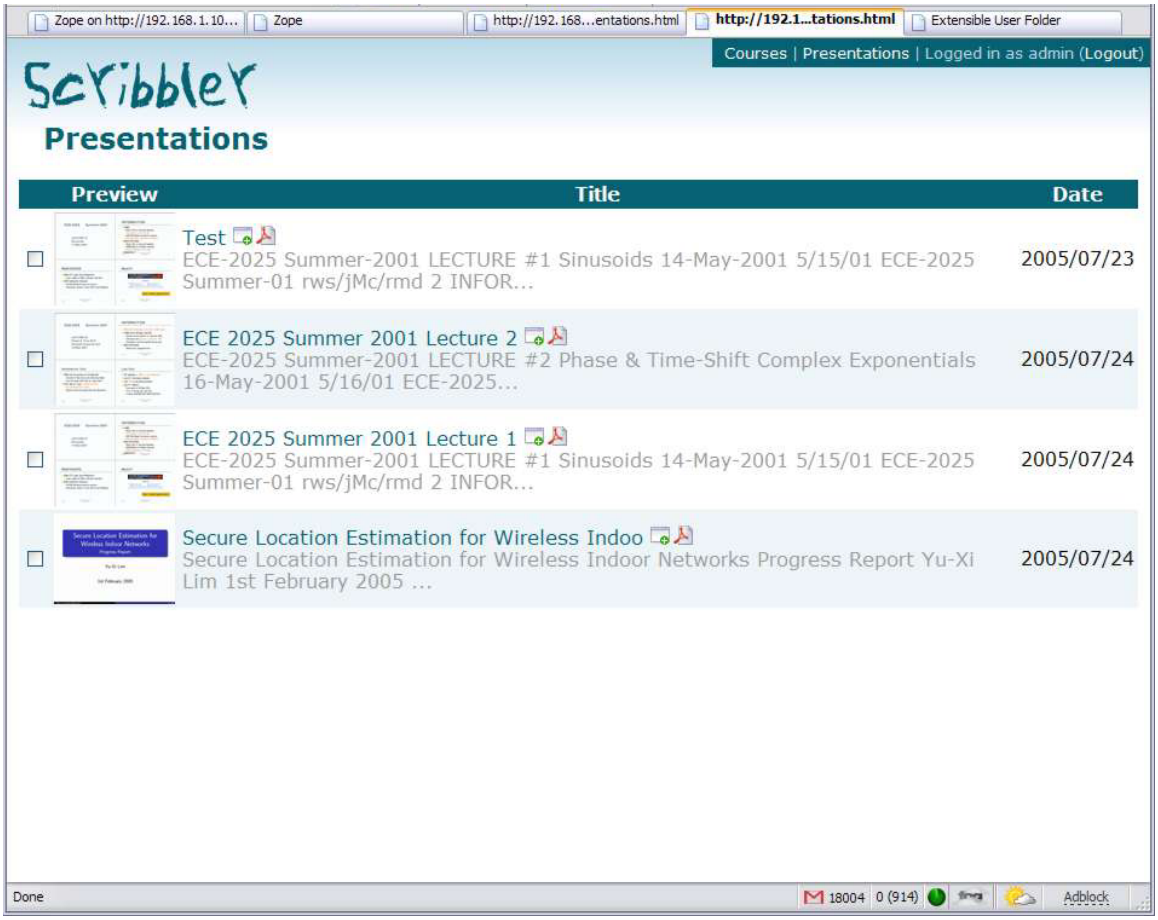



Figure 24 : Scribbler listing of annotated presentations.

We designed Scribbler as a more comprehensive system, involving management of slide-sets over multiple courses. It is a server based implementation that stores all of the image, annotation, and text data in a MySQL database. Figure 23 shows a screenshot of stored presentations for a single user. This implementation is closest in design to the Adobe Acrobat implementation in Section 3.3.4. Slides stored as PDF files are loaded and converted to images. The goal is to support both pen and typed text annotations (see Figure 24).

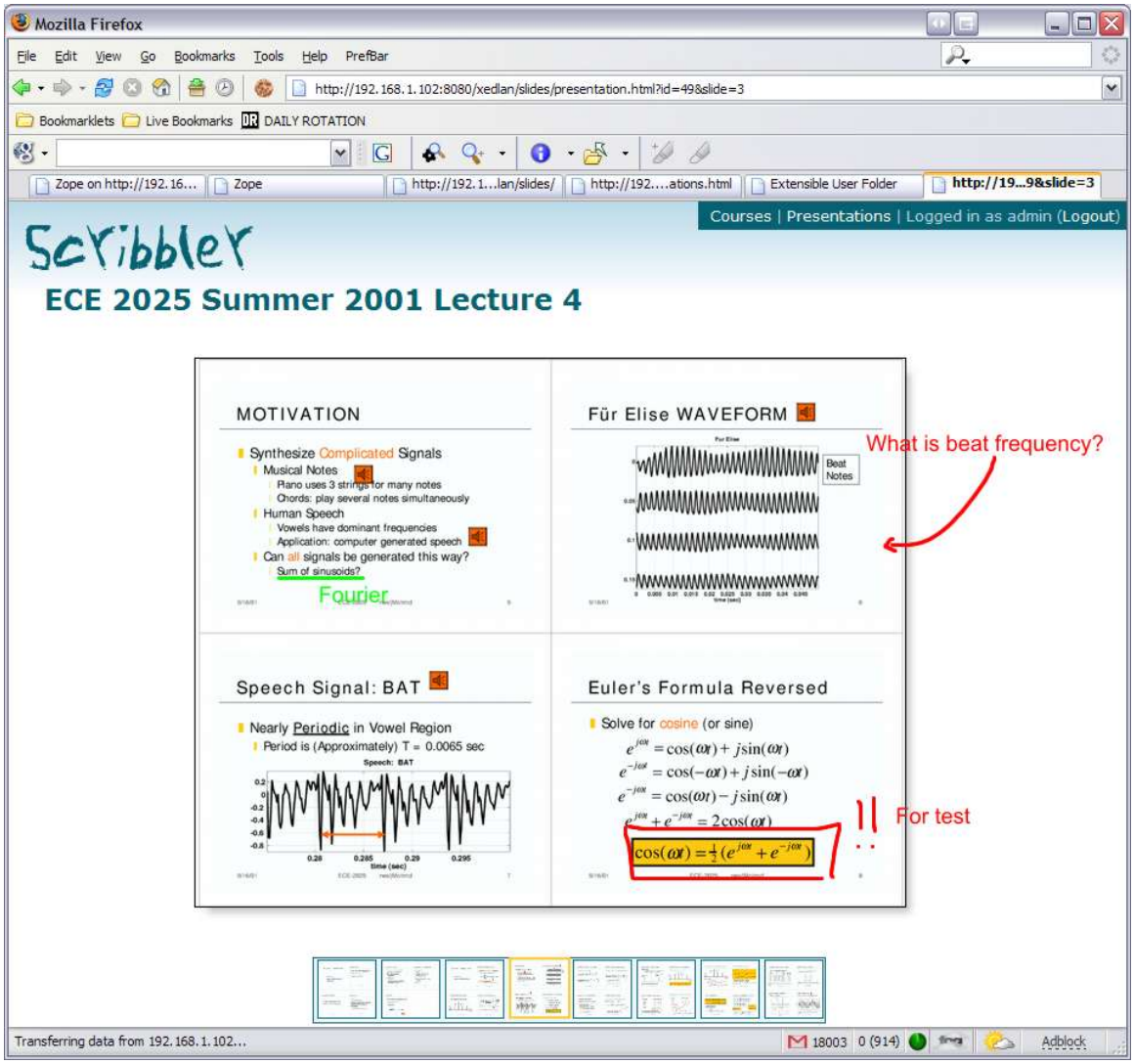



Figure 25 : A Scribbler annotation slide. Text and pen annotations are supported.

### *3.4 Technology Survey*

As part of the design process, a new survey was developed and administered to explore the student perception of embedding access into notes, the availability of technology, their willingness to use or acquire technology, and their opinion of possible technologies. The survey was administered to students at the beginning of Fall 2004 (198

out of 256) and the beginning of Spring 2005 (164 out of 188). The questions, responses, and student comments are available in Appendix C.

Though clear codification of the student's comments is difficult, we can roughly divide them into three, equivalent parts. One segment of the students favored the concept of enhanced notes (or technology enhanced classrooms), another segment was indifferent, and the third segment of the students saw no value in the concept of enhanced notes (or technology enhanced classrooms). Cost seemed to be a significant factor in the shaping of the student perception. The clear preference towards paper and pen is evident in the collected comments, pointing towards opportunities for development with the digital pen. However, there was also an overwhelmingly negative response to the purchase of the digital pen technology. This negative response towards purchasing the digital pen was a significant factor in our decision to develop our target application primarily for the laptop computer.

The surveyed students were fairly evenly divided with respect to laptop ownership. The majority of reported laptop owners indicated that they would use their laptop for this purpose. The majority of non-laptop owners indicated that the service would not be worth the purchase of a laptop. In both survey groups, two thirds of the respondents would not be willing to buy a digital pen, at the listed price of $180, in order to take enhanced notes.[1]

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[1] Because the Logitech digital pen has dropped below $100 since the survey, it would be interesting to see if the responses would be different.

The responses to the open question asking about "other" technologies tended to be positive and constructive. In both survey groups, support for a PDA based implementation was present. However, PDA ownership is lower than laptop ownership within the student body. Two existing technologies were also indicated, audio/video capture of the classroom, as well as capturing the teacher annotations. The responses did reveal a lack of understanding of what was already available to the students. There is also evidence of a negative impression of the PRS, a hand held "public response system" required in some Chemistry and Engineering courses. Though the PRS was not a topic of these surveys, comments and comparisons to this required technology purchase were included in the responses we received. This highlights the general student concern of being required to purchase technology (or other resources) for use in their education.

The platform that had both positive support as well as tangible representation was the laptop or pen-tablet computers. For this reason, we decided to develop our initial prototype, NoteNexus, as a PC based application that students could use on both of those platforms as well as on a traditional desktop computer. Our guiding scenario, however, was still the idea of taking notes in class.

## *3.5 NoteNexus: A Tool for Accessing Proficiency-Oriented Content from Student Notes*

Based on our evaluation of the five prototype designs, we developed NoteNexus, a PC-based application that students use on their laptop, tablet-pc, or desktop computer. In part, it was developed in response to some of the limitations in the PowerPoint, Acrobat, and Web prototypes. We also based the design upon some of our previous work in classroom capture technologies [1, 15, 89, 90]. Evaluating the impact of this involved

further analysis of web log data from all of the servers involved, as well as further survey data, focus groups, and interviews. Specifically, we were looking at:

- Does the technology increase the use of proficiency-oriented content?
- What is the impact of our technology on the use of performance-oriented content?
- Do the different types of content gain or lose value in student perceptions?

To examine the qualitative questions we expanded the student surveys. We also used interviews and focus groups to form an understanding of the students' perception of note-taking, the available online content, and their impression of the NoteNexus technology. Specifically, we hoped to discover the student perception of the technology, their expectations of the usefulness of the technology, their feedback on the prototypes that we have developed, and their expectation of the impact of the technology.

### 3.5.1 Focus Groups

We held two focus groups, each with six students. The purpose of the first was to review the initial implementation of the NoteNexus prototype and the second was to evaluate the revised version of the system. Each focus group session began with a demonstration of the NoteNexus application and a brief tutorial. This introduction lasted for 15 minutes. We conducted the focus groups in a classroom setting that included desktop computers. The students were then shown 20 minutes of a lecture from ECE 2025 and we asked them to use the NoteNexus tool to take notes. After using NoteNexus, we asked the students to complete a survey, which took approximately 15 minutes. We used the remaining time for a round-table discussion. Survey data and discussion notes

can be found in Appendices F and G. Compensation, in the way of a Barnes & Noble gift certificate, was provided for students who participated in the study.

The overall feedback from the participants was positive. We received constructive comments on the interface. When asked how useful they expected the technology to be, the majority of participants were neutral, and the rest were positive (see Figure 26). Likewise, the evaluation of the interface as well as the adequacy of the functionality was positive. Students identified the lack of keyboard shortcuts to access certain functions and the difficulty of entering equations as major drawbacks to the NoteNexus system.

The expectation of usage was also high (see Figure 27). 54% of the students in the focus groups believed that they would use this technology if we made it available. Another 36% of the students answered “maybe” to this question. This is higher than what we expected from our interpretation of the technology survey results [3.4.] However, this is probably due to the higher interest of those who chose to take part in the focus group, as well as a better understanding of what the technology entailed.

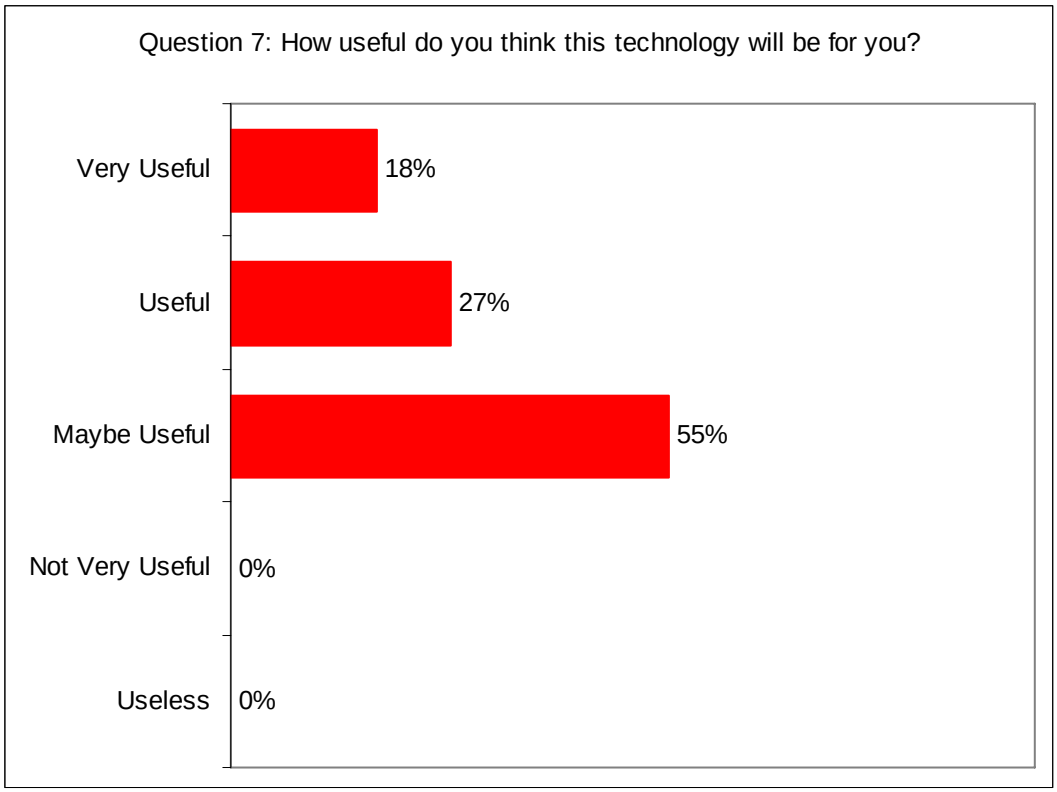


Figure 26 : Focus group perception of how useful the technology will be.

Based on the comments collected during the survey, we believe that many of the responses in the technology survey expressed a neutral response due to uncertainty about the abilities of the technology.

Three other important results of the focus group study relate to how this technology would affect student work practices. Since the research included an intention to enhance and encourage student note-taking, to impact how students study, and to increase their use of online resources, the students' perception of this technology in relation to those factors is important.

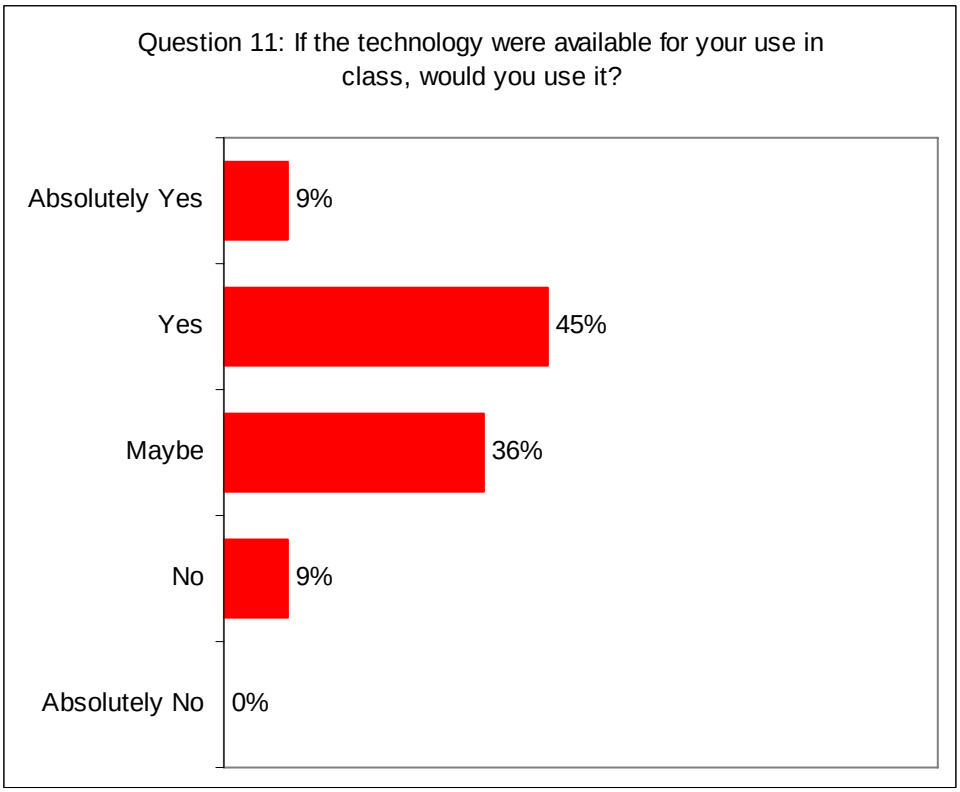


Figure 27 : Expected adoption of technology from the focus group.

Figure 28 shows that a small majority of the students believe that the NoteNexus technology will change the way they take notes. Reasons for why it would not change their note-taking practices included: they were already using a Tablet PC to take notes, prefer pen and paper, belief that handwriting on paper is faster, and concern that it will be hard to keep up in class. In contrast, reasons for why it would change their note-taking included: easier to share notes with friends, allow for better concentration on the professor, ability to integrate notes with slides, enable centralized notes, make note-taking easier, and provide more motivation. All respondents appeared to assume the indicated change as positive.

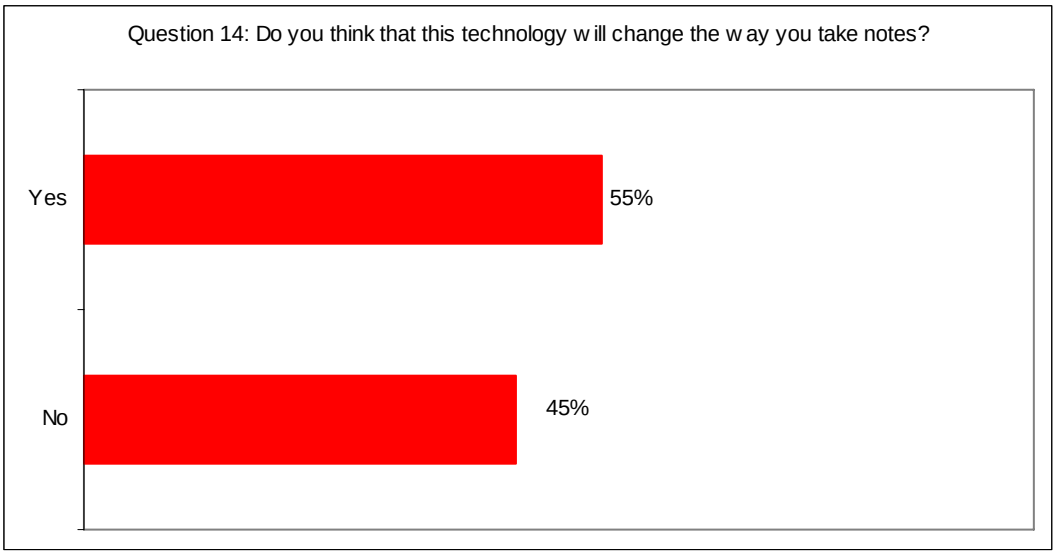


Figure 28 : Focus group perception of whether technology will change note-taking practices

As discussed earlier, the taking of notes, though beneficial, is more valuable if students use those notes to review material. Notes generally play an important role in the students' study task. It is not surprising to see that two thirds of the participants felt that the NoteNexus technology would change the way they study (see Figure 29). They expressed the expectations that: it would increase their use of the computer to aid study, the keyword database would provide them all they needed to study, they would have more content to study from, it would integrate study and practice exercises, it would improve efficiency. The negative responses were based on the belief that, though the medium would change, their study practices would remain the same.

The final question in the focus group survey asked the participants if they felt that this technology would change the way they use online content, the primary goal of this research (see Figure 30). Again, a narrow majority believed that it would change the way they used the available resources online. We developed NoteNexus to increase the use of

the proficiency-oriented material available online, which students use far less than the performance-oriented content provided.

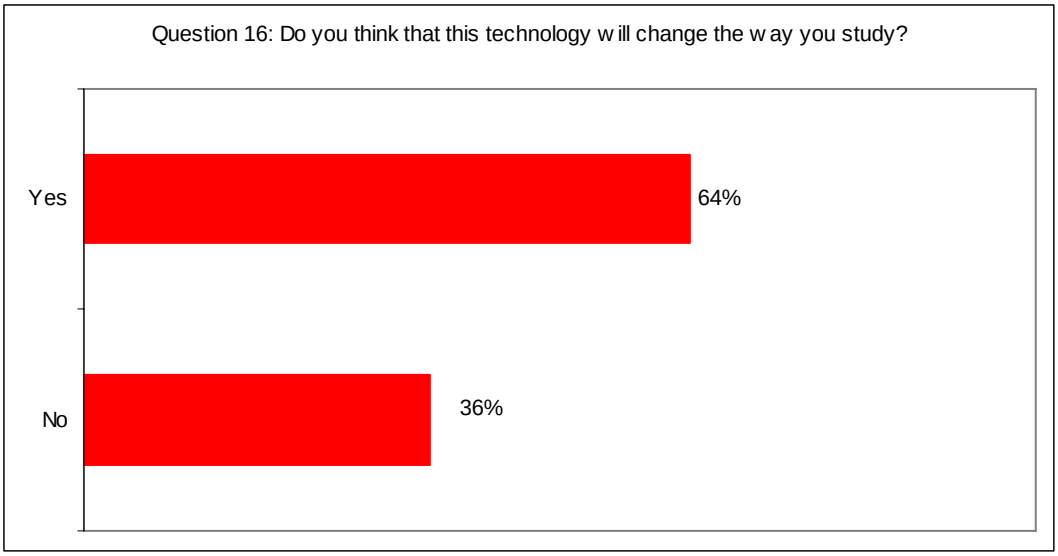


Figure 29 : focus group perception of whether technology will change study practices

The focus group sessions ended with a brief round-table discussion. In general, the group comments were reflections of the comments that students made in their surveys.

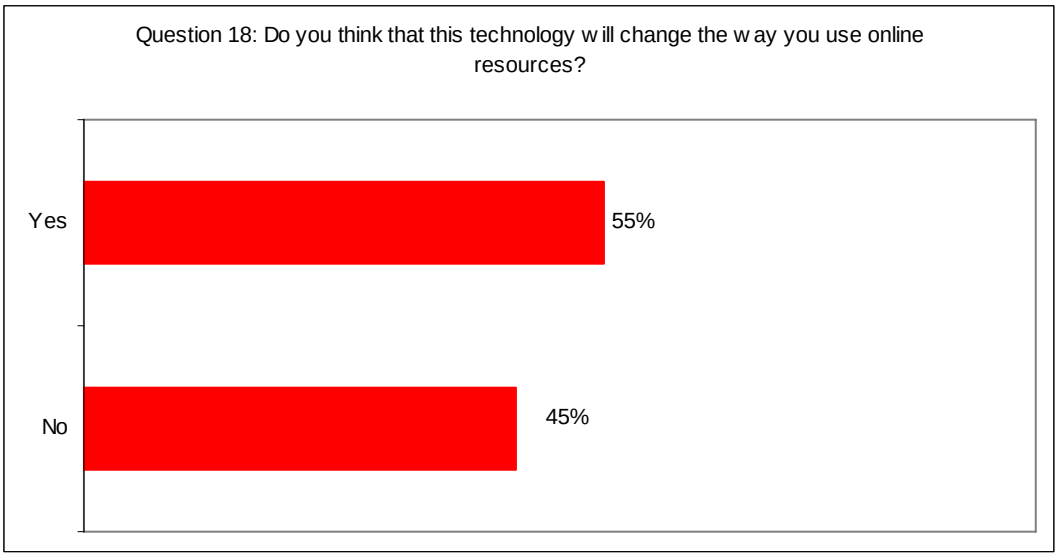


Figure 30 : Focus group perception of whether this technology will change their use of online resources.

The majority of the feedback was positive, with constructive suggestions for altering NoteNexus or for possible future directions in which we could take the work. Students identified the lack of support for equations as the most significant shortcoming in the application. There were many requests to take the prototype software with them for immediate use. The responses to the focus group survey questions are available in Appendix E, and the student comments from the discussions are in Appendix F.

### 3.5.2 Interface Design

The input interface is oriented around the metaphor of *pages*. Students are able to load a set of lecture slides; the application automatically places these on separate pages. Students may then add keyboard entered notes to each page. There is also a *notepad* associated with the note-taking session. The notepad can be moved independently of the slide pages.

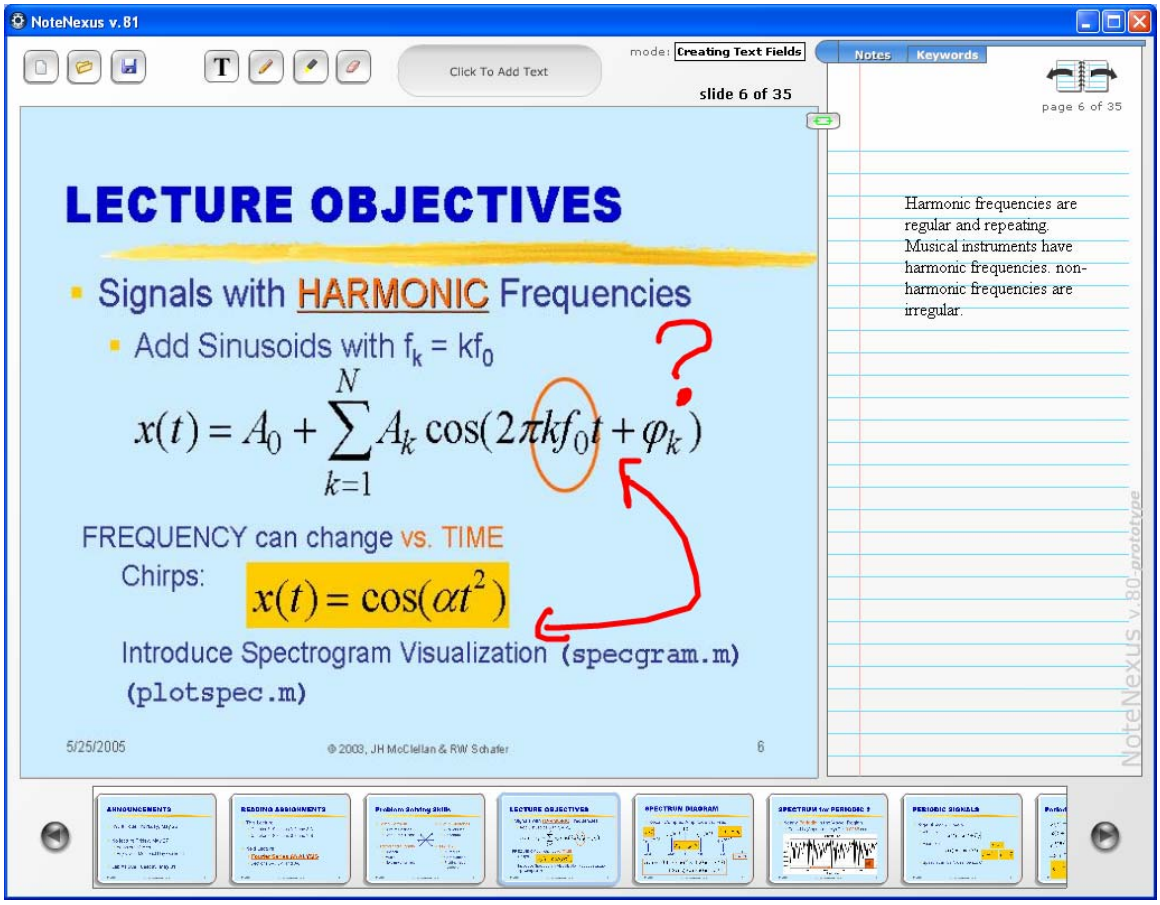


Figure 31 : NoteNexus interface showing pen-strokes (in red) and a few notes typed on the notepad. Application icons are at the top of the application and slide thumbnails are at the bottom.

The application icons are located at the top of the application screen (see Figure 31). At the top left are the file control icons for open lecture, open saved annotations, and save annotations. The lecture files from have an ".nnl" extension. They are the lecture slides provided by the instructor. We chose to have the student annotated slides saved in a separate file; these have a ".nna" extension. This choice caused some confusion for the students as we discuss later in this section.

Next to the file-control icons are those for input-control. In order, they represent the input modes for: typed text, pen tool, highlighter, and an eraser. Next to these is an area for options that changes based on the tool selected. Options include selections like

color choices, pen width, font size, and highlighter color. The mode display area displays the current input tool selected.

At the top of the notepad are two tabs marked “notes” and “keywords.” When students select the “notes” tab, they are able to enter text or pen tool notes on the notepad. When they select the “keywords” tab, a java implementation of embedded access identifies keywords and then provides a listing of the available content for each term, (see Figure 32). Selecting one of the content types under a keyword launches a window that provides links to the available content of that type. In Figure 32, the “Exercises” content type has been selected under the keyword “Harmonic.”

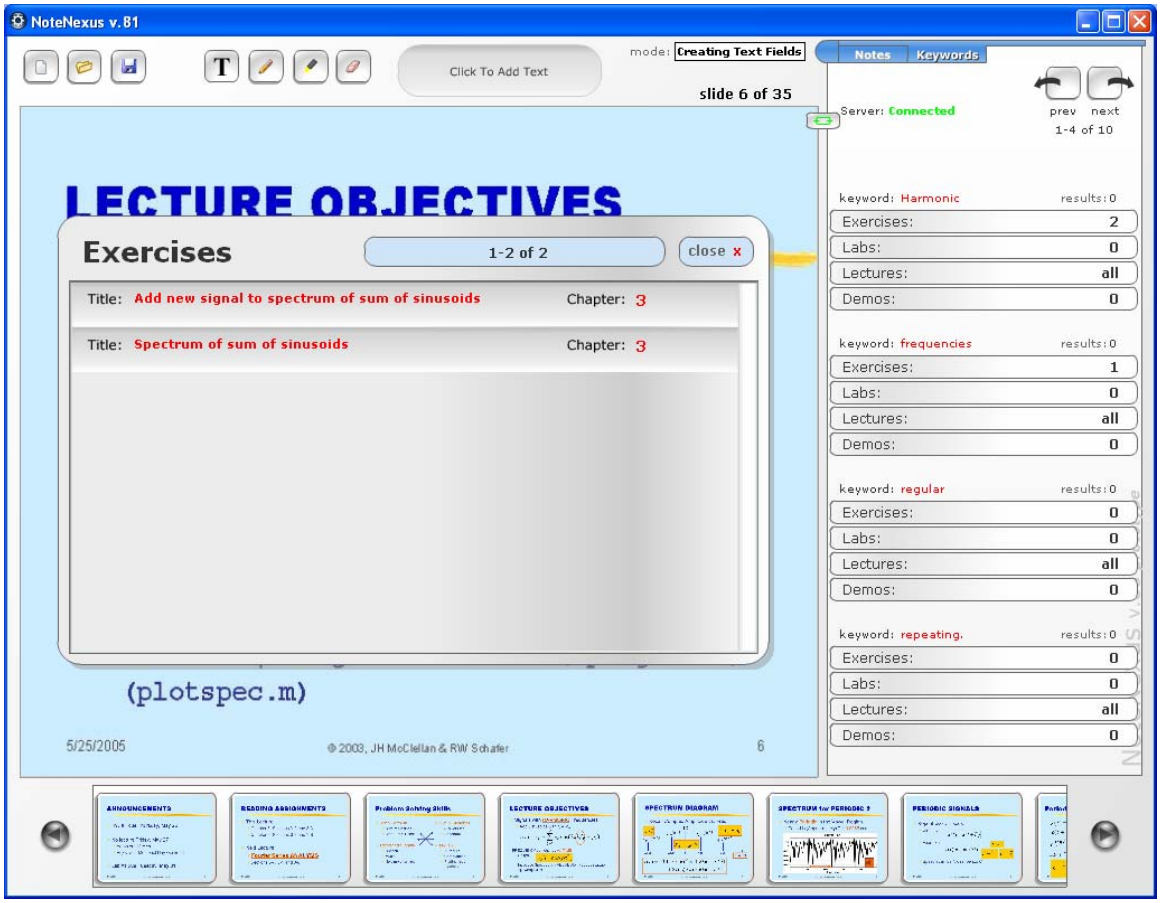


Figure 32 : NoteNexus application showing keyword links. The number of links for each content type is displayed. Links to all of the current lectures from that course are always provided.

We designed NoteNexus for use inside the classroom. However, the surveys and focus groups introduced the idea of using NoteNexus outside of class by students doing review as well as by students who were reviewing the class lecture videos. After consideration, we did not feel that this second use would require a significant change in the interface. Our concern was with the capability of student displays to have both the NoteNexus and the streaming content available at the same time.

One system change we made turned out to be a problem in the real classroom setting. Based on feedback from the focus groups, we reduced the sampling rate used with the pen input in order to make it easier for students to draw straight lines and produce geometric figures. This, however, turned out to create another problem, as discussed in the deployment study. The concept of drawing within the application is mostly a product of the focus group environment. Though a few students have tablet-pcs, the majority of students with laptops in class are restricted to trackpoints or finger pads for controlling the cursor. This makes drawing difficult. The test environment, however, provided them an input mouse. The log files from the focus groups show more drawing input than those from the actual deployment study. In hindsight, the lower sampling rate on pen input was a mistake.

There were some functionality requests that students made during the focus groups that we also added. Students desired more control over fonts in the text tool, so we added a font controller to the toolbar when the text tool is active. Likewise, we provided more control over the pencil tool as well. Students made an almost unanimous appeal for a “highlighter” during discussion, with some comments also provided in the surveys. The added highlighter also allows for selection of color and width.

A significant complaint about the interface during the discussions related to the "nuclear erase" function. Our original prototype would erase all drawings if they selected the eraser option. This was obviously not appropriate, so we created a targeted erase tool that allowed the erasure of individual strokes. We defined the erased stroke as a continuous collection of segments from mouse/pen down to mouse/pen up. There is still an expressed need for a pixel based erase function, but we have not yet implemented it.

There is still a problem in the design related to the directional buttons located on either side of the thumbnail bar. They affect both the slide thumbnails as well as the currently displayed slide. This behavior is not intuitive and resulted in a good deal of confusion. Adding a second set of directional buttons was even more confusing. The next version of NoteNexus will use a slide bar to control the thumbnails and reserve the directional buttons to control the current slide displayed.

There is a small, four page help file that comes with the application that students can access by pressing F1 [see Appendix D]. Overall, the interface is intuitive, and based on familiar metaphors and iconography. The result is an application that is easy to use, in most cases requiring no assistance from the developers. There was some confusion regarding the load and save functions. This has been partially addressed by changing the icons. There is still some confusion over the loading of *lecture files* (.nnl) and the saving and subsequent loading of *annotation files* (.nna). The lecture files come from the faculty, and once the students have annotated them, they are saved as annotation files. The confusion lies in understanding the need to reload the annotation file to see previous notes and not the lecture file.

## *3.6 Design Summary*

Through a series of design prototypes, we explored a variety of interaction media. We considered various issues related to deployment: availability of technology, interaction support, and student perception. This exploration resulted in the development of NoteNexus, a laptop based application for student note-taking. The NoteNexus application uses the embedded access architecture to connect keywords in the student notes to available and relevant content on the server. This design meets both of our criteria for convenience. First, by using student notes, we are creating a technological intervention that is situated in the student work practice. Second, by providing direct links to the online content, we reduce the number of navigational steps necessary to access the content. In Chapter 4, we evaluate the impact of our design in a classroom setting, interpret the results, and provide an evaluation on a second design iteration in the classroom.

# CHAPTER FOUR

## Impact of Student Use of Online Content

The purpose of this study was to determine whether *using student-generated notes as an access interface will increase the undergraduate student use of captured and authored digital content.* The goal was to increase student use of online content, specifically, to increase their use of proficiency-oriented content. By embedding links from keywords in the students' notes to available content online, we proposed to affect an increase in usage. Our belief was based on results of a large summary study in digital libraries that indicated that students would make more use of online material if it was convenient, relevant, and part of their workflow. Through observation, surveys, small studies, and focus groups, we designed NoteNexus to meet those requirements.

The deployments of learning technologies in classrooms face many obstacles. Usually, the technology will not be ubiquitous enough within the students' learning environment to encourage adoption. Unless provided to the students, there is rarely a common development platform available. Students in general resent requirements to purchase technology in order to use unproven applications, or those whose value they question. Likewise, students are unwilling to expend time and effort on new technology and practices unless they feel that it will benefit them in achieving better performance. All of these perceptions posed obstacles for the NoteNexus study. Given that, we expected the number of participants to be low. With a large set of base-line data, and the ability to compare the participants to the general class population on many dimensions, we believe that we were able to acquire significant insight into both the application and the general question of content use.

## *4.1 Deployment Studies*

Several factors posed difficulties with the deployment and adoption of the NoteNexus technology. These include: the stability of the networks and the servers, available student equipment, student willingness to participate, ability to track usage, and our ability to interact with individual users. We decided to have two deployment studies.

### 4.1.1 Limited Deployment Study

In the first study, we asked for 10 participants, with the hope that at least half would complete the study. Our goals were to field test the software, get additional feedback, and evaluate how the students used the technology. We recruited the participants via email to the ECE 2025 class list and posting to the class message board. It took three email messages to recruit 10 participants. The only selection criterion was that the students were enrolled in ECE 2025 that semester. The study ran for the last five weeks of the course during the Spring of 2005, including the last quiz and the final exam. We asked the 10 students to take part in a brief explanation of the project, an introduction to the software, a short survey, and the completion of the consent form.

In this deployment, we asked the students to upload their log files to a Buzzport group dedicated to the NoteNexus deployment. We also asked them to upload their annotation files. Reminder emails were sent via the Buzzport group during the second, fourth, and fifth week of the study. Three of the students, who were not able to attend the briefing session, downloaded the software, but never completed the consent forms so their data is not included. A fourth student completed all the requirements except the final survey. Due to a family situation, he had to leave the country earlier than expected. The

first deployment study ended with six full participants and a seventh partial participant. The study ended with a closing survey and a discussion group session.

We gave the same survey to the participants at the beginning of the study as well as at the end. The intent was to track any changes in student opinion after the five week period was over. The same survey was also used at the end of the semester to explore the opinions of the ECE 2025 student population for comparison. The distribution of the participant responses in the initial survey did not differ significantly from that of the population survey. Though there was some shift in the closing survey of participants, the small sample size limits the interpretation of those results. The largest shift was a self-reported increase in the amount of notes taken. The students echoed this response during the discussion group. All participants reported an increase in their note-taking.

Through an evaluation of the log files, we identified one participant who used almost exclusively stroke input (a tablet-pc user), one participant had no stroke data and only used keyboard input, and the remaining participants had a collection of stroke and keyboard entry. Keyboard entry was usually limited to short phrases, often key terms selected by the student from the lecture. The timestamps on the log files indicate that the students did not use the system in every class. During the discussions, this was explained by bad weather and the risk to the laptop; quiz; not attending class; and laptop forgotten. Two students found the software more useful while reviewing the online lecture recordings instead of in the live lectures. Only four of the seven participants were regular users of the software. However, all claimed to find the software useful.

### 4.1.2 Results of the Limited Deployment Study

As an application, NoteNexus was successful throughout the deployment study. There were no reports of crashes, nor have we had any in our laboratory testing. The connection to the server was only available on campus, but that did not pose a significant obstacle to our participants. Again, the feedback from the deployment study participants was generally positive with constructive recommendations for improving the interface. The problems were similar to those already identified in the focus group study that we were not able to correct before the deployment study. One repeated complaint during the discussion session was that the sampling rate was too low. Though the focus group participants had requested a lower sampling rate, the deployment group participants found the lower sampling rate more of a problem. As explained earlier, the deployment group did not attempt the level of graphic drawing on their systems as the focus group did with theirs. The exception was the member of the deployment group who possessed a tablet-pc.

However, NoteNexus failed in our goal to use embedded access to increase the use of proficiency-oriented content. After a few, initial, exploratory connections to online content, the participant log files show no use of the NoteNexus software to access the online content. It is important to note that, after showing the participants the capability of accessing online content; we provided no reinforcement of that capability or encouragement to use it. Our tracking was not solely dependent on the student log files. The content used in this study was loaded on a separate server from the rest of the course content in order to make it possible for us to track access independent of the log files. The server logs represented the same lack of access as the participant log files. Likewise,

there was no significant change in the use of online content by the class in general or reported by the participants. Finally, though an evaluation of the student log files show that all of the note sessions resulted in available keywords for matching, the students did not make use of the functionality. The lowest number of matched keywords in a note session was six, and the highest was forty-two.

Not only were these results disappointing, but also they seem to contradict parts of the survey data, the focus group results, as well as the initial briefing session with the participants. Though the participants did not use the embedded access capability of the NoteNexus system, they continued to declare it as useful and important during the closing discussion session. When asked what they believed to be valuable in the system, the general consensus was the ability to locate all of the available content associated with a given concept. It also became clear that: ***accessing online content was not a part of the note-taking task***; as the focus group data predicted, NoteNexus did not change their study practices; without a change in the perceived value of the content or other incentive, the students pattern of content use will not change.

Given the results, we decided to repeat the study, with open access to the software for the whole class. It was necessary to see if a second study produced similar results. Also, based on the feedback from the students, we decided to develop another application, C-Nexus. A discussion of the design, deployment, and evaluation of C-Nexus is in Section 4.3.

### 4.1.3 Open Deployment Study

Though the results of the first deployment study were disappointing, there was still evidence from the survey data and student focus and deployment groups that this

implementation of embedded access could be successful in increasing the student use of the online, proficiency-oriented content. This motivated a second deployment study to validate the findings of the first. We decided to stage the second deployment study as an open study by making the software available to all of the ECE 2025 students in Summer 2005. Again, we solicited student participation by email; the email provided a link to a website for downloading NoteNexus as well as Lecture Packs (modules containing the upcoming lectures). Instead of a group briefing session, we demonstrated the software to the class at large during the second week of the course. The demonstration was just under seven minutes long. There was no incentive offered for participation.

Since we would not be directly monitoring the individual students, we instrumented the download site to track accesses to the software as well as to the lecture packs. In addition, we instrumented the PHP script that responds to NoteNexus requests for content to produce an anonymous log of activity. Though we would ask students who were willing to grant consent to provide us with their logs, we needed the independent log files in order to have a more accurate record of use.

### 4.1.4 Results of the Open Deployment Study

In total, ten students chose to use the NoteNexus system (out of 117 students). Three students downloaded the software and the lecture packs in the first two weeks. Two more joined just before the midterm quiz. Two more joined just after the midterm quiz. The remaining three students joined just before the final quiz and, of course, the subsequent exam. Students tended to download all available lecture packs when downloading the software for the first time. Our attempt to track who downloaded lecture packs was somewhat foiled by students who reported emailing the packs to friends using

the software. We also have some reports of students acquiring the software through the same method, so we are not completely sure how many students adopted the software. Four of the "official" adopters completed surveys at the end of the semester, including the three early adopters.

The responses of these four participants are interesting. Their evaluation of the system and their perception of its impact on how they take notes, study, and use online resources is positive, significantly above that of the focus group responders. In contrast, their survey answers report taking fewer notes than the class population, as well as using their notes less often. Contrary to our original predictions, the open adopters of the NoteNexus system appear to be individuals who do not take many traditional notes, and who do not normally use their notes often. Three of the four respondents indicated that the software might entice them to take notes. The fourth respondent indicated that they did not use the software in class, but instead, used it to search for "old assignments." In general, the responses to the note-taking capabilities of the software were positive and indeed, a little more so in this deployment. The sample set, however, was still small.

With regards to access of the proficiency-oriented content, our PHP access log, that reflects only the access via NoteNexus, shows 8 content access sessions prior to the midterm. IP matching indicates that three participants requested this content. The total NoteNexus content access requests prior to the midterm were 12. However, after the midterm, use of the NoteNexus embedded access disappears. Though there are 20 content requests just before the final, these are from two sessions, both from the same IP, and both fairly short. It is our belief that these accesses relate to the search for old assignments reported by one of our survey respondents. This belief is supported by the

fact that 19 of these later accesses were for exercises, whereas the previous twelve were for a mixture of exercises, demos, labs, and lectures. The exercises accessed, however, were not past assignments, but instead, practice exercises.

### *4.2 Summary of the NoteNexus Study*

Taking into account the hurdles facing its adoption, NoteNexus was a successful note-taking application. Higher adoption is not reasonably possible without a much greater ubiquity on campus, or at least within a curriculum, and without evidence that student use improves grade performance. The success of the application as a note-taking tool is important to understanding why the system failed as a tool for increasing student access to online content. Though the student adopters rate the application highly, claim an improvement in note-taking, and present requests for its continued use, they did not use the application to access the proficiency-oriented content. It is clear that this implementation of embedded access was not successful. The question remains whether embedded access itself is a viable means for improving student use of online content. Our continued exploration resulted in the C-Nexus study.

### *4.3 Design Iteration: C-Nexus*

In our attempt to understand the failure of NoteNexus as a content access system, we have focused on three factors: the students' continued belief that the keyword-based access is valuable, student motivation to improve performance, and, finally, how students perceive the value of content. Considering these, we developed a new prototype called C-Nexus (Content Nexus). In designing C-Nexus, we have interpreted the student desire for the keyword access capability as a need for a tool that aggregates available content in

relationship to concepts identified by their instructors. This factor relates to both student motivation for improved performance as well as a move towards supporting student work practice. In order to motivate the student use of the C-Nexus system, we chose to make the class lecture videos more easily accessible via this interface.

In NoteNexus, we made the mistake of attempting to interconnect note-taking with content selection and review. In C-Nexus, we acknowledge that for most students, these appear to be separate activities. Our expectation was that as students use keywords to access the videos, they would be introduced to available proficiency-oriented content related to that concept. By pairing unused content with valued content, we hope to encourage students to reconsider their perception of the proficiency-oriented material.

The C-Nexus application is fundamentally an aggregate search interface. It is a web-based application, which substantially reduces the technology requirements for its use. When accessing C-Nexus, students are presented with a list of keywords extracted from the keyword metadata associated with the explanatory content available online. Three boxes represent the low-use content: demos, exercises, and labs (see Figure 33). In the bottom right corner is a fourth box listing the captured lectures from the current and the previous semester. In the far bottom right is a link to the highly used performance-oriented files.

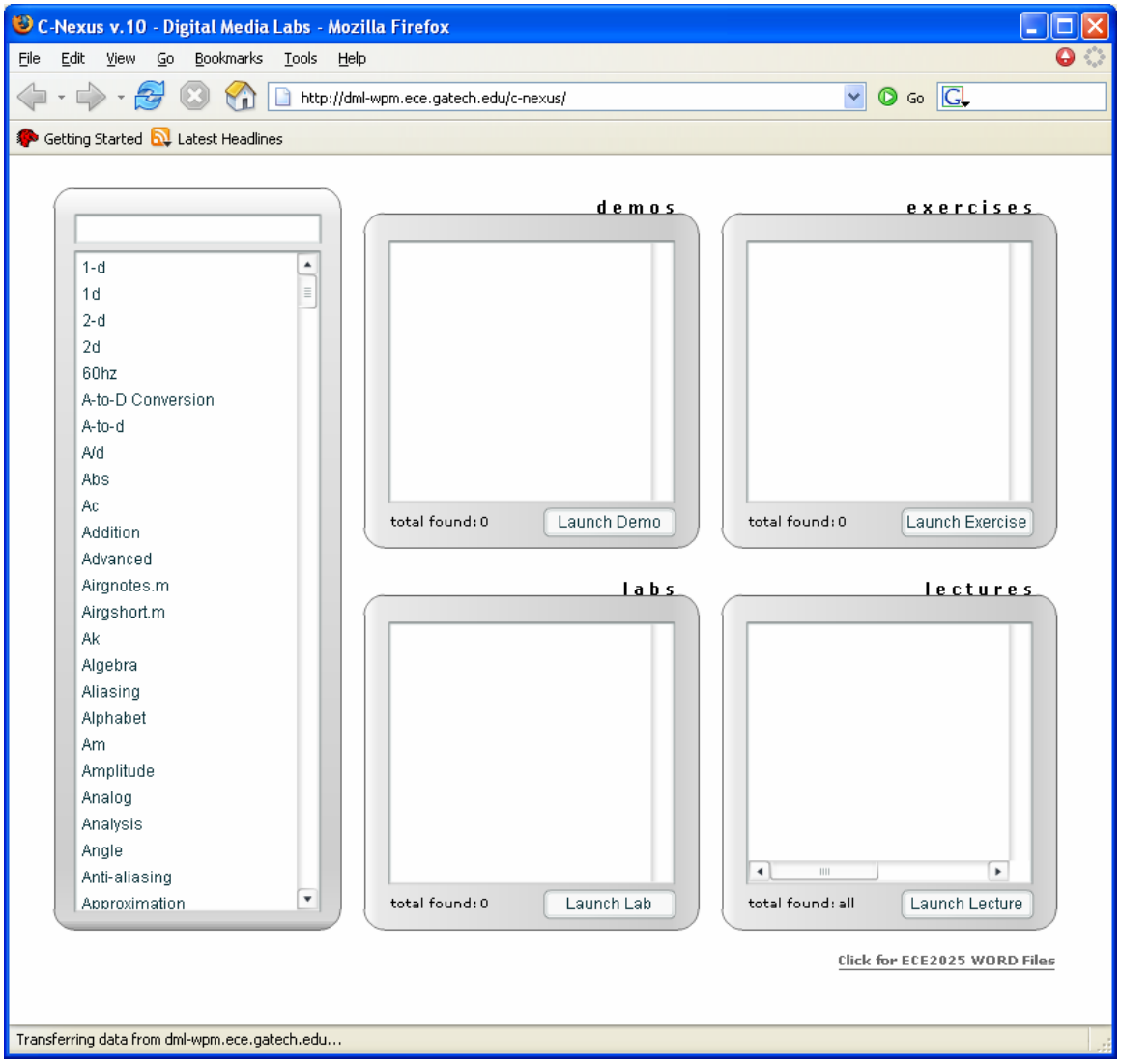


Figure 33 : Initial C-Nexus screen. The keywords on the left are taking from the keyword meta-data stored in the content repository.

Students can select terms from the keyword list or type in the available box to filter the keyword list. When a student selects a keyword, the application displays available content in the respective boxes (see Figure 34). Regardless of the selected keyword, all of the videos available to C-Nexus are presented. Students are able to launch available content in separate windows for their use.

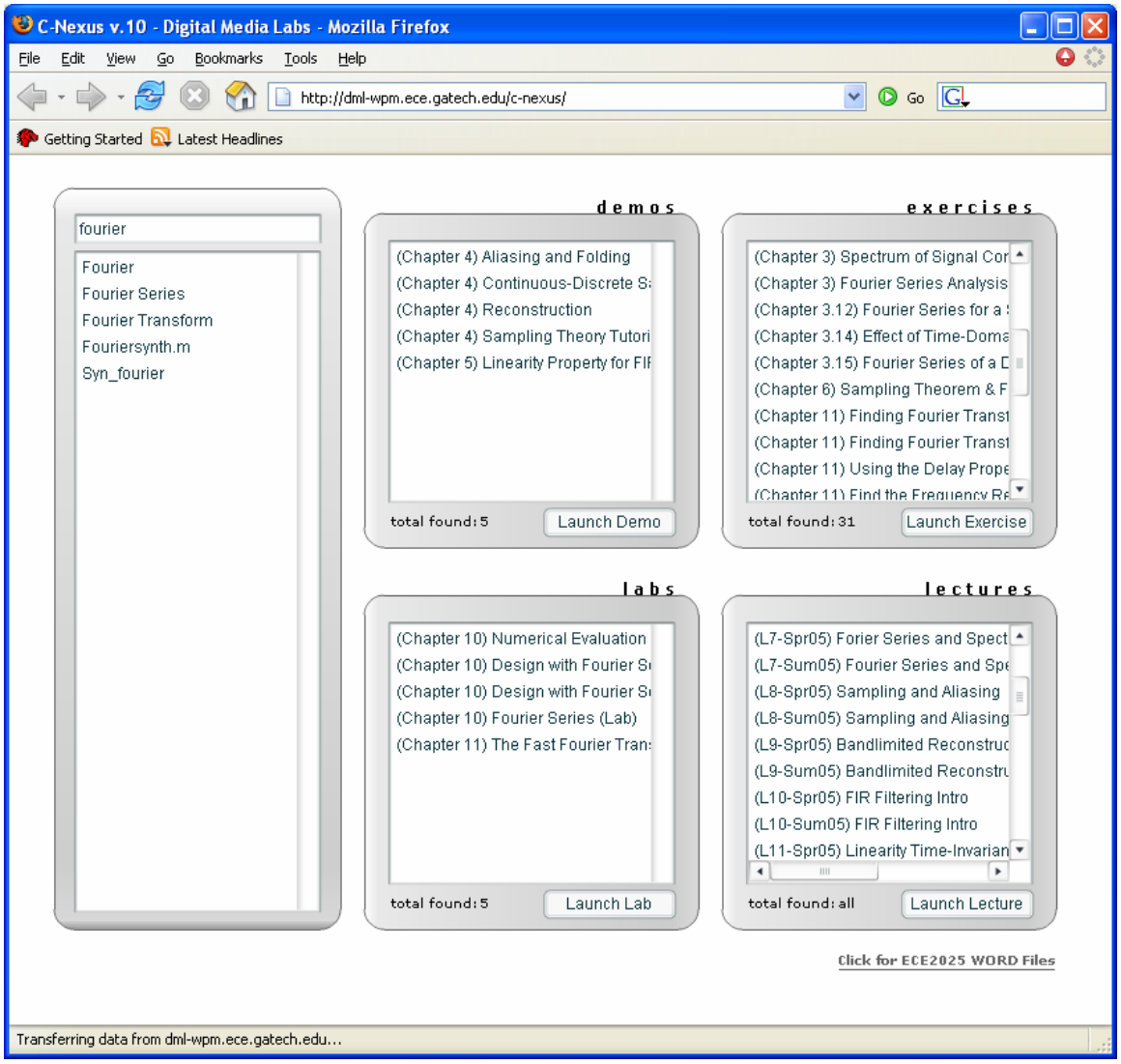


Figure 34 : C-Nexus interface after input of “Fourier” in the selection filter. Each content type is ranked by chapter, except lectures, which are presented in presentation order. Matching lectures from different semesters are listed together.

We instrumented the PHP script behind the C-Nexus application to provide logging of student interaction. Logging includes keyword selection as well as content selection and records IP address and timestamp. Using these last two, we constructed a concept of sessions.

### 4.3.1 Deployment Study

The design and development of C-Nexus began after the evaluation of the initial Limited Deployment Study (Sections 4.1.1 & 4.1.2). To evaluate C-Nexus, we opted for an open deployment. We introduced the application to the students on June 23rd, 2005, five weeks into Summer semester. There were 117 students enrolled during that semester. A message sent to the class email list provided the URL to the students. Leveraging the student motivation to improve performance, we released C-Nexus to the students shortly before the semester midterm. C-Nexus was deployed in the same ECE 2025 class as the second NoteNexus deployment.

Each semester of 2025 begins with a speech from the instructor encouraging the students to use the online content. Though there are different instructors, the speech is relatively the same, and the results have likewise been relatively uniform. In the Summer of 2005, the instructor gave this speech during the first week of class. In the second week of class, we gave the NoteNexus presentation, effectively reinforcing the first speech; this was immediately followed by an email directing students to the NoteNexus site. In the third week of the semester, we sent an email message reminding students of the NoteNexus application. In the fifth week of the semester, students received an email message introducing them to C-Nexus.

Student response was positive and immediate. Within the first 24 hours after release, there were 16 sessions comprising 60 content requests. By the end of the semester there were 111 sessions comprising 320 content requests. The access spikes before each of the quizzes and the final exam. As expected, the majority of these content requests were for captured lecture videos. One third of the content requests, however, was

for the demos, exercises and labs. The original NoteNexus deployment resulted in virtually no increase in use of the proficiency-oriented content; the open NoteNexus deployment resulted in an increase of 20 content requests. The C-Nexus deployment resulted in an increase of 320 content requests (108 if we do not count the videos). Though these results indicate some measure of success, it is still a relatively small number of content requests for the 117 students enrolled during the Summer semester of 2005.

### *4.4 Summary of the C-Nexus Study*

In reviewing the results from the C-Nexus study, it is important to remember that we do not have an absolute account of all student access to the available content. The low-use content we are offering is also available in other media. The analysis of content use in Chapter 2 needs to be kept in mind when looking at the results of the NoteNexus and C-Nexus studies. We believe that the best way to interpret our results is as increases in use; usage levels from our deployment studies have not reached a magnitude to imply a significant change in overall practice. However, C-Nexus does indicate a move in the right direction, with both a significant impact as well as level of adoption. However, C-Nexus does not constitute the end of the journey; instead, it is a promising place from which to embark.

In both the NoteNexus and C-Nexus studies, we differentiated between the high-use, performance-oriented content and the low-use, proficiency-oriented content. Our focus was to increase the access to the low-use content. Much of this content is on the seldom used CDs that come with the textbook. Many of the demos are also available on the WebCT site. Though our focus was on the low-use content, we still tracked the use of

the other. As noted earlier, we also had the goal of increasing overall student use as well as increasing the students' perceived value of the online content.

### *4.5 Evaluation of Impact*

Throughout the early NoteNexus focus group studies in Fall 2004, and the subsequent focus group and then deployment study in Spring 2005, there was no significant change in the student use of online content in general. However, there was a marked change in content use in Summer 2005, with the dual release of NoteNexus and C-Nexus, Figure 35. The use of the online content on the primary server doubled from the average use of the content over the last four years. Though we would like to claim this as a direct result of our applications, we instead hold it to be a secondary impact related to multiple factors, including the possibility of the Hawthorne effect.

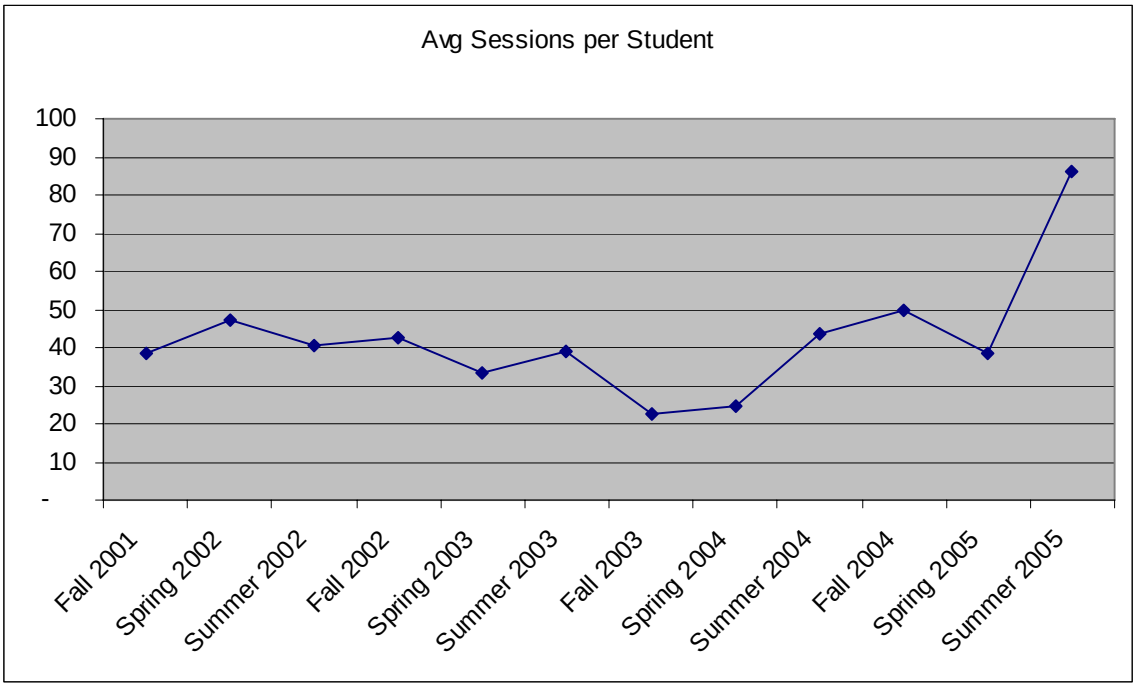


Figure 35 : Student use of WORD content. The rise in average session in Summer 2005 coincides with the dual introduction of NoteNexus and C-Nexus.

These factors relate to a shift in demographics in the Summer semester of 2005. During this semester, the number of women enrolled in the course rose sharply. This can be seen in Figure 36, which shows both the percentage of men enrolled (the top line) and the percentage of women enrolled (the bottom line).

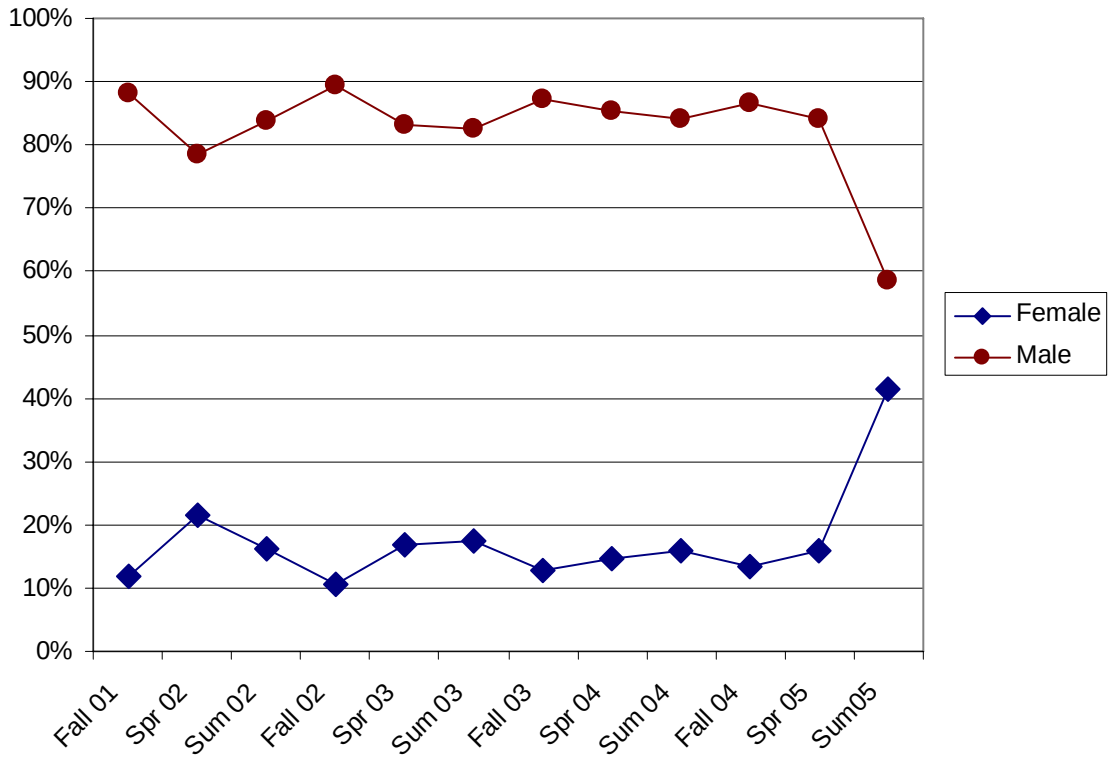


Figure 36 : Graph showing the percentage enrollment of men and women in ECE 2025.

This is a rather significant change in the enrollment of women in the course. Plotting the enrollment over time and the change in content access is revealing, Figure 37. The enrollment data is the percentage of enrollment by gender. The access data uses the axis on the right, which is the average number of sessions per student (performance-oriented content).

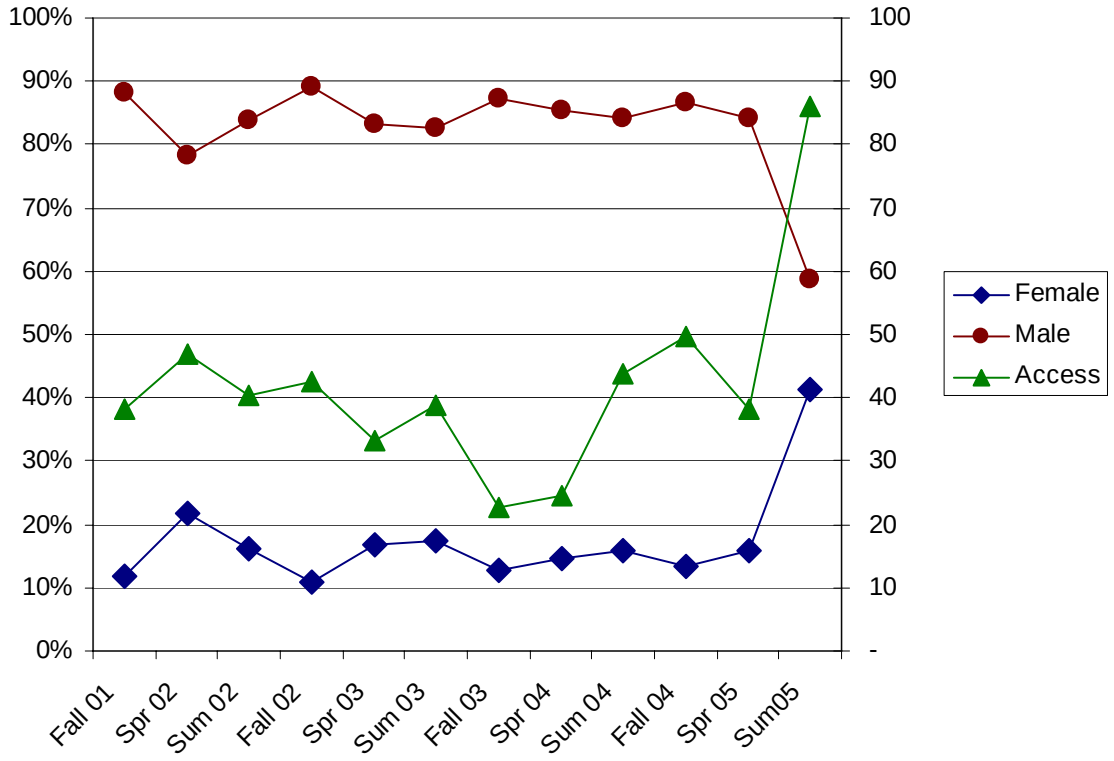


Figure 37 : Graph showing the percentage enrollment of men and women, along with the average number of sessions per student (right axis) of performance-oriented content.

The correlation between the enrollment of women in the course and the level of content access is 0.84 (p=0.001). However, other factors also contribute. One reason for the increase in the number of women enrolled is a change in the distribution of majors enrolled in the course. Unlike the usual distribution, shown in Figure 3, in the Summer of 2005, 47% of the enrolled students were Bio Med students. There were also a higher percentage of juniors and seniors, and a generally higher student GPA.

This change in demographics and the correlated change in access of the performance-oriented content raise a question about the increased use of our target content, the proficiency-oriented content. Was the increase in proficiency-oriented

content caused by the same factors that increased the use of the performance-oriented content? In order to answer this question, we compared the pattern of use during the target semester with the model of use we derived from our log analysis. Specifically, we looked at the pattern of access for the previous Summer semesters in comparison to the pattern of access for the Summer of 2005 (Summer semesters have fewer weeks and generate a slightly different pattern than the Fall and Spring semesters).

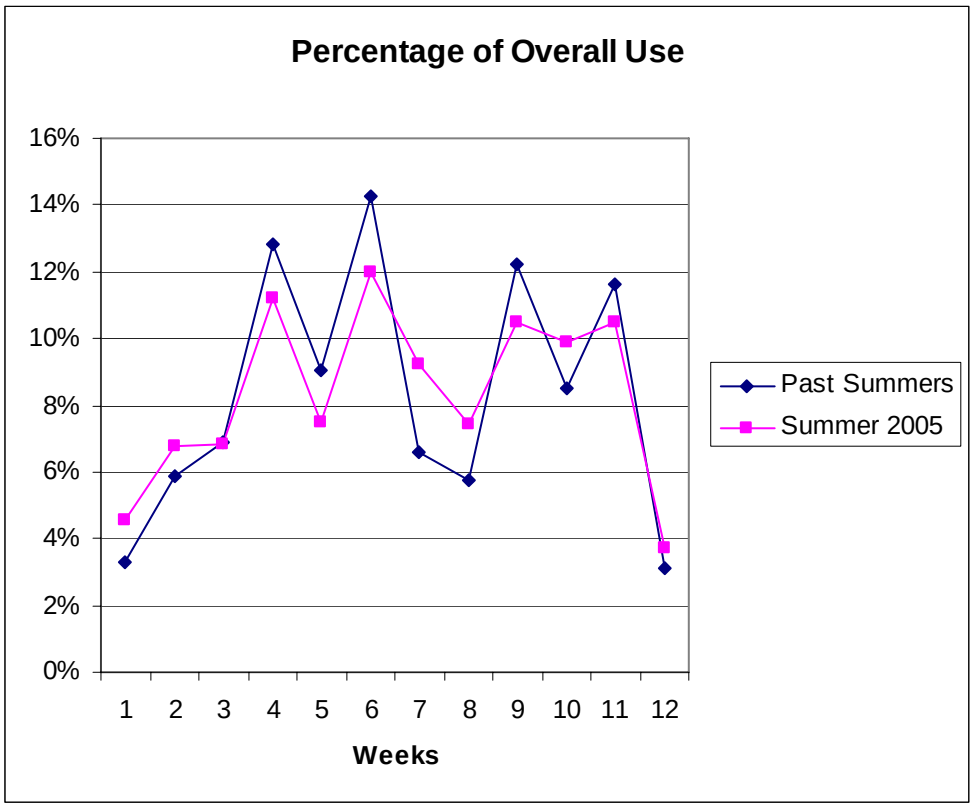


Figure 38 : Usage patterns of access for performance-oriented content.

The comparison of these patterns, Figure 38, shows that though the quantity of use increased, the pattern of use remained the same. Also, a comparison of the two NoteNexus studies show extremely close results. Though we performed the second study

during Summer 2005, with the significant change in demographics, the results of the study did not show an increased use in proficiency-oriented content.

The increase in use of proficiency-oriented content begins with the insertion of the C-Nexus design into the course. Figure 39 shows the distribution of accesses, this time as bandwidth, for the proficiency-oriented content. The captured lectures are not included in this graph, but also follow a similar pattern. We deployed C-Nexus the week of 6/20.

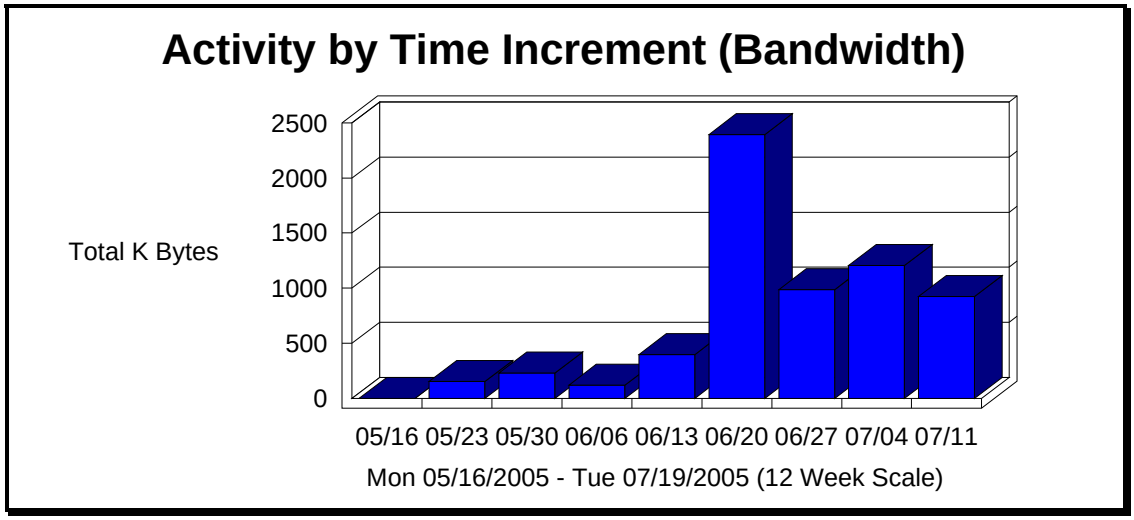


Figure 39 : Distribution of content use over the Summer semester 2005. This graph only includes the 108 accesses to the proficiency-oriented content.

Though the NoteNexus design did not change the use of proficiency-oriented content, it is clear that the insertion of the C-Nexus design iteration did have an impact on content use. We interpret this as support for the hypothesis underlying the C-Nexus design. Whereas convenience was not sufficient in itself to produce an increase in content use, the coupling of convenience with a design that leverages student motivation can increase the student use of online content.

# CHAPTER FIVE

# Conclusions and Future Work

The goal of our work was to increase the student use of online educational content provided as part of their course material. Our thesis proposed that *using student-generated notes as an access interface [would] increase the undergraduate student use of captured and authored digital content* [Section 1.3]. We used the *embedded access* technique to make direct connections between keywords identified in student notes and relevant content provided via an online repository.

## *5.1 Summary of Results*

Survey data showed that students tended to agree with the assertion that this would be useful and beneficial [Section 3.4]. Likewise, focus groups using the NoteNexus prototype indicated that: the tool would be useful and likely adopted, would result in a positive change in their note-taking and study practices, that the technology would change the way they study, and that the keyword linking would be useful [Figure 26 - Figure 30]. The limited deployment study and open deployment study of NoteNexus showed a similar positive perception of the note-taking tool and a reported increase in note-taking [Sections 4.1.2 & 4.1.4]. However, the students did not use the tool to access online content, and the introduction of the technology into the course produced no increase in the use of online content [Section 4.2].

We founded our premise in part on the Tenopir survey study on the use and perception of digital libraries and collections [86]. A conclusion of that study was: *students use and like electronic resources, and most readily adopt them if the sources are*

*perceived as convenient, relevant, and time saving to their natural workflow*. Our approach to meeting these user requirements was based on our past studies and experience with developing and providing online content [1, 2, 7, 15, 31, 32, 35, 63, 64, 79, 89]. We believed that providing relevant links to online content within student notes was both convenient and a part of their current work practices regarding the study task. However, the motivation behind the work practices was not deeply considered.

The issue of student motivation is an active and often debated area of research.[5, 48, 51, 73, 76]. Consistent, low-level use provides some evidence that intrinsically motivated students in ECE 2025 access proficiency-oriented content throughout the semester. However, the majority of content access occurs shortly before grade-related events like homework, quizzes and tests, and those accesses are predominantly of performance-oriented content [Chapter 2]. We interpret this as a reflection of the extrinsic motivation driving the majority use of online content. Even for self-motivated students, the amount of content available and the limited amount of time that they can give to a single course limits the percentage of content accessed and the overall use of supporting content.

In general, our study in conjunction with the low use of online content reported by other studies raises questions about the value of creating large collections of supportive course content for undergraduate students. *The access interfaces for successful collections of content need to be* ***designed around an understanding of the predominant student motivation*** *in the course as well as meeting the previously stated requirements for convenience, relevance, and the desire to save time.* To explore this claim, we developed the C-Nexus system that tied access to the low-use explanatory content with

access to the moderately used captured lecture videos. Since students generally believe that topics covered in lecture are important with regards to performance on exams, our hope was that a topical (or keyword) interface that provided relevant explanatory content alongside the listing of video lectures would induce students to make use of the supportive material [Sections 2.4, 3.2, 4.2, 4.3, References 12, 13, 29, 37, 55, 59]. The primary result of introducing this technology was a moderate increase in the use of the performance-oriented content. We attribute the significant increase in the use of the performance-oriented content in ECE 2025 to demographic shifts during the semester of the deployment study [Section 4.4].

### *5.2 Related Questions*

The results of our study raises several questions related to the creation and use of online content in support of courses. We have discussed many of these in this dissertation. However, some important questions stemming from our research go beyond the scope of this dissertation. We discuss some of them briefly in this section.

A possible negative interpretation of the data relates to the amount of time students have available and the nature of the content provided. Does such a wealth of proficiency-oriented content provided, and the student's extrinsic motivation to earn high marks, result in a reduction of the time spent on proficiency-oriented content? Does the educational value of the performance-oriented content warrant the amount of time spent by students? There are student comments in our surveys that raise interesting questions about how students are using the performance-oriented content. Several students indicate that they use the past exercises to increase the number of practice problems they have to test their understanding of concepts in the course. This is obviously a constructive use of

the performance-oriented content. However, the motivation behind the use of the performance-oriented content does appear to be a desire to find a shortcut to good scores. A study of why students are using the performance-oriented content, and its value, would benefit content designers and providers.

The drastic increase in the use of the content not targeted by our study is intriguing. Though a strong correlation to the change in gender exists, what is the relationship? It is important to note that the increase in the enrollment of women parallels the increase in both Bio Med majors and the increase in juniors and seniors. Was the increase caused by gender, major, class, or a combination? In addition, Bio Med students take courses designed around Problem Based Learning. Does the PBL experience increase the students' use of online content in other courses? Would instruction on the use of online content in a course significantly increase use?

These and other questions require a finer-grained data set and deeper analysis than provided by this study. We are pursuing some of these questions in our ongoing research.

### *5.3 Future Work*

A deeper, more specific understanding of what online content students are using, and to what purpose, will enable us better to understand what content they need. Likewise, a more detailed study of the relationship between content use and performance is necessary to move beyond the *perception* of value to a real *knowledge* of value. Finally, the design requirements that we have proposed, in tandem with those that we have adopted, need to be further tested through the design, deployment and assessment of content access interfaces in actual course settings.

### 5.3.1 Study of Content Use and Performance

The Advanced Learning Technologies (ALT) division of the Board of Regents (BoR) of the University System of Georgia has done a study related to the use of online content in distance learning courses and the relationship to class performance [24]. In the coming year, we will be joining with them to design a large-scale analysis of the kind of content used in distance as well as campus courses, the volume of use, the demographics of use, and the impact on performance if any. A disappointment in our thesis research was the poor usage data available from the WebCT CE server. The WebCT Vista server, currently in use by the BoR, provides a much richer set of data even with courses like ECE 2025 that are not formulated with content modules. Georgia Tech will be moving to the Vista Server in the coming year as well. By collaborating with the ALT division, we will be able to include several hundred courses from multiple institutions and disciplines in our study.

### 5.3.2 Continued Research in Classroom Capture

Beginning with the work of Brotherton at Georgia Tech, we continue to find a strong student belief in the value of captured class lectures [1, 15, 31]. Many institutions now provide captured lectures, and there are many commercial options for providing the service. The Office of Information Technology (OIT) at Georgia Tech has recently completed a new capture system, Digital Class Recording System (DCRS), and they are engaged in a limited deployment at this time. We are collaborating with OIT and Distance Learning and Professional Education, to evaluate the use and value of these lectures. We have also re-engineered the GT eClass system to work in tandem with

DCRS to capture annotated faculty notes as well. NoteNexus and Scribbler will also be reworked to interconnect with the new archive.

As mentioned, several commercial products also provide various kinds of support for captured lectures. Georgia Tech is currently doing a broad test of the Tegrity system, which includes Tegrity Notes. Georgia Tech began its exploration of student note capture with Truong's StuPad system [89]. We will continue to explore the value of this concept via NoteNexus, Scribbler, and perhaps Tegrity Notes. Beyond the interconnection with lectures, there is also the possibility to provide connections to other content within the framework of our understanding of student motivation.

### 5.3.3 Supporting Effective Use of Online Content

Though the NoteNexus tool was not successful in increasing the student use of online content, we were able to increase content use by including an understanding of student motivation in our design requirements for C-Nexus. This research also provides an understanding that, though increased use has value, the overall goal should be *effective* use of online content. Designing for effective use balances extrinsic student motivation and course learning objectives by providing tools that meet both sets of requirements simultaneously.

Working with a well structured course with clearly stated learning objectives, like ECE 2025, we will design and develop interfaces that use the learning objectives and performance artifacts (e.g. tests) to provide relevant content listings for students. Our first prototype is WOTT (What's On The Test). Though "teaching to the test" is inappropriate, instructors routinely provide students with an understanding for the scope of an exam. WOTT will use an instructor provided definition of an exam that includes the lecture

dates and associated keywords. WOTT will then present to the student a comprehensive listing of relevant online content that reflects the learning objectives that may be represented on the test. In a very real sense, WOTT provides an automatic study guide constructed with the metadata associated with the content in our repository. We will evaluate WOTT on content use as well as student performance. We will also seek IRB approval to expand our assessment to include student performance in subsequent electrical engineering courses.

### *5.4 Summary*

Our research shows that creating collections of supportive course content is not sufficient for aiding student learning. Other studies show that such collections are not widely used by students. Our analysis of the student use of ECE 2025 content shows that beyond the use of primary content (current assignments and required lab pre-tests), the students' confined use of the supporting content almost entirely to the performance related content like past quizzes and homework assignments. The optimistic view that students will use supportive content if we make it convenient, held by many in the digital library and content creation communities, is based on a belief that student behavior is intrinsically motivated. Even for students that are so motivated, time constraints reduce the opportunity for using content that does not support the extrinsic goal of performance.

We conclude, therefore, that interfaces intended to provide students access to learning repositories must go beyond convenience, relevance, and time saving; they must also support the students' understanding of need. Like search and browsing tools, our embedded access was useful, but did not meet the students' requirements. Tools like C-Nexus and WOTT explore the interlinking of instructor objectives with student

motivation. Our preliminary results from the C-Nexus study indicate that this approach is promising and worthy of further research.

# Appendix A

## Apache Server Log Data

| | | Fall 2001 | Spring 2002 | Summer 2002 |
|---|---|---|---|---|
| **Enrollment** | | **299** | **162** | **111** |
| Hits | | 276,573 | 129,137 | 80,250 |
| Avg. Hits per Day | | 2,343 | 1,076 | 966 |
| Avg. Hits per Student | | 925 | 797 | 723 |
| Views | | 37,221 | 23,895 | 14,539 |
| Avg. Views per Day | | 315 | 199 | 175 |
| Avg. Views per Student | | 124 | 148 | 131 |
| Sessions | | 11,435 | 7,621 | 4,493 |
| Avg. Sessions per Day | | 96 | 63 | 54 |
| Avg Sessions per Student | | 38 | 47 | 40 |
| Avg. Session Length | | 0:07:41 | 0:07:16 | 0:09:01 |
| Most Active Day of Week | | Monday | Monday | Monday |
| Least Active Day of Week | | Saturday | Saturday | Wednesday |
| Most Active Day Ever | | 12/6/2001 | 4/30/2004 | 7/29/2002 |
| Num Hits M.A.D.E. | | 11,153 | 6,938 | 3,859 |
| Most Act as % of Total Hits | | 4% | 5% | 5% |
| Most Act as % of Avg. Higs | | 476% | 645% | 399% |
| Most Active Hour of Day | | 17:00 | 13:00 | 15:00 |
| Least Active Hour of Day | | 6:00 | 5:00 | 5:00 |
| % of Sessions <= 1 min | | 64% | 65% | 63% |
| % of Sessions >= 19 min | | 11% | 10% | 11% |
| % of Sessions Viewing <= 5 pages | | 84% | 86% | 83% |
| % of Sessions Viewing >= 12 pages | | 1% | 0% | 1% |

| | | Fall 2002 | Spring 2003 | Summer 2003 |
|---|---|---|---|---|
| **Enrollment** | | **265** | **178** | **86** |
| Hits | | 197,730 | 91,677 | 60,624 |
| Avg. Hits per Day | | 1,675 | 776 | 739 |
| Avg. Hits per Student | | 746 | 515 | 705 |
| Views | | 41,107 | 22,034 | 14,890 |
| Avg. Views per Day | | 348 | 186 | 181 |
| Avg. Views per Student | | 155 | 124 | 173 |
| Sessions | | 11,277 | 5,930 | 3,340 |
| Avg. Sessions per Day | | 95 | 50 | 40 |
| Avg Sessions per Student | | 43 | 33 | 39 |
| Avg. Session Length | | 0:08:15 | 0:08:15 | 0:08:30 |
| Most Active Day of Week | | Monday | Monday | Monday |
| Least Active Day of Week | | Friday | Saturday | Wednesday |
| Most Active Day Ever | | 12/9/2002 | 4/27/2003 | 6/15/2003 |
| Num Hits M.A.D.E. | | 11,887 | 3,516 | 4,713 |
| Most Act as % of Total Hits | | 6% | 4% | 8% |
| Most Act as % of Avg. Hits | | 710% | 453% | 638% |
| Most Active Hour of Day | | 13:00 | 20:00 | 11:00 |
| Least Active Hour of Day | | 6:00 | 6:00 | 5:00 |
| % of Sessions <= 1 min | | 60% | 59% | 57% |
| % of Sessions >= 19 min | | 12% | 11% | 11% |
| % of Sessions Viewing <= 5 pages | | 81% | 81% | 78% |
| % of Sessions Viewing >= 12 pages | | 1% | 1% | 1% |

| | | Fall 2003 | Spring 2004 | Summer 2004 |
|---|---|---|---|---|
| **Enrollment** | | **243** | **195** | **75** |
| Hits | | 73,638 | 53,355 | 44,129 |
| Avg. Hits per Day | | 624 | 452 | 538 |
| Avg. Hits per Student | | 303 | 274 | 588 |
| Views | | 21,307 | 16,195 | 15,727 |
| Avg. Views per Day | | 180 | 137 | 191 |
| Avg. Views per Student | | 88 | 83 | 210 |
| Sessions | | 5,517 | 4,785 | 3,281 |
| Avg. Sessions per Day | | 46 | 40 | 40 |
| Avg Sessions per Student | | 23 | 25 | 44 |
| Avg. Session Length | | 0:06:31 | 0:07:11 | 0:08:58 |
| Most Active Day of Week | | Thursday | Wednesday | Thursday |
| Least Active Day of Week | | Saturday | Saturday | Saturday |
| Most Active Day Ever | | 8/23/2003 | 3/4/2004 | 7/29/2004 |
| Num Hits M.A.D.E. | | 5,817 | 2,417 | 2,561 |
| Most Act as % of Total Hits | | 8% | 5% | 6% |
| Most Act as % of Avg. Hits | | 932% | 535% | 476% |
| Most Active Hour of Day | | 22:00 | 13:00 | 16:00 |
| Least Active Hour of Day | | 6:00 | 5:00 | 6:00 |
| % of Sessions <= 1 min | | 65% | 64% | 60% |
| % of Sessions >= 19 min | | 8% | 9% | 12% |
| % of Sessions Viewing <= 5 pages | | 84% | 84% | 82% |
| % of Sessions Viewing >= 12 pages | | 1% | 1% | 1% |

| | | Fall 2004 | Spring 2005 | Summer 2005 |
|---|---|---|---|---|
| **Enrollment** | | **256** | **188** | **117** |
| Hits | | 176,725 | 95,326 | 128,137 |
| Avg. Hits per Day | | 1,497 | 807 | 1,601 |
| Avg. Hits per Student | | 690 | 507 | 1,095 |
| Views | | 58,046 | 28,434 | 33,733 |
| Avg. Views per Day | | 491 | 240 | 421 |
| Avg. Views per Student | | 227 | 151 | 288 |
| Sessions | | 12,705 | 7,190 | 10,071 |
| Avg. Sessions per Day | | 107 | 60 | 125 |
| Avg Sessions per Student | | 50 | 38 | 86 |
| Avg. Session Length | | 0:08:25 | 0:09:18 | 0:11:10 |
| Most Active Day of Week | | Monday | Monday | Wednesday |
| Least Active Day of Week | | Friday | Saturday | Saturday |
| Most Active Day Ever | | 10/14/2004 | 3/30/2005 | 7/20/2005 |
| Num Hits M.A.D.E. | | 4,436 | 3,112 | 5,946 |
| Most Act as % of Total Hits | | 3% | 3% | 5% |
| Most Act as % of Avg. Hits | | 296% | 386% | 371% |
| Most Active Hour of Day | | 15:00 | 21:00 | 14:00 |
| Least Active Hour of Day | | 6:00 | 6:00 | 6:00 |
| % of Sessions <= 1 min | | 59% | 22% | 25% |
| % of Sessions >= 19 min | | 27% | 32% | 24% |
| % of Sessions Viewing <= 5 pages | | 79% | 19% | 85% |
| % of Sessions Viewing >= 12 pages | | 1% | 1% | 1% |

| | | Combined | STDEVP |
|---|---|---|---|
| **Enrollment** | | **2,175** | |
| Hits | | **1,407,301** | |
| Avg. Hits per Day | | **13,094** | |
| Avg. Hits per Student | | **7,869** | 227.08 |
| Views | | **327,128** | |
| Avg. Views per Day | | **3,064** | |
| Avg. Views per Student | | **1,902** | 56.536 |
| Sessions | | **87,645** | |
| Avg. Sessions per Day | | **816** | |
| Avg Sessions per Student | | **40** | 15.34 |
| Avg. Session Length | | | |
| Most Active Day of Week | | | |
| Least Active Day of Week | | | |
| Most Active Day Ever | | | |
| Num Hits M.A.D.E. | | | |
| Most Act as % of Total Hits | | | |
| Most Act as % of Avg. Hits | | | |
| Most Active Hour of Day | | | |
| Least Active Hour of Day | | | |
| % of Sessions <= 1 min | | | |
| % of Sessions >= 19 min | | | |
| % of Sessions Viewing <= 5 pages | | | |
| % of Sessions Viewing >= 12 pages | | | |

# Appendix B

## Questions from the ECE 2025 Course Survey

| | | Fall 2003 | | Spring 2004 | |
|---|---|---|---|---|---|
| **Question 6. The demos on the SP-First CDROM/Web page helped me understand the concepts being demonstrated** | Strongly agree | 29 | 14% | 24 | 14% |
| | Agree | 87 | 41% | 70 | 41% |
| | Do not agree or disagree | 50 | 23% | 30 | 17% |
| | Disagree | 10 | 5% | 9 | 5% |
| | Strongly disagree | 1 | 0% | 4 | 2% |
| | I did not view them | 37 | 17% | 35 | 20% |
| | Total | 214 | | 172 | |
| **Question 7. I used the homework solutions (i.e., "word") on the web page** | Very often | 39 | 18% | 63 | 37% |
| | Often | 47 | 22% | 43 | 25% |
| | Occasionally | 59 | 28% | 32 | 19% |
| | Seldom | 48 | 22% | 20 | 12% |
| | Never | 21 | 10% | 14 | 8% |
| | Total | 214 | | 172 | |
| **Question 8. I used the sample problems and solutions on the SP-First CDROM** | Very often | 16 | 7% | 17 | 10% |
| | Often | 25 | 12% | 31 | 18% |
| | Occasionally | 36 | 17% | 35 | 20% |
| | Seldom | 45 | 21% | 33 | 19% |
| | Never | 92 | 43% | 56 | 33% |
| | Total | 214 | | 172 | |

| | | Fall 2004 | | Spring 2005 | | Sum 2005 | |
|---|---|---|---|---|---|---|---|
| **Question 6. The demos on the SP-First CDROM/Web page helped me understand the concepts being demonstrated** | | | | | | | |
| | Strongly agree | 31 | 14% | 32 | 24% | 21 | 20% |
| | Agree | 99 | 44% | 44 | 32% | 37 | 35% |
| | Do not agree or disagree | 42 | 19% | 17 | 13% | 12 | 11% |
| | Disagree | 9 | 4% | 6 | 4% | 7 | 7% |
| | Strongly disagree | 3 | 1% | 4 | 3% | 3 | 3% |
| | I did not view them | 40 | 18% | 33 | 24% | 26 | 25% |
| | Total | 224 | | 136 | | 106 | |
| **Question 7. I used the homework solutions (i.e., "word") on the web page** | | | | | | | |
| | Very often | 108 | 48% | 86 | 63% | 56 | 53% |
| | Often | 59 | 26% | 27 | 20% | 31 | 29% |
| | Occasionally | 37 | 17% | 11 | 8% | 13 | 12% |
| | Seldom | 11 | 5% | 10 | 7% | 6 | 6% |
| | Never | 9 | 4% | 2 | 1% | 0 | 0% |
| | Total | 224 | | 136 | | 106 | |
| **Question 8. I used the sample problems and solutions on the SP-First CDROM** | | | | | | | |
| | Very often | 24 | 11% | 16 | 12% | 13 | 12% |
| | Often | 28 | 13% | 18 | 13% | 7 | 7% |
| | Occasionally | 38 | 17% | 19 | 14% | 22 | 21% |
| | Seldom | 50 | 22% | 31 | 23% | 28 | 26% |
| | Never | 84 | 38% | 52 | 38% | 36 | 34% |
| | Total | 224 | | 136 | | 106 | |

| | | Combined | |
|---|---|---|---|
| **Question 6. The demos on the SP-First CDROM/Web page helped me understand the concepts being demonstrated** | Strongly agree | 137 | 16% |
| | Agree | 337 | 40% |
| | Do not agree or disagree | 151 | 18% |
| | Disagree | 41 | 5% |
| | Strongly disagree | 15 | 2% |
| | I did not view them | 171 | 20% |
| | Total | 852 | |
| **Question 7. I used the homework solutions (i.e., "word") on the web page** | Very often | 352 | 41% |
| | Often | 207 | 24% |
| | Occasionally | 152 | 18% |
| | Seldom | 95 | 11% |
| | Never | 46 | 5% |
| | Total | 852 | |
| **Question 8. I used the sample problems and solutions on the SP-First CDROM** | Very often | 86 | 10% |
| | Often | 109 | 13% |
| | Occasionally | 150 | 18% |
| | Seldom | 187 | 22% |
| | Never | 320 | 38% |
| | Total | 852 | |

| | | Fall 2004 | | Spring 2005 | | Sum 2005 | |
|---|---|---|---|---|---|---|---|
| **Question 16c. The lectures were recorded and converted to a streaming format for viewing over the Web. Did you use these?** | Yes, often | 30 | 13% | 18 | 13% | 13 | 12% |
| | Yes, but only a few times | 71 | 32% | 48 | 35% | 24 | 23% |
| | No | 71 | 32% | 51 | 38% | 57 | 54% |
| | Didn't know they were available | 34 | 15% | 12 | 9% | 8 | 8% |
| | Tried, had technical problems | 18 | 8% | 7 | 5% | 4 | 4% |
| | | 224 | | 136 | | 106 | |
| **Question 16a. I viewed the tutorial movies in WebCT** | When I needed help, I look for one of these | 14 | 6% | 4 | 3% | 7 | 7% |
| | Several times | 33 | 15% | 9 | 7% | 7 | 7% |
| | Once | 59 | 26% | 37 | 27% | 18 | 17% |
| | Never | 85 | 38% | 64 | 47% | 42 | 40% |
| | Didn't know there were any movies available | 33 | 15% | 22 | 16% | 32 | 30% |
| | | 224 | | 136 | | 106 | |
| **Question 16. I viewed computer demos used in class later via the web or the SP-First CDROM** | Almost always | 6 | 3% | 6 | 4% | 7 | 7% |
| | Frequently | 32 | 14% | 20 | 15% | 17 | 16% |
| | Occasionally | 78 | 35% | 43 | 32% | 24 | 23% |
| | Seldom | 62 | 28% | 28 | 21% | 22 | 21% |
| | Never | 46 | 21% | 39 | 29% | 36 | 34% |
| | | 224 | | 136 | | 106 | |
| **Question 14. I used the lecture notes posted on WebCT** | Always | 45 | 20% | 35 | 26% | 42 | 40% |
| | Often | 58 | 26% | 34 | 25% | 30 | 28% |
| | About half the time | 29 | 13% | 22 | 16% | 11 | 10% |
| | Every once in a while | 70 | 31% | 33 | 24% | 19 | 18% |
| | Never | 22 | 10% | 12 | 9% | 4 | 4% |
| | | 224 | | 136 | | 106 | |

| | | Combined | |
|---|---|---|---|
| **Question 16c. The lectures were recorded and converted to a streaming format for viewing over the Web. Did you use these?** | Yes, often | 61 | 13% |
| | Yes, but only a few times | 143 | 31% |
| | No | 179 | 38% |
| | Didn't know they were available | 54 | 12% |
| | Tried, had technical problems | 29 | 6% |
| | | 466 | |
| **Question 16a. I viewed the tutorial movies in WebCT** | When I needed help, I look for one of these | 25 | 5% |
| | Several times | 49 | 11% |
| | Once | 114 | 24% |
| | Never | 191 | 41% |
| | Didn't know there were any movies available | 87 | 19% |
| | | 466 | |
| **Question 16. I viewed computer demos used in class later via the web or the SP-First CDROM** | Almost always | 19 | 4% |
| | Frequently | 69 | 15% |
| | Occasionally | 145 | 31% |
| | Seldom | 112 | 24% |
| | Never | 121 | 26% |
| | | 466 | |
| **Question 14. I used the lecture notes posted on WebCT** | Always | 122 | 26% |
| | Often | 122 | 26% |
| | About half the time | 62 | 13% |
| | Every once in a while | 122 | 26% |
| | Never | 38 | 8% |
| | | 466 | |

# Appendix C

## Technology Survey

The following two surveys (Fall 2004 and Spring 2005) were given to students in ECE 2025 via WebCT.

### Fall 2004

**Question: 1. Student's approval to use their response**

Data from students who refused consent have been removed.

**Question: 2. Willingness to use own laptop**

If you own a laptop, would you be willing to bring it to class in order to use this service ? (Repeated here for convenience: technology that will support in class note-taking, connect those notes with the online lecture material, and also connect those notes with other resources available for the course)

- ☐ a. Yes
- ☐ b. No
- ☐ c. Not Applicable

---

**Response Summary**

| Answer | Value | Frequency Distribution |
|---|---|---|
| a | 50% | 99 |
| b | 6% | 12 |
| c | 44% | 87 |

**Question: 3. Willingness to purchase laptop**

If you do not own a laptop, would you be willing to purchase one in order to use this service? (Repeated here for convenience: technology that will support in class note-taking, connect those notes with the online lecture material, and also connect those notes with other resources available for the course)

- a. Yes
- b. No
- c. Not Applicable

---

**Response Summary**

| Answer | Value | Frequency Distribution |
|---|---|---|
| a | 19% | 37 |
| b | 36% | 71 |

| | | | |
|---|---|---|---|
| c | 45% | 90 | |

**Question: 4. Willingness to purchase digital pen**

If we supported digital pens, would you be willing to purchase one in order to use this service? (a Logitech digital pen costs about $180)

(Repeated here for convenience: technology that will support in class note-taking, connect those notes with the online lecture material, and also connect those notes with other resources available for the course)

- a. Yes
- b. No

---

**Response Summary**

| Answer | Value | Frequency Distribution |
|---|---|---|
| a | 34% | 67 |
| b | 66% | 131 |

| Title | N | Frequency | | | | Mean | SD | Median | Mode |
|---|---|---|---|---|---|---|---|---|---|
| | | - | a | b | c | | | | |
| 1.Student's approval to use their response | 198 | 0 | 196 | 2 | - | 1.01 | 0.10 | 1.0 | a |
| 2. Willingness to use own laptop | 198 | 0 | 99 | 12 | 87 | 1.94 | 0.97 | 1.5 | a |
| 3. Willingness to purchase laptop | 198 | 0 | 37 | 71 | 90 | 2.27 | 0.76 | 2.0 | c |
| 4. Willingness to purchase digital pen | 198 | 0 | 67 | 131 | - | 1.66 | 0.47 | 2.0 | b |

**Question: 5. Other technologies**

What other technology, similar to the one mentioned at the top, would you want us to support?

---

**Responses**

| User ID | Response |
|---|---|
| 1 | wearable computers |
| 3 | none |
| 4 | N/A |
| 9 | a device that can translate voice recordings into word documents. |
| 10 | Not sure. |
| 15 | Integrated chat/email and group productivity technology. |
| 16 | Nothing really..this is a good idea. A little expensive, but useful! |
| 17 | none |
| 18 | I'm not sure what the technology is. |
| 19 | pdas etc |
| 20 | PRS (Personal Response System) |
| 21 | streaming lectures |
| 23 | n/a |
| 25 | PDAs |
| 26 | PDAs |

| | |
|---|---|
| 28 | cant think of any |
| 30 | None that I can think of. |
| 32 | PDAs with WIFI capabilities |
| 34 | None |
| 35 | |
| 36 | N/A |
| 38 | change from quicktime to windows media player for recorded lecture movies |
| 39 | not applicable |
| 43 | interactive prelabs |
| 44 | i wouldn't by a laptop, period. too expensive. |
| 46 | I would like to see support for lecture interaction between users' computers and lecturer, such as in-class questions/quizzes for instant feedback. |
| 48 | I would only use laptops |
| 52 | I don't know of any. |
| 53 | I really don't know what else is out there, but if you were to provide a list of current technologies out there, maybe the students can pick from those on what would suit our needs better. |
| 54 | Provide recorded lectures. |
| 55 | |
| 56 | |
| 58 | None |
| 59 | No idea |
| 60 | none |
| 65 | There is a similar technology to digital pens which may be a cheaper alternative. They work by placing a type of scanner at teh top of the paper and a small beacon in the pen. The scanner follows the pen whereever it is on the paper |

| | |
|---|---|
| | and traces the image on the computer |
| 66 | If someone would invent a dry board or chalk board that scans can scan itself and create PDFs of exercises done while in class then that would be very nice. I've always wanted that in classes. |
| 68 | Frankly, I think the best note-taking is done with a pen/pencil and a paper. Therefore, I believe the technologies you are planning to support would be more than sufficient. |
| 69 | Maybe PRS's to give us the ability to have practice problems. |
| 71 | audio recording technology |
| 72 | |
| 73 | None. |
| 74 | I don't care |
| 78 | Professor note synchronization where the students are able, if desired, to have the notes the professor writes while lecturing. |
| 79 | I'm fine with the way I take notes, and I'm broke, so I don't want to buy a expensive pen or laptop. Sorry! |
| 82 | Bluetooth |
| 83 | PDA support might be a plus, though it might be difficult to implement. I still wouldn't buy one for the service, but it would be a help to people that have them. |
| 84 | na |
| 86 | |
| 87 | PDA support? |
| 90 | thats fine |
| 91 | asdf technology |
| 92 | Palm pilot? |
| 93 | Microsoft One Note Microsoft Outlook (for calendar) Palm Pilot |

| | |
|---|---|
| 94 | na |
| 95 | Nothing, that I can think of at the moment. This sounds like something that could be useful. |
| 97 | Nothing off the top of my head. |
| 100 | n/a |
| 101 | PDA notetaking |
| 103 | Video-taping (recording) all lectures and classes for them to be available on-line. |
| 104 | none |
| 105 | N/A |
| 107 | dunno |
| 108 | . |
| 109 | None that I can think of. |
| 110 | ... |
| 111 | Flash memory sticks |
| 112 | none |
| 115 | none |
| 117 | Not quite sure |
| 118 | the digital seems like an excellent idea but for the price $180, i doubt if students will want one. to answer the question on other technology similar to one mentioned above, I think a wireless printer should be available for students use for online lecture materials. |
| 119 | None |
| 120 | no comment |
| 121 | Palm Pilot, PDA technologies |
| 122 | Anything fun |

| | |
|---|---|
| 123 | Anything else y'all feel is spiffy |
| 125 | none |
| 126 | A Holodeck. |
| 128 | na |
| 130 | The technology so that the professors dont waste class time trying to figure out the projection and audio systems. |
| 133 | none |
| 136 | |
| 138 | professor can write directly onto powerpoint slides, so we can ask questions in calss and they can be used for everyone's use, including the other classes. |
| 140 | Not really, but open to other technologies. |
| 142 | any |
| 143 | I have no idea. |
| 144 | No other new technology, but please replace the computers in the Bunger-Henry DSP lab..... |
| 145 | n/a |
| 146 | I prefer my paper notes |
| 147 | none |
| 148 | I would like to learn more about your technology before I can comment on it. |
| 149 | If I had a laptop I would love to use this technology, but I am very found of my desktop PC and unfortunately cannot afford a new laptop |
| 150 | Use a built in laptop note taker such as Microsoft One Note. |
| 151 | None |
| 152 | Technology for typing quickly the symbols used on a day to day basis in these classes. Such as sigma, and omega, without having to look up the unicode values. |

| | |
|---|---|
| 153 | none |
| 154 | use computers in recitation room for note-taking possibly |
| 155 | perhaps there shoudl be places where one can plug in their power cord for their laptop |
| 158 | none |
| 159 | Netmeeting for times when coming to class is not possible. Lectures are very important. However, not everyone can be in class every day no matter how much they desire. Maybe "canned" or standard lectures could be available over the internet like they are at MIT. |
| 161 | more online multimedia |
| 163 | None. |
| 168 | its fine as it is |
| 169 | dont know |
| 170 | nothing. |
| 172 | Indifferent, digital pen and laptop support are sufficient. Tablet PCs could be alternatives to both the digital pen/laptop. |
| 174 | Better networking system. |
| 175 | Sounds good to me |
| 176 | none |
| 177 | I dont know |
| 178 | The one mentioned is more than enough. |
| 181 | I like the saved lectures.. sometimes the professor explains topics in such a way during lecture that is difficult to capture his meaning in your own words on a sheet of paper. Having the ability to re-visit the lecture and actually hear the explanation again is very beneficial. |
| 182 | Don't know of any other. |
| 184 | nothing more |

| | |
|---|---|
| 185 | The one involving personal laptop is ok, but the current platform is just fine. |
| 186 | I think you should video the lectures all the time and make them available when students have to miss a class. |
| 187 | audio/video recordings of the lectures (ECE2025 has this and i believe it would be useful in other classes as well) |
| 189 | you also might want to consider supporting PDA's. |
| 190 | I believe that the DSP lecture material is very well presented and available outside of lecture on webct. Not only are all the lecture slides up to be seen in two formats, but most all of the lectures are recorded and available for download. I do not believe that further educational aids are required for this class. The only thing I could ask for is more knowledgeable TAs, but I believe changing the capabilities of the TAs is a difficult task. |
| 191 | More MacOS support |
| 193 | Instead of laptops and digital pens, I think PDAs would be a better solution (or addition). |
| 194 | none |
| 195 | n/a |
| 196 | nothing |
| 197 | some sort of interactive white board. something that would allow professor to draw on an 'active board'. maybe have it anti-alias lines, allow easy creation of 2-d sketches on a grid, support mathematical equations. that would be sweet. obviously these 'soft-notes' could be published to a web distro. point and shared. |
| 198 | Not sure |

**Question: 6. Comments (class note-taking)**

Please let us know if you have any comments on the in-class note-taking technology :

---

**Responses**

| User ID | Response |
|---|---|
| 1 | no questions |
| 3 | none |
| 4 | Personally, I don't see the point..the lecture slides and your presence at lectures should be more than enough. You're not really going to get anything new from this note-taking technology. Not all applications of advanced technology necessarily cause advances. |
| 9 | none |
| 10 | Sounds interesting, more details on what exactly it is would be nice. |
| 15 | Sounds interesting. |
| 16 | nothin really |
| 17 | none |
| 18 | Doesn't sound like it's worth the price of a laptop, but then I'm not really sure how you could have a particularly intricate system without it distracting from the lecture. Details, please. |
| 19 | ya, more technology the better |

| | |
|---|---|
| 20 | Easier alternative might be to provide these notes online. |
| 21 | none |
| 23 | n/a |
| 25 | It sounds like a great idea, i think most people taking the class will benefit from this technology. |
| 26 | Provide a useful and bug-free working environment. Too many software programs are problem-ridden because they are hard to manipulate. |
| 27 | Honestly, i still prefer the good old pencil and paper for taking my notes. A laptop solution would have to be VERY convenient and cross-platform for me to want to use it |
| 28 | none at this time |
| 30 | Sounds like a great idea. I just wouldn't be willing to shovel out money to buy a laptop to use the service. |
| 31 | I just prefer hand-written notes. There is no way I'd buy a lap-top in order to take notes, even if it did link stuff. Hand-written notes work just as well and don't cost thousands. |
| 32 | I would like to see this technology used. |
| 34 | None |
| 35 | |
| 36 | I don't think it is necessary. |
| 37 | DO more examples. The lecture notes are read word for word. I like the idea of doing examples, but use examples that are not in the slides. |
| 38 | how cool is it? |
| 39 | no comments |
| 40 | I'll just stick to pencil and paper. Can't really afford anything else and don't know if I would really even use it if I could. |
| 43 | sounds interesting |

| | |
|---|---|
| 44 | i wouldn't by a laptop, period. too expensive. |
| 46 | N/A |
| 47 | the only problem i can forsee with this is the students not really paying attention to the lectureer |
| 48 | Laptop technology is probably best |
| 49 | I would use a digital pen if we could get a substantial group discount |
| 52 | I don't really have any other comments, but it does sound like a good idea to me. However, I do not believe that people should be required to use this service if it would cause a financial burden. |
| 53 | I would like the notes written on the white board to be produced into a file or what not so that we may have reference to them. |
| 54 | None. |
| 55 | |
| 56 | would have to be very convenient and applicable for many classes and extra curricular activites for me to buy equipment |
| 58 | None |
| 59 | not really! |
| 66 | I like the cameras used lately in class to get a closeup of the board. My eyes aren't so great, so it helps me a great deal. |
| 68 | This could be a really efficient way of taking notes and tying them to other course materials. Keep up the research! |
| 69 | Where would we be using these pens? |
| 71 | none |
| 72 | I don't really see the point of implementing the technology in question. |
| 73 | As someone who will most likely never use this technology, two things come to mind. Is this necessary? (I assume there was a large student response for such technology, but I never heard about it.) Second, where's the money coming from? (I |

| | |
|---|---|
| | assume a grant of some kind is supporting this and not tuition or any other student fees.) |
| 74 | none |
| 77 | I think the best strategy for taking notes is and always will be pencil and paper. In an engineering class, one must write out many diagrams and odd symbols that are difficult to access on a computer. The only change that would be useful is professors put more of the lecture material online, but most do that already anyway. |
| 78 | It would be hard to get people to buy laptops specifically for that purpose enless you offered a discount with some company where students can afford a good laptop for low costs. Everything would change in that case. The same goes with the digital pens if they are so expensive. If you can lower the costs by agreements with manufacturers then this technology can start probably as soon as next semester. |
| 79 | I don't like taking notes, it's distracting and I end up missing what the prof is talking about |
| 82 | none |
| 83 | It does sound like a good idea. People with laptops could certainly make good use of it. I wouldn't because I don't have a laptop and won't buy one just for enhanced notes since I do pretty good with pen and paper. |
| 84 | none |
| 86 | |
| 87 | The computers in recitation and labs are very helpful in instruction and teaching basic concepts. |
| 90 | none |
| 91 | asdf |
| 92 | I don't see how my notes would be of help, the lecture slides are almost the same as one's notes would be from lecture. Perhaps this for recitation makes sence because those notes are generally accessable unless they are recorded by a student... It's possible the concept merely wasn't explained fully, thus I'm missing something. |

| | |
|---|---|
| 93 | no comments |
| 94 | na |
| 95 | One specific questions at this point in time. Is each students notes uploaded so everyone can see or how exactly are they used? |
| 97 | Would eliminate paper usage, but needs to be cheap. |
| 98 | I don't think you should advance the technology too much. Some students do not have the resources to spend large amounts of money on class supplies that they can only use once. Hundreds of dollars on a pen that will only be used for one semester is a little extreme. |
| 100 | i don't see much advantage to digital note-taking...so much money to invest for the few pros to it. |
| 103 | No comments. |
| 104 | none |
| 105 | N/A |
| 106 | |
| 107 | I can take notes just fine with paper and pencil. It is not worth spending hundreds of dollars so I can become lazier. But I do like the online lectures! |
| 108 | . |
| 109 | Taking notes would probably be more effective if the professor taught stuff not mentioned on the slides. Otherwise students can just skip class and just download the notes. |
| 110 | ... |
| 111 | n/a |
| 112 | the technology has already been created in the form of a tablet pc which allows you to handwrite notes and paste in parts of the lecture slides where needed. |
| 115 | none |
| 117 | nope |

| | |
|---|---|
| 118 | It will be excellent to have options for students who can afford it. Brilliant for time management, students will have fast access to class notes. |
| 119 | Great idea and I think it owuld help a lot of students if they could actually follow the lecture notes without having to write them down at the same time. |
| 120 | no comment |
| 121 | I support any move to improve the use of technology in class. |
| 122 | no |
| 123 | i don't think it's too much of a problem to do it on paper, but hell, if it gets kids hooked while they're young, it's good by me |
| 124 | I much prefer real paper and a real pen or pencil for all my note-taking. Computers are slow and unreliable. Also, I remember material better when I write it on paper. |
| 125 | it's fine with me |
| 126 | OK!!! |
| 128 | na |
| 130 | It sounds like a nice idea, although Im not clear of what it does exactly. I might use something that connected the notes i took in class to the class lectures and notes. |
| 133 | no comments |
| 136 | |
| 138 | I do not beleive it to be fair to require students to purchase anything that huge ($180 or more) for in-class note-taking. You might want to consider the PRS system that the physics department uses for class feedback and analysis. |
| 140 | I think its a good idea. |
| 141 | It sounds very useful. |
| 142 | none |
| 143 | no. |
| 145 | n/a |

| | |
|---|---|
| 146 | none |
| 147 | I don't understand exactly what you are proposing |
| 148 | Microsoft PC tablets can also be used where a network can be created and whenever you enter a classroom all the HW's and Lecture Notes are directly uploaded to your tablet. |
| 149 | None |
| 150 | No comment |
| 151 | None |
| 152 | It's a good idea, and with a pen could be very convenient, but why does the pen have to be so expensive? |
| 153 | no comments |
| 154 | ok |
| 155 | none |
| 158 | Forget all this crap. Its about time we ECE majors started learning how these technologies work and how to build them rather than just using them. You just want to show that you're sophisticated...its just a waste of time and money. By the way..Are you trying indirectly encourage us to take notes in class? |
| 159 | how will symbols and mathmatical notation easily recognized by a note-taking program |
| 161 | good idea! |
| 163 | None. |
| 168 | its seems too expensive |
| 169 | no comments |
| 170 | good. |
| 174 | It's a good idea for developing technological and practical skills |
| 175 | not really sure how it works |

| | |
|---|---|
| 176 | none |
| 177 | I dont know |
| 178 | n/a |
| 181 | I can understand the benefits of this type of system for someone with a learning handicap. But for the general student body, I think implementing this kind of system is a bit absurd. This college is expensive enough as it is without adding in some extra expenses for "note-taking capabilities." Frankly, I find that this idea is only catering to the laziness of students to attend lecture and take notes themselves. I have absolutely no problems with the material by taking my own choice notes on a regular notepad with your everyday pencil (and I am by far not a genious student). If a student cannot find the discipline to regularly attend lecture and write his own notes, I don't think that the course has any need to try and support that student. |
| 182 | Sounds helpful, but the costs involved are too high for me to consider. |
| 184 | pen and paper works for me |
| 185 | . |
| 186 | It sounds good, but you really haven't told me how it works. For instance, is this something that I would do for myself or would there be in-class notes posted? The short paragraph above is very vague. |
| 187 | it's a really good idea |
| 189 | I don't think students would be willing to pay too much for such a service. |
| 190 | I doubt you would even consider it, but to 'require' a laptop for a class merely for the purpose of additional note-taking capabilities would be somewhat bizarre. Not having a laptop, I would be pretty miffed, especially if it were a required class for my major (which DSP is). |
| 191 | It would need to be rugged and not buggy. Definitely need Mac and PC support |
| 193 | The in-class note-taking technology would have to be of large benefit to the student to justify the use of laptops and digital pens, which are expensive in contrast to pen and paper. |

| | |
|---|---|
| 194 | no comment |
| 195 | n/a |
| 196 | n/a |
| 197 | just aim for practicallity and try not to get carried away in pie-in-the-sky ideas. these things would be hard to catch on as-is I would imagine, given the legacy of the notepad and ballpoint pen! |
| 198 | None |

## Spring 2005

**Question: 1. Student's approval to use their response**

Data from students who did not grant consent has been removed.

**Question: 2. Willingness to use own laptop**

If you own a laptop, would you be willing to bring it to class in order to use this service ? (Repeated here for convenience: technology that will support in class note-taking, connect those notes with

the online lecture material, and also connect those notes with other resources available for the course)

| | | |
|---|---|---|
| ☐ | a. | Yes |
| ☐ | b. | No |
| ☐ | c. | Not Applicable |

---

**Response Summary**

| Answer | Value | Frequency | Distribution |
|---|---|---|---|
| - | 0% | 9 | |
| a | 0% | 98 | |
| b | 0% | 16 | |
| c | 0% | 51 | |

**Question: 3. Willingness to purchase laptop**

If you do not own a laptop, would you be willing to purchase one in order to use this service? (Repeated here for convenience: technology that will support in class note-taking, connect those notes with the online lecture material, and also connect those notes with other resources available for the course)

- a. Yes
- b. No
- c. Not Applicable

---

**Response Summary**

| Answer | Value | Frequency | Distribution |
|---|---|---|---|
| - | 0% | 9 | |
| a | 0% | 30 | |
| b | 0% | 62 | |
| c | 0% | 73 | |

**Question: 4. Willingness to purchase digital pen**

If we supported digital pens, would you be willing to purchase one in order to use this service? (a Logitech digital pen costs about $180) (Repeated here for convenience: technology that will support in class note-taking, connect those notes with the online lecture material, and also connect those notes with other resources available for the course)

- a. Yes
- b. No

---

**Response Summary**

| Answer | Value | Frequency | Distribution |
|---|---|---|---|
| - | 0% | 10 | |
| a | 0% | 51 | |
| b | 0% | 113 | |

| Title | | Frequency | | | | Mean | SD | Median | Mode |
|---|---|---|---|---|---|---|---|---|---|
| | | - | a | b | c | | | | |
| 1. Student's approval to their response | 64 | 10 | 161 | 3 | - | 1.02 | 0.13 | 1.0 | a |
| 2. Willingness to use own laptop | 65 | 9 | 98 | 16 | 51 | 1.72 | 0.91 | 1.0 | a |
| 3. Willingness to purchase laptop | 65 | 9 | 30 | 62 | 73 | 2.26 | 0.75 | 2.0 | c |
| 4. Willingness to purchase digital pen | 64 | 10 | 51 | 113 | - | 1.69 | 0.46 | 2.0 | b |

**Question: 5. Other technologies**

What other technology, similar to the one mentioned at the top, would you want us to support?

---

**Responses**

| User ID | Response |
|---|---|
| 3 | real-time student-teacher chat capabilites |

| | |
|---|---|
| 4 | i dont know |
| 5 | Beepers that allow students to answer example questions, which in return give the percentages of the class understanding the material and those who do not. |
| 6 | No idea. |
| 8 | None |
| 13 | |
| 14 | none |
| 15 | NA |
| 16 | I am not familiar with many technologies, so I couldn't give you good advice. |
| 17 | Webcams so we can work at home if we dont have a laptop. |
| 19 | pda's |
| 20 | Maybe having lecture videos for all lecture classes. |
| 21 | Have lecture slides and class video online. |
| 22 | PDA's |
| 24 | none |
| 25 | PDA |
| 26 | None. Current technological support is sufficient. |
| 27 | Not sure about technology |
| 28 | regular pen and paper is fine with me |
| 29 | None. |
| 30 | none |
| 31 | No Answer |
| 32 | video/sound recording |
| 33 | The thing that attaches to the board that allows what is written on the board to be transferred to a computer |

| | |
|---|---|
| 34 | audio and video recording |
| 35 | Undecided |
| 36 | Depends on how fast the technology advances |
| 38 | none |
| 40 | I like the current system used and would not want more things to be mandatory. I like having a printout in front of me and then I can add in notes by writing it with a pencil or pen. Getting technological with this stuff seems, for lack of a better word, retarded. While notes on the computer is nice and all, I personally prefer the traditional way of note-taking because looking at a computer the whole time for notes puts more strain on the eyes and makes me get tired more quickly. |
| 42 | none |
| 43 | dont have any ideas |
| 44 | not sure |
| 45 | nothing i can think of. palm pilots maybe. |
| 46 | good ole handwritten notes |
| 48 | don't know enough to put in any input |
| 49 | none, really, i like the powerpoint and online help (i.e. message boards. |
| 50 | none yet |
| 51 | - |
| 52 | The technology above sounds good. I use a tablet PC to take notes if/when I do take notes. |
| 53 | nothing i can think of on top of my head |
| 55 | something cheaper than a $180 pen for something thats not exactly necessary |
| 57 | none |
| 58 | Please provide support for operating systems other than MacOS and Windows, mainly linux and it's variations. |

| | |
|---|---|
| 59 | snapshot of notes and examples written on the dry erase board posted online. |
| 60 | This would be sufficient. |
| 61 | Live web broadcast for all classes. |
| 62 | Live web broadcasts of classes. |
| 63 | |
| 65 | none I'm aware of |
| 66 | be able to IM questions to the prof during class. |
| 68 | None. |
| 69 | I don't know |
| 70 | not sure |
| 73 | Webct provides enough material and technolgy to support the material |
| 75 | prs |
| 76 | Link video footage of the lectures to the notes and slides |
| 77 | not sure |
| 78 | I don't know |
| 79 | I don't know |
| 80 | I was previously unaware of the technology mentioned at the top, and, unfortunately, am unaware of any similar technologies that could be supported. |
| 81 | 8 track technology |
| 82 | webcam. So that we might be able to attend class from any location with access to the internet. I know that that is complicated, but it would still be pretty neat to not have to leave one's dorm to go to class. |
| 83 | i'm not familiar with this technology. |
| 84 | b |
| 85 | When no one is using the big lecture hall, could I possibly use it to practice my bagpipes? It's hard to find anywhere to practice where I'm not bothering anyone and the |

| | |
|---|---|
| | hall seems ideal. Thank you. My number's 404-731-3768 by the by. |
| 86 | don't know. |
| 88 | Streaming audio and video of lecture. Printing support for laptops during lab. Allow network drives to be accessed from laptops. |
| 89 | technology that supports instant interaction with instructor and the rest of the class in a big class, like computer at each desk in a network connect all computers and also to the screen of the instructor 's computer. |
| 91 | Just as many business organizations are all networked, I'd like to see classes become connected with Outlook or a similar program. For those that keep their Outlook calendars up to date, it would be nice if test dates could be automatically set up as an appointment, instead of having to do it myself. |
| 92 | No clue. |
| 93 | Keep stacks of paper available...Distribute handouts with a summary of lecture in advance. |
| 94 | tablet PCs, Microsoft OneNote |
| 96 | No suggestions. |
| 98 | none |
| 99 | Technology not that expensive |
| 100 | Provide digital pens, and/or laptops |
| 104 | I don't think there is a supplement for handwritten notes, for me I learn the material while taking notes, and typing doesnt give the same effect for me. |
| 105 | No response. |
| 106 | None |
| 107 | The aformentioned sounds good. |
| 108 | complete online notes (not half full) |
| 110 | n/a |
| 112 | *shrug* |

| | |
|---|---|
| 113 | S |
| 115 | Can't really think of anything. |
| 116 | I don't know |
| 117 | Ability to import lecture notes from other students if you missed class, and with their permission? |
| 118 | not quite sure |
| 121 | No |
| 122 | None |
| 123 | can't think of any other |
| 125 | none |
| 126 | None. |
| 127 | Whatever one is fine with me |
| 128 | softboard(hand written notes are saved online as files) |
| 129 | VoIP |
| 130 | stream online lectures to students. |
| 131 | nothing |
| 132 | whatever technology is created, in terms of hardware should be very durable. |
| 133 | 1 |
| 135 | N/A |
| 136 | Probably not a good idea because of THIEFS!!! but cool idea. |
| 137 | Large volume on the lecture |
| 138 | Don't have any. |
| 139 | |
| 140 | Matlab |
| 141 | No idea... |

| | |
|---|---|
| 142 | I cant think of anything but no one is gonna buy $180 digital pens for class. You might want to wait until their price drops; or negotiate a mass deal so we get them cheap($20) |
| 143 | nothing |
| 145 | none at the moment |
| 146 | I would like to have smaller, longer classes w/ detailed instruction on what and how we are to learn material. I just took my first quiz in 2030, I understood the course material very well up to that point, but because of the time asked to reproduce what I learned was to quick for me, I will now be failing the class. Having many tools to learn material with is fun, but in my reality all these tools do is take up more of my time (setting the tools up, learning how to use them, learning how to fix them when they break, having more room for error, et..)...time I could be using to learn the course material without the distraction of more toys. When an all compter drivin study environment is chosen, especially founded on the use of laptops, there are a huge amount of problems that will result. Nothing can substitute for the good ol' paper and pencil...at least until we can inject experience directly into our brains. |
| 147 | I don't know of one |
| 148 | Consider doing lectures that can be viewed online. That way students can see them at their convenience and see it more than once if needed. |
| 149 | I can't think of one. |
| 150 | Infrared data transfer |
| 151 | Not familiar enough with technology available to answer the question |
| 153 | ? |
| 155 | I can't think of anything right now. |
| 157 | - |
| 161 | None that i know of |
| 162 | - |

| | |
|---|---|
| 163 | none |
| 166 | pc tablets |
| 168 | Video Conferencing |
| 169 | N/A |
| 170 | using PDA's in class, using it for homework, etc |
| 171 | none |
| 172 | none |
| 173 | I don't know much about these different types of technologies. Anything that would allow internet and CD-ROM availabilities in class would be useful |

**Question:** **6. Comments (class note-taking)**

Please let us know if you have any comments on the in-class note-taking technology :

---

**Responses**

| User ID | Response |
|---|---|
| 3 | $180 for a pen to be used in at most a couple of classes is not worth it. |
| 4 | sounds cool |
| 5 | n/a |
| 6 | No comments. |
| 8 | I am not willing to spend money for in-class note-taking technology. |

| | |
|---|---|
| 13 | |
| 14 | no comment |
| 15 | Sounds interesting. |
| 16 | I suppose possibly providing computers in the classroom.....kinda like in room 361 in the ECE building...to help with note-taking. |
| 17 | It is a little boring. |
| 19 | none |
| 20 | N/A |
| 21 | no |
| 22 | nope |
| 24 | ok |
| 25 | Sounds great |
| 26 | Not interested |
| 27 | I like it, I like the video lectures |
| 28 | nope |
| 29 | None. |
| 30 | none |
| 31 | I think it would be a good idea, but I do not fully understand it. |
| 32 | seems more complicated than its worth. this class is allready way too time consuming. |
| 33 | fads |
| 35 | N/A |
| 36 | No |
| 37 | Although I am not that familiar with the digital pen it seems like it is going in the right direction. I had a laptop in high school and it was a huge distraction. For that reason I don't think I can sit in class with a laptop, but with something like the digital |

| | |
|---|---|
| | pen, where there is limited distraction I think would be a good idea. |
| 38 | I'd rather spend $5 on paper and pencil that $1500 on a laptop and some special pen. |
| 40 | What prompted this survey, is it becase of some problem out there or is it just for research purposes? It just seems like if you try to implement this new technology, it just makes students more inefficient, and most of them are going to print out their notes that they take at a later time. There is only so much you can do with technology - why is it that the sale of online books is not very high - because reading stuff just off a computer puts a huge strain on the eyes and makes the reader get tired easier. Don't fix it if it isn't broken. Also, the state of technology of stuff in suggestion is still a lot and most people would back down due to cost, due to how fragile the technology is, how something like a pen could get lost easily, and how students don't want to carry a laptop to all their classes if they are only going to use it in one. |
| 42 | very good idea |
| 43 | none |
| 44 | I heart technology |
| 45 | pen and paper isnt bad i dont like reading from computer screens and writing equations in text is ussually dificult to read... |
| 46 | none |
| 48 | the recorded lectures are very helpful |
| 49 | the only thing I can say, is that more students should attend class. I don't like the idea of mandatory attendance, i.e. PRS systems, and I don't think that this stuff would help. I think action should be taken by teachers to encourage/motivate kids to come to class because I think that it is very important. I understand there is much material that needs to be covered in engineering cirriculums, but time/effort should be made to make class fun. Tech is know for dry lectures and uninteresting professors (not entirely true, partially due to the type of student body), but hell do something. Jokes, demonstrations, hand's on.....Good luck. |

| | |
|---|---|
| 50 | none |
| 51 | - |
| 52 | Not sure exactly what the proposed in-class note-taking technology is. I expect very few students will want to pay $180 to take notes. |
| 53 | ok |
| 55 | Good Idea, make it cost efficient |
| 57 | none |
| 58 | I believe this could be a great service. What would also be nice is, instead of having to log onto a specific website to check course updates, some other form of instant communication such as newsgroups and RSS feeds would be beneficial. Potentially, you could have a Java based cross platform software environment that would authenticate a connection with a centralized server and download and manage all course materials for the current class or multiple classes. Students could then use either digital pens or other interface devices to navigate through the course materials and take either handwritten digitial notes or typed notes. This could also provide some type of peer to peer service for students willing to share ideas and notes. Just some ideas... |
| 59 | none |
| 60 | It would be nice thing to have. |
| 61 | I like the way I take notes. |
| 62 | I have no idea what you are talking about. What does me taking notes (on whatever medium) have to do with any technology that you support. |
| 63 | |
| 65 | |
| 66 | paper and pen is cheaper and for this class probably good enough. i would rather pay more TA's to be available late at night to help for the class. i think that would be the most helpful thing. |
| 68 | Sounds like a good idea if it weren't so much of an added expense. Perhaps an |

| | |
|---|---|
| | alternative could be found to the digital pens. |
| 69 | I think it's a clever idea |
| 70 | nope |
| 72 | note-taking has always been the same for decades and personally I don't think there is anything wrong with good ol' pencil and paper. Why change? |
| 73 | I think taking class notes helps students atleast undertand what is going on. |
| 75 | none |
| 76 | Sounds like a good idea but that it would be difficult for students to use without having been instructed. Perhaps a short amount of class time to teach students how to use it would be useful. |
| 77 | Sounds like a good idea. |
| 78 | N/A |
| 79 | How would we access them? Wouldnt this just lead to people skipping class and relying on other people's notes? |
| 80 | The description of the class note-taking technology is rather sketchy in so far as *how* it would connect all the related materials, however it seems like a outstanding idea. It does seem unlikely to be useful in a Powerpoint presentation driven class where one can, for the most part, already print out the notes ourselves. However, this a is a powerful stride in the direction of engaging students. |
| 81 | no |
| 82 | I do not have much comment. I believe that you if you want to introduce this sort of technology to the classroom, it will ultimately be up to the student to choose to make use of it or not. |
| 83 | no comment |
| 84 | b |
| 85 | As long as it doesn't increase the cost of attending college significantly, it's fine by me. I probably won't be utilizing the technology, but if it helps people learn better, |

| | |
|---|---|
| | you have my permission... |
| 86 | none |
| 87 | It is too expensive, and carrying laptops is not easy for everyone. Some have back to back lectures, and then they have to keep their laptops with them through out the day. |
| 88 | None |
| 89 | not very effective. with the use of slides of instructor like the current techonology, taking note is a very minor part which students should do in traditional way as a way to focus more on lecture. |
| 91 | It seems too expensive to use at this point. I also do not know too much about it and don't know whether it has conveniences or inconveniences. I am not particularly excited about the fact that one day my notes could all be on a computer. I stare at my screen enough without having notes on it. If I did have notes on my computer, I might even be tempted to print them out anyway. |
| 92 | No comments. |
| 93 | I dont think I have any problems right now, b ut new technology cant hurt. |
| 94 | I feel that the maturity of tablet PCs will provide for much greater flexibility in note-taking on laptops, and I feel that a solution using electronic note-taking should incorporate them. |
| 96 | No suggestions. |
| 98 | none |
| 99 | Would you like to pay for it? |
| 100 | Think it is a good idea but too expensive for me |
| 104 | I've read about a highliter that stores and recognizes text that it runs over, that might be useful to noting key points in reading material. |
| 105 | No response. |
| 106 | It seems too expensive for many students, especially those who do not have |

| | |
|---|---|
| | laptops. Students without laptops would be at a disadvantage. |
| 107 | Really, I would be a bigger supporter of the technology if I had the money to use it - however, I think it is a wonderful idea. |
| 108 | this technology will make class attendance mandatory. i want to be able to stay up to date with the material being tought even if i miss a class or am late for one. furthermore, college is already expensive. any convinience that forces students to pay more isn't favored. finally, students managed to learn before without any of this new technology, therefore i don't see it as something that's needed. |
| 110 | I do like the distance learning videos of the lectures online for when i accidentally sleep through a lecture, that's a plus. But paper and pen is fine for my note-taking technology. Here's a tip, use that R&D money to make our books cheaper or provide chipsets/boards for microelectronics labs at discounted prices. |
| 112 | None |
| 113 | Combined with the videos of lectures and availability of lecture slides, I think that would be more than adequate. |
| 115 | Thanks, I will. |
| 116 | No comment |
| 117 | I like the idea, it would be very convenient for organizing purposes. |
| 118 | no comments |
| 121 | NO |
| 122 | none |
| 123 | It's difficult in classes that have equations and proofs like math and physics. If you're tech would make those really easy, I would bring my laptop to class |
| 125 | good job |
| 126 | I personally hate computers and prefer old-fashioned pen-and-paper notes. Lectures and other course resources are already available online. Perhaps i don't fully understand what the phrase "connect those notes with the online lecture material, and |

| | |
|---|---|
| | also connect those notes with other resources" means exactly, and therefore i don't see why it would benefit me at all. It just seems like this technology would give me more electronics to deal with and more hardware to lug around campus. And after tuition, i can barely afford groceries, so a Logitech Digital Pen is out of the question. |
| 127 | NO |
| 128 | none |
| 129 | Ok |
| 130 | Would be a good idea if it were cheaper for the students. The digital pen is expensive for a students tight budget. |
| 131 | none |
| 132 | speech recognition and speech writer (recognize speech and type it in???) |
| 133 | 1 |
| 135 | The digital pens are pretty expensive. If applicable, a cheaper digital pen should be used. Or some type of discount should be available to the students. |
| 136 | This will not work...too expensive...wait until it becomes cheaper. |
| 137 | It is very great. |
| 138 | The note-taking technology is a brilliant idea, but the price for each student would not be possible. Students are struggling to purchase materials & books that are required for class, and to have to pay for the pins would not help those cost. Laptops purchase would be an investment that is needed in the field of Engineering, so most students who don't have one would probably be more apt to purchase one. |
| 139 | |
| 140 | No comments |
| 141 | While many students already have laptops and/or a pen mouse, this does not mean that those that do not already have them are willing to spend so much money in order to use such technology, when pencil and paper still work fine. |
| 142 | see question 5 |

| | |
|---|---|
| 143 | the class right now is fine. |
| 145 | I'm interested in knowing more details so I can answer these survey questions properly |
| 146 | In my opinion the lecture periods, recitation periods and most of the labs are not worth the effort. I realize that this school and perhaps many buisnesses like the use of matlab to simplify the production of results, aside from learning to do this, I have place no value in spending time doing labs. The recitation period and lecture simply take time away from me that I could be using to study the book for this class. Simply studying the book, and going to a 1-1 session w/ a professor or tutor would be all I need to do well at this school. The lecture slides are good for streamlining what is pertenent about the material I'm to learn, but it seems that I must maintain the expected norm of the group by going to class and suffer with the group at the expense of limited staff and limited time. |
| 147 | No comment |
| 148 | I think it is a good idea but very expensive. Please keep in mind that it is expensive to attend GT and its difficult to do extras like buying pens for $180. |
| 149 | no comments. |
| 150 | none |
| 151 | The technology would a substantial benefit to students, espicailly if it could be used with a desk-top computer at a later time other than lecture. |
| 152 | Please do not use powerpoint slides. |
| 155 | no comments. |
| 157 | - |
| 161 | Other than posted powerpoint presentations and notes, i dont know |
| 162 | - |
| 163 | none |
| 166 | none |

| | |
|---|---|
| 168 | I think digital pens will lead to some messy not taking as the surface of the monitor is very slick. It might be a good idea though. |
| 169 | SEEMS TO BE GOOD |
| 170 | N/A |
| 172 | not needed |
| 173 | These are good ideas, but as it is, books and laptops and PRS devices are expensive. If it were possible to include these services without an extra fee, the uses of them in classrooms would be more widely accepted by students. |

# Appendix D

# NoteNexus Help

This NoteNexus help file was written by Chris Scheibe, the developer of the NoteNexus software.

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## [1] **How do I open lecture files?**

To open your professors lecture files, press the far left button on the upper menu as seen in figure 1-1.

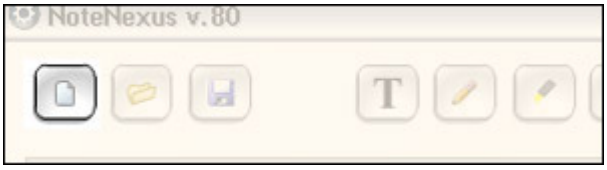


figure 1-1.

Navigate to the default install directory if it doesn't automatically start you there. The default is "C:\Program Files\NoteNexus\". You should see a folder labeled "Lectures" as in figure 1-2.

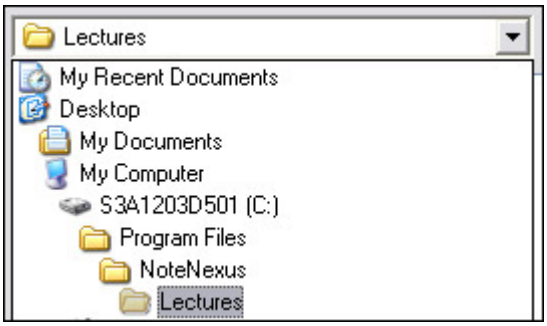


figure 1-2.

You should see a list of all the available lectures like the figure below.

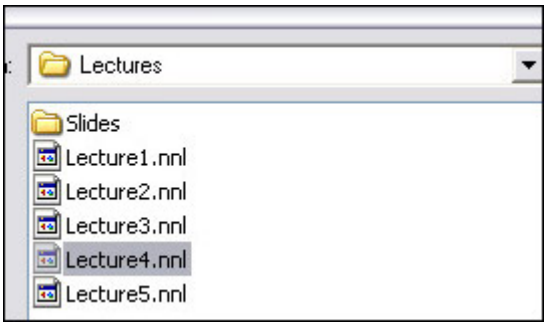


figure 1-3.

Pressing the "Open" button should load the lecture slides once you've selected a lecture.

---

[2] **How/where do I save annotations once I've made them?**

To save your pencil marks, text and hilites, press the diskette icon in the upper left menu. It should be the third from the left, as seen below.


figure 2-1.

Navigate to the default install directory if it doesn't automatically start you there. The default is "C:\Program Files\NoteNexus\". You should see a folder labeled "Saved Annotations" as in figure 2-2.

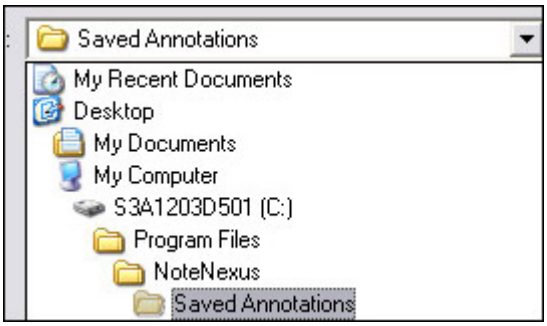


figure 2-2.

Give your file a meaningful name and press "Open" to finish the dialog. It is recommended to save all your annotations together in this folder. You also have the option of saving them elsewhere. We provide this folder as a convenience to you.

---

[3] **How do I open saved annotation files?**

To open your saved annotation files, press the folder icon in the upper left menu. It should be the second to the left, as seen in figure 6.


figure 3-1.

Navigate to the default install directory if it doesn't automatically start you there. The default is "C:\Program Files\NoteNexus\". You should see a folder labeled "Saved Annotations" as in figure 3-2.

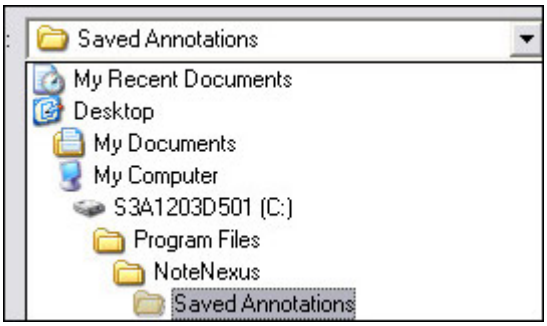


figure 3-2.

You should see a list of your saved files. Pressing "Open" will complete the dialog.

---

[4] **What are the shortcut keys?**

**Ctrl-n** - Open a lecture file

**Ctrl-o** – Open a saved annotation file

**Ctrl-s** – Save your current file

**Ctrl-k** – Toggle view between dynamic content and notepad

**Ctrl-n** – Next slide

**Ctrl-p** – Previous Slide

**Ctrl-t** – Text insert mode

**Ctrl-d** – Drawing mode (pencil)

**Ctrl-h** – Hilite mode

**Ctrl-c** – "nuclear" erase, wipes the screen (something more useful coming soon)

**F1** – This help file

**Esc** – Quits

---

[5] **The Text tool is acting weird, what's up?**

The Text tool works on a "one-up" basis. That means that each time you engage the text tool and start typing, you'll need to engage it again (ctrl-t or press the T box) to create a new text box. We promise this isn't to aggravate you ☺

---

[6] **What's the chain link and what does it do?**

NoteNexus gives you the ability to "link" your notepad and the slides. Some prefer to have their notepad turn the page every time the slide changes, other want to have independent control over their notepad. We are giving you the choice. Below you can see the link engaged (figure 6-1) and disengaged (figure 6-2). Feel free to experiment and find out what is most comfortable to you.

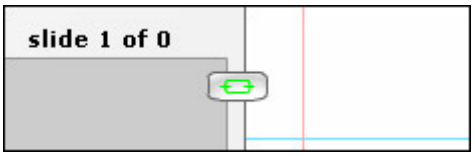


figure 6-1.

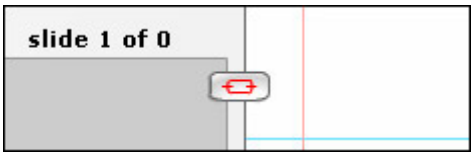


figure 6-2.

# APPENDIX E

## NoteNexus Focus Group Technology Survey

The following survey was given to the two focus groups. A total of 12 students participated in the focus groups. One student did not take the survey. The same survey was also made available to the students who adopted the NoteNexus tool during the Open Deployment. Four of the 10 adopters responded.

1. Please enter your ID (text box)
2. Do you take notes in class?
    a. Yes, I take a lot of notes
    b. Yes, I take a few notes each class
    c. I occasionally take notes
    d. I usually don't take many notes
    e. No, I don't take any notes at all
3. How often do you use your notes?
    a. I review my notes regularly (once a week or more)
    b. I occasionally review my notes
    c. I only review my notes to prepare for a test or other assignment
    d. I rarely review my notes
    e. I never review my notes
4. How often do you use your notes after a course is over? (Text Box)
5. Please explain. (Text Box)
6. Do you use online resources when you study?
    a. All the time if available
    b. Some of the time
    c. Occasionally
    d. Not very often
    e. No
7. How useful do you think this technology will be for you?
    a. Very Useful
    b. Useful
    c. Maybe Useful
    d. Not Very Useful
    e. Useless
8. How would you rate the interface's "ease of use"?
    a. Excellent
    b. Good
    c. Passable
    d. Poor
    e. Horrible

9. Does the interface have the tools and features necessary to support your note taking activities?
    a. Yes
    b. No
10. Please explain. (Text Box)

11. If the technology were available for your use in class, would you use it?
    a. Absolutely Yes
    b. Yes
    c. Maybe
    d. No
    e. Absolutely No
12. Please explain. (Text Box)
13. If the technology were available outside of class, how would you imagine using it"? (Text Box)
14. Do you think this technology will change the way you take notes?
    a. Yes
    b. No
15. Please explain. (Text Box)
16. Do you think this technology will change the way you study?
    a. Yes
    b. No
17. Please explain. (Text Box)
18. Do you think this technology will change the way you use online resources?
    a. Yes
    b. No
19. Please share your ideas for future development. (i.e. changes, additions, other technologies, etc.) (Text Box)

| ID | Do you take notes in class? | How often do you use your notes? | How often do you use your notes after a course is over? | Please explain. | Do you use online resources when you study? | How useful do you think this technology will be for you? | How would you rate the interface's "ease of use"? |
|---|---|---|---|---|---|---|---|
| 1 | a | c | when needed | if another course brings up a past subject, i review my notes to bring the information back to memory | b | c | c |
| 2 | b | a | few times | if there is a problem that I run across and I know there is a simpler way to solve it then I will refer back to the old note from a previous class to figure it out | b | c | b |
| 3 | b | c | Occasionally | If a friend has a question, and the answer's at the back of my<br><br>head, and I'm pretty sure that it's in my notes, and not online. | a | c | c |
| 4 | a | c | Look over for test in Hw | I take notes because I remeber what I write, as long as I fully understand. Sometimes I will take notes that I don't understand and either apply them to hw or try to reinterpret them | c | c | c |

| ID | Does the interface have the tools and features to support your note taking activities? | Please explain. | If the technology were available for your use in class, would you use it? | Please explain. | If the technology were available outside of class, how would you imagine using it? |
|---|---|---|---|---|---|
| 1 | a | | c | | after i get a job as a project manager to keep up with conferences i attend |
| 2 | a | Everything was provided for so that it was easy to take the notes. | b | It is easier for me to type instead of writing everything down, except in math. | Simply for class projects and study aids most likely. |
| 3 | a | Can't re-edit notes after starting new notes. Content in slides<br><br>can't be selected. Drawing tool could be smoother. Keyboard shortcuts<br><br>should be available for above buttons. Erase button erases everything<br><br>in both pages: could be more selective. | c | Probably wouldn't draw/write on the slides to much, use the<br><br>notebook option more often. Very similar to Powerpoint Notes option<br><br>when printing. I probably wouldn't use the keyword engine because I<br><br>might loose track of whatever the lecturer is saying. | Outside of class, I probably wouldn't use it much.<br><br>That is the time I would probably use it's Keyword feature, similar to<br><br>using google on the slides. |
| 4 | b | When i write I can include handwrittem shortcuts like => and the three dots meaning therfore. Its cumbersome to write these shortcuts on paper. I also tend to make dwgs of stuff that is talked about but not written or drawn. I never use the lecture slides | b | I would use in conjunction with my notebook | to review notes |

| ID | Do you think that this technology will change the way you take notes? | Please explain. | Do you think this technology will change the way you study? | Please explain. | Do you think this technology will change the way you use online resources? | Please share your ideas for future development. (i.e. change, additions, other technologies, etc.) |
|---|---|---|---|---|---|---|
| 1 | b | i already use a tablet pc | b | | b | |
| 2 | a | Well, it would make it easier to copy and paste the notes if a friend misses the class and save on paper | b | I have to do a lot of practice work to study or else I would only know the concepts so my studying habits would remain the same. | a | if one of the options under the keywords is something that will help me, then I will definately use it |
| 3 | b | I prefer to use hardcopy notes that I can take anywhere unless I'd<br><br>use a PDA or Tablet or something. | b | Study-wise, If I had to go over the slides anyway, I may make<br><br>small notes on it or highlight important parts. | a | Modifying the user interface to be smoother would be great. The<br><br>textboxes, erasing tools, more options, and shortcuts for buttons. The<br><br>slides on the bottom shouldn't move automatically, or at least be<br><br>animated when they do so. Re-editting could also be |
| 4 | b | Its still faster to write notes by hand. Problem is that I can't read my handwirttin | a | Maybe i'll look at lecture slides or even go over lectures before and after class | a | might use slides |

| ID | Do you take notes in class? | How often do you use your notes? | How often do you use your notes after a course is over? | Please explain. | Do you use online resources when you study? | How useful do you think this technology will be for you? | How would you rate the interface's "ease of use"? |
|---|---|---|---|---|---|---|---|
| | | | | | | | |
| 5 | b | b | Rarely | Its only if that class topic comes up in some future class that I need to refer to the previous notes. Otherwise they are mostly thrown away after the semester ends. | a | b | b |
| 6 | b | a | variable | Some important classes like calc and ECE core classes I will refer to the notes to refresh my memory on what was done. But mainly I look for specifics in my notes | b | a | c |
| 7 | c | d | almost never | For this class it may be different, since DSP is a keystone to ECE. However ine past there just wasn't any need or desire. Usually just to find some peice of contact info I jotted down with notes. But during class, I have difficultly keeping pace with the | a | b | d |
| 8 | c | c | sometimes | If I need to review some concepts, particularly math. | a | b | d |

| ID | Does the interface have the tools and features to support your note taking activities? | Please explain. | If the technology were available for your use in class, would you use it? | Please explain. | If the technology were available outside of class, how would you imagine using it? |
|---|---|---|---|---|---|
| | | | | | |
| 5 | a | It provides the user with all the basic needs while taking the notes. However, certain areas like the slides and note pad can be integrated in a better way for allowing user a better accessibilty. | b | It seems like a good idean to take notes without getting distracted continuously ans so it would certainly be popular. | Maybe we could use it offices, during meetings where rapid note taking is required. It may also be used daily to just amke notes for appointments and keep memos. |
| 6 | a | Yes all the features necessary are there but acessing them quickly in a lecture is a concern. | b | My concern is how fast I can use the interface in a lecture. If I am able to use the software fast enough to keep up I would definitly prefer this method. | Both for preparing for class and revision after class. The keyword search feature is really useful outside of class but i cannot imagine using it in class. The full use of this software must be out of class. |
| 7 | a | I heavily use short cuts. Needing to use my mouse every couple of seconds wastes time. As since I will most likely using a touch pad, even more time will be wasted. I found the notepad to be odd. I could choose to type of have lines, which could be a litt | c | I might be just as well off with ppt slides and notepad. CLearly the keyword function is amazing. However if you could import any rtf or txt file, it would greatly reduce my need for the technology as a complete package. The interface needs to be improved | Since it is the keyword function that I like the most, some database would have to be available for making this program worthwhile outside of class. Otherwise I would have PowerPoint, notepad, and a browser with google. |
| 8 | b | This needs stationary text fields; needs some kind of symbol input - preferably some kind of LaTex implementation; current slide needs to be more clearly outlined in the preview panel; | b | | It could be probably be used in any presentational setting, such as conferences/business meetings. |

| ID | Do you think that this technology will change the way you take notes? | Please explain. | Do you think this technology will change the way you study? | Please explain. | Do you think this technology will change the way you use online resources? | Please share your ideas for future development. (i.e. change, additions, other technologies, etc.) |
|---|---|---|---|---|---|---|
| | | | | | | |
| 5 | a | It will certainly allow me to concentrate more in the class and thereby allow better hearing of what the professor has to say. | a | More notes means more data available for study and this will certainly help during exam preparations. | b | More interactive and faster processing would help. Allow access to other applications so that rapid transitions can take place. |
| 6 | a | Though I currently take notes on paper I would definitly switch if I could integrate my notes with the lecture slides. The ability to organize notes on a computer would be extreamly useful. Papers get lost, they are bulky to store and are generally less p | a | If my notes are on the computer then I would definitely study more on the computer. | b | I already use online resources extensively so I dont forsee any increase in that. |
| 7 | b | I imagine that I will still have difficulty keeping up in class. However, it facilitate the sharing of notes. So if there is one good person the class, I could see how they took notes and perhaps remember some points in the lecture. | a | By have the keyword database at hand, everything I would need to study would be at hand. | a | 1) Keyboard shortcutes- at the very least to change slides and switch from slides to notes<br><br>2) import an rtf to the notepad in order to take advantage of the keywork feature |
| 8 | a | I usually don't take a lot notes, this would enable more centralized/sane note taking. | a | more to study from | a | kbd shortcuts! ctrl-[string] for symbol input and open/close, alt-left and alt-right for changing slides, etc. This shouldn't require pushing around a rodent whatsoever, particularly because laptop mice are painful. |

| *ID* | *Do you take notes in class?* | *How often do you use your notes?* | *How often do you use your notes after a course is over?* | *Please explain.* | *Do you use online resources when you study?* | *How useful do you think this technology will be for you?* | *How would you rate the interface's "ease of use"?* |
|---|---|---|---|---|---|---|---|
| 9 | a | c | rarely, if ever | If I remember that I went over something in a previous class and have the notes readily available, I will look them over. This usually only happens if I can find the section of notes easily and/or my current resource (maybe the book for the current class | b | c | c |
| 10 | b | b | Not Often | only when i need them for another class | a | a | b |
| 11 | a | | none | | a | c | c |

| ID | Does the interface have the tools and features to support your note taking activities? | Please explain. | If the technology were available for your use in class, would you use it? | Please explain. | If the technology were available outside of class, how would you imagine using it? |
|---|---|---|---|---|---|
| 9 | b | If I'm taking notes for a math class or something with equations, this interface would not be acceptable. It seems too difficult to type in equations, and the pencil tool is not easy to use. I think this interface would be helpful with a stylus or somet | d | At this point, no, I would prefer to take notes by hand. Maybe with a stylus feature I would use it but I would not use it as it is now - the way I used it for this test. It's too hard to manuever inside the interface. There really does need to be shor | I might use this for business purposes, maybe listening to a collegue's presentation. I might also use this to take notes in any professional setting. I could imagine a nurse using this to take notes on a patient and then later, having the notes transla |
| 10 | a | the best part is when you enter keywords and have all the matches appear from labs, book, cd, etc.... | a | I usually bring my laptop most of the days to school, and I usually take notes on the printouts. | i woiuld use it when watching the online videos. |
| 11 | b | I have a rather advanced system, but occasionally it would freeze my system and if I didn't save my notes constantly I would lose information. I found it too difficult to manage and it kept me from really paying attention in class. | c | | |

| ID | Do you think that this technology will change the way you take notes? | Please explain. | Do you think this technology will change the way you study? | Please explain. | Do you think this technology will change the way you use online resources? | Please share your ideas for future development. (i.e. change, additions, other technologies, etc.) |
|---|---|---|---|---|---|---|
| | | | | | | |
| 9 | a | Eventually, I'm sure something like this be the way to take notes. It's beneficial because it eliminates the need for printing so much and wasting paper. I hope to see this interface become like writing notes on paper, but more like a dry erase board | a | Eventually, if it replaces paper, it will change the way I study. I will still probably keep reviewing by doing practice problems and reading from the textbook and lecture slides but if I can do all that on a notepad/stylus kind of thing I would opt for | b | An easy-to-use equation editor is a must. It must be fast to input equations. If there isn't an equation editor that is fast enough/easy to use, then I would say that using a stylus/notepad thing is a must.<br><br>The pencil feature isn't precise. |
| 10 | a | I would be more motivated to take notes. For example my noted would be stored in a better place and won't loose them easily. | a | it would take me less time to go over basic concepts for example. | a | Maybe a little more help on the labs and prelab quizez, as far as answering questions and having some explanation to it. |
| 11 | b | | b | | b | |

The same survey was also offered to students who adopted NoteNexus during the Summer 2005 deployment.

| *ID* | *Do you take notes in class?* | *How often do you use your notes?* | *How often do you use your notes after a course is over?* | *Please explain.* | *Do you use online resources when you study?* | *How useful do you think this technology will be for you?* | *How would you rate the interface's "ease of use"?* |
|---|---|---|---|---|---|---|---|
| 1 | d | e | never | In other classes notes are very helpful but in ECE 2025, notes have proven not to be very helpful. | a | a | b |
| 2 | c | c | hardly ever | | b | c | b |
| 3 | c | c | rarely | Only if I need to relearn material. | b | a | c |
| 4 | d | e | never | They usually do not help me much in preparing for tests. I mainly just try to read the text and work problems. | a | a | b |

| ID | Does the interface have the tools and features to support your note taking activities? | Please explain. | If the technology were available for your use in class, would you use it? | Please explain. | If the technology were available outside of class, how would you imagine using it? |
|---|---|---|---|---|---|
| 1 | a | | c | | to watch lecture videos |
| 2 | a | | c | | |
| 3 | a | It is absolutely wonderful. | b | If may be difficult to take notes and study at the same time. | At home on my PC |
| 4 | a | It would be faster to take notes this way in class than it is to take notes with pen and paper; I can type faster than I can write. | b | I might review my notes if I took them this way. | I have no idea. |

| ID | Do you think that this technology will change the way you take notes? | Please explain. | Do you think this technology will change the way you study? | Please explain. | Do you think this technology will change the way you use online resources? | Please share your ideas for future development. (i.e. change, additions, other technologies, etc.) |
|---|---|---|---|---|---|---|
| | | | | | | |
| 1 | a | I think I might actually start taking notes again. | a | I can watch the lectures over again and catch any concepts that I might have missed when attending lecture | a | make the searches for keywords a little more specific. |
| 2 | b | I was just using it to search old assignments... | | | | |
| 3 | a | I will work more efficiently and can find and retrieve things otherwise difficult to do. | a | See above. | a | Continue improving the interface, if possible. Thanks. |
| 4 | a | I would actually take notes and maybe read them later. | a | I might actually read my notes. | a | I really found it helpful to watch the lecture movies. |

# APPENDIX F

## Student Comments from Focus Group Discussion

- Keyboard shortcuts are needed
- Hell to go point to change pointers
- How do we do math formulas?
- Slides & notes should be joined
- Separated thing [moving notes and slides separately] not working
- Keyword feature is great
- Yes, keyword feature is nice
- Keywords are good, also the pen-based writing
- Need the ability to move text
- Text doesn't scroll correctly, end up with a black hole of text
- Yeah, need to be able to move lines as well
- Get rid of the nuclear erase!
- I didn't know what happened, all my marks disappeared
- Need text auto-formatting
- No, need to be able to control formatting of text better
- Hard to shift between things [clarified: from pen to text input]
- Problem with note text being a one-up, should always be on
- Pen input is really necessary
- Good for history notes. Support is needed for equations
- How can we translate equations?

- Too hard to write equations with the pen.
- Yeah, not like paper
- Without shortcuts, it’s hard to keep up with lecture
- Why can’t we cut & paste?
- I need a highlighter. [yeah, from rest of group]

# APPENDIX G

## Deployment Survey and Discussion Data

The following survey was given to the seven participants in the Limited Deployment Study. The questions are also given to all of the students in ECE 2025 at the end of the semester. The deployment participants were given the survey before the beginning of the study and at the end. There was also a brief group discussion at the end of the study, following the second survey.

1) The demos on the SP-First CDROM/Web page helped me understand the concepts being demonstrated.

a. Strongly agree
b. Agree
c. Do not agree or disagree
d. Disagree
e. Strongly disagree
f. I did not view them

2) I use the homework solutions (i.e., "word") on the web page.

a. Very often
b. Often
c. Occasionally
d. Seldom
e. Never

3) I use the sample problems and solutions on the SP-First CDROM.

a. Very often
b. Often
c. Occasionally
d. Seldom
e. Never

4) I read the FAQ/Help documents on the web page.

a. I thoroughly read them
b. I read them
c. I read some of them
d. I glanced at them
e. Help documents????

5) I use the web page to get homework and lab assignments.
   a. Very often
   b. Often
   c. Occasionally
   d. Seldom
   e. Never

6) I use the lecture slides posted on Web-CT
   a. Always
   b. Often
   c. About half the time
   d. Every once in a while
   e. Never

7) Do you take notes in class ?
   a. Yes, I take a lot of notes
   b. Yes, I take a few notes each class
   c. I occasionally take notes
   d. I usually don't take many notes
   e. No, I don't take any notes at all

8) I review my class notes (hand-written)
   a. Regularly (once a week or more)
   b. Occasionally
   c. To prepare for a test or other assignment
   d. Rarely
   e. Never

9) How often do you use your class notes (hand-written) after a course is over ?
   a. Very often
   b. Often
   c. Not very often
   d. Never
   e. I do not keep my notes

10) If your answer to previous question was choice a,b or c, please explain the way it was used (text box)

11) I view computer demos used in class later via the web or the SP-First CDROM.

a. Almost always
b. Frequently
c. Occasionally
d. Seldom
e. Never

12) Some of the lectures were recorded and converted to a streaming format for viewing over the Web. Have you used these?

a. Yes, often
b. Yes, but only a few times
c. No
d. Didn't know they were available
e. Tried to view them, but always had trouble with the server/network or with the player (e.g., Quicktime or Real Player)

Survey results from beginning of deployment study.

| ID | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PS | e | d | e | e | a | b | e | e | d | | e | b |
| TG | b | d | c | e | a | c | b | c | c | To refresh my understanding of a topic that is covered in a subsequent class. | c | e |
| SK | e | b | e | c | a | a | b | c | c | If I read the content of the course again later I view the notes instead of using texts. | c | a |
| MH | b | a | a | b | a | b | b | b | d | | b | b |
| VS | e | a | e | d | a | a | d | d | d | | b | a |
| GJ | b | a | b | c | a | a | b | b | c | Sometimes to refer to material previously studied or to review a concept that may be used in the current class | b | c |
| PM | e | b | e | e | a | e | a | b | b | I've used notes on interships and in classes that are built on that class. | e | d |

Survey results after the deployment study.

| ID | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PS | f | d | e | e | a | b | c | d | d | | e | b |
| TG | b | a | c | e | a | a | b | c | c | | c | e |
| SK | | | | | | | | | | | | |
| MH | b | a | b | d | a | b | b | c | c | If I took a subsequent class about DSP | c | c |
| VS | f | a | d | d | a | a | c | d | c | Since I was a part of this survey, I did review my notes but otherwise I don't take notes | d | a |
| GJ | b | c | b | c | a | b | a | b | c | | b | c |
| PM | f | b | e | b | a | b | a | b | e | | e | d |

Student comments from the post-study survey.

| ID | |
|---|---|
| PS | The writing/notes section has a very low sampling rate, and therefore, the writing needs to be big. |
| TG | I will confess that I don't use NoteNexus very much as I find that simply reading the on-line lecture and homework is just as effective. |
| SK | |
| MH | The software was pretty good. There were a few issues with the program. For one, I am a very keyboard oriented person and thus, when I am typing, I find it easy to use the arrows to go bettween words. In this software, the arrow keys changes slides. Additionally, I didn't like the way the text tool worked. I feel that if I simply clicked the text box on the right, it could automatically start a cursor there. |
| VS | The software had a comfortable layout. But I was confused about which file I was opening or saving. It was also hard to record equations as it hasn't been incoporated yet. Save the file automatically! Make the lecture file organization better. For example: Lecture 24 folder has original nnl file and save .nna file. Increase sampling rate. |
| GJ | Good use of oclors - Must have keyboard shortcuts - Should have direction keys - The clicking should be more prompt - must be able to highlight - must be able to use auto-words - more text fonts should be used - the program will surely improve class attendence & make it fun. |
| PM | I initially thought that typing my notes was slower than writing them, but found that typing my notes was just as fast. Notice a screen lag when typing. Might be me system. I have a Compaq Presario laptop. Also can the arrow keys be switched to flow through text. |

Student comments and observations from post-study discussion

Text did not keep up well with typing

Any chance I can get it for the rest of my classes?

The save and open functions are confusing. Auto-save of the .nna file would be really nice. Not always sure that my work has been saved.

Clicking on the notebook pane should automatically open a text input box. Having to use the mouse to select the T tool then click on the notebook was to slow. Distracted from the lecture and note taking.

The sampling rate is too low. Hard to form equations. There is no support for equations. Just wrote them on paper instead. Need to get equations in if you are going to use it for engineering.

Asked about how the tool affected their note-taking: all expressed an increase in note taking as well as an increase in review of notes.

# APPENDIX H

## IRB Protocols

**Protocol:** H04214
**Title**: Student technology survey for in class note taking.
**Description:** Students will be asked to complete an anonymous, online survey asking six questions. The first questions asks for permission to use the data. Only data provided with consent will be used. We are requesting a waiver of consent documentation since such documentation would be the only source of identification in the data set.

**Protocol:** H04215
**Title**: Analysis of Student Use of Online Content in ECE 2025
**Description:** In this work, we will look at web server logs and WebCT logs in order to further our understanding of how students use online content. In this protocol, we are requesting permission to review the past six years of log data. These logs are generated as part of the operating procedures of the ECE computer support group and OIT. We will also look at aggregate population data similar to what is used for academic assessment. This includes population information regarding gender, major, and course and cumulative grades. No individual identification data will be used in this study.

**Protocol:** H04258
**Title**: Evaluation of Learning Technologies
**Description:** The purpose of this study is to acquire student feedback on learning technologies being developed or evaluated at Georgia Tech. The information gathered in this study will help researchers and developers better understand the impact of a learning technology and how it will be used, prior to full deployment of that technology.
Each participant will be asked to attend one (1) focus group session. During that session, they will receive a 15 minute introduction to the technology. This will be followed by a 20 minute period of using the technology themselves. After using the technology, they will be asked to complete a survey that will take approximately 15 minutes. The session will end with a 30 minute group discussion. The total session time will be limited to 90 minutes. Their identity will not be associated with their survey answers or with any comments made during the group discussion. Annotations of their responses will follow the format of: Session#:Subject#. Where Session# refers to which session they are in and Subject# is assigned randomly.
The group discussion will focus on features of the software, how viable the technology is for deployment, and the general concept of connecting notes to online resources.

**Protocol:** Amendment #1 for H04258
**Title**: Evaluation of Learning Technologies
**Change in Procedures:** Willing participants will be allowed to take the prototype technology with them for use in ECE 2025. They will then be asked to participate in a second focus group discussion. The discussion will be conducted in the same manner as the current protocol. The software will log their use, and they will be asked to upload the log files at the end of their trail period (approximately six weeks). If a student chooses to opt out, their data will not be included. The upload is controlled by the student. The risks to participants does not change significantly. There may be increased benefits from the use of the software. The software being studied allows students to take notes on their laptop, either as text or via pen tablet based on the technology of the laptop. Course keywords are then identified in those notes and structured links are presented to the students. All information logged about the student use of the technology is stored on the student system. They will be requested to upload those log files as the study progresses. If they choose to opt out of the study, their previous uploads will be removed from the system. The links are directions to online content that is already available to the students. The goal of the study is to determine if targeted links, embedded in student notes, improves the use and efficacy of online academic content.

**Protocol:** H05065
**Title**: Impact of the enhanced note-taking support on student performance.
**Description:** In this research project, we will compare the performance of students using the enhanced note taking technology against the aggregate population data for the course that they are in. We will be conducting this study in the ECE 2025 Digital Signal Processing course. Students will attend a brief initial meeting to sign consent forms and load the software on their systems. A final meeting will be held to get feedback from the students.

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