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# Developing the Ultimate Course Search Tool: A Pilot Study

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## ABSTRACT

Security IT professionals are in high demand, yet university computer science programs have low retention rates. In an effort to increase retention of these millennial students, universities should provide interactive, individualized, student controlled learning. Ultimate Course Search (UCS) was developed to provide an interactive content search learning tool for students. A pilot study was conducted to determine attrition rates, how students use UCS and integrate learning preferences into studying, and the learning outcomes. The retention rates of the experimental class were much higher than that of the control class. Student comments of UCS are discussed.

*Keywords: technology, online learning, iSECURE, learning preferences, learning styles*

As computers, smart phones and other devices continue to be the targets of malware and other security issues, it is imperative that more knowledgeable security professionals move into the workforce. However there is a high attrition rate in university computer science programs (Beaubouef & Mason, 2005; Chen & Soldner, 2013). Traditional university courses are not meeting the needs of Millennial students who are technologically savvy and are requesting more control over their learning, individualized education, and schedule flexibility (Patota, Schwarts, & Schwartz, 2007; Shih & Allen, 2007). Ultimate Course Search (UCS) is a learning tool that was designed to help students access course content while individualizing their choice of materials. Currently in Beta form, this pilot study assessed the student use of UCS, how learning preferences information was received by the students, and learning outcomes of students in control and experimental groups.

## MILLENIAL STUDENT LEARNING

As a specific generation, millennial students have characteristics that continue to challenge traditional learning methods. Millennial students are able to multitask, may have short attention spans, tend to be visual learners, and tend to bore easily (Elam, Stratton & Gibson, 2007; Howe & Strauss, 2000; Johnson & Lopes, 2008; Shih & Allen, 2007). Thus traditional lecture courses are frustrating for these technology savvy learners (Shih & Allen, 2007). Expecting instant gratification (Patota, Schwarts, & Schwartz, 2007), and flexibility (Bracy, Bevill, & Roach, 2010), millennials are often frustrated by the lack of control they have over learning environments (Patota, Schwarts, & Schwartz, 2007). In addition, millennial students' lack of self-reflection skills (Elam, Stratton & Gibson, 2007) coupled with an expectation to succeed, create learning difficulties because these students lack insight into their own knowledge base. Bracy, Bevill and Roach (2010) believe that adding a variety of technology and delivery options of course content while enabling students to be flexible in their learning would help millennial students feel empowered and create a successful learning environment.

According to Chen (2003), the most successful learning activities in a course should be developed from ordinary practices and tools of the culture and developed to help construct knowledge multiple times using a variety of methods and contexts. Since millennial students consider technology as part of their current cultural norms, it is important to use technology in creative and encompassing ways to help students build their knowledge base. If universities want to increase retention rates in computer science majors, learning tools should be developed that address the needs of millennial students.

## ULTIMATE COURSE SEARCH

Ultimate Course Search is a learning tool that searches all electronic course materials, including videos, and creates a result list categorized by type of material and in order of relevancy. Since millennial students tend to lack self-reflection about their learning (Elam, Stratton & Gibson, 2007), individual learning preference information is assessed and provided to the students. Learning preference information and explanations are provided to the students both in verbal, written and video podcast forms. The intention of this information is to help students determine specific materials that will enhance their studying style. When students want to learn more about a subject, they can instantly search the course materials to find appropriate learning items. The flexibility in learning can help students feel empowered and successful, as they have the flexibility (Bracy, Bevill, & Roach, 2010) and control (Patota, Schwarts, & Schwartz, 2007) of their learning they tend to prefer. Students would be able to learn information multiple times in a variety of ways, utilizing their multitasking abilities (Shih & Allen, 2007), by choosing to watch a specific point in the video lecture, read a few pages in the textbook, or review slides in the PowerPoint presentations. When students encounter a term or topic they are unfamiliar with, UCS can be used to search for information to fill the knowledge gap, and then the students can continue studying. This multitasking can help students stay focused as they move back and forth between their current and past knowledge base instantly. In addition, UCS helps students determine what materials are in the course content and where these materials are located, reducing the feeling of being "lost" in the course that can contribute to higher attrition rates (Morris & Finnegan, 2008). As a course tool, UCS can help students become more familiar with the course itself, with specific material, or with specific technologies used within a course. This ability to change the overall environment of a learning management system can provide students with the feeling of control and flexibility they are seeking.

## USING ULTIMATE COURSE SEARCH

UCS is a tool that indexes all electronic course material including e-textbooks, PowerPoint presentations, and video podcasts. The information available to the students is currently categorized into tabs for slide/video, textbook, and ontology searches. Students input search terms to find related course materials. For example, if a student in a security course searches for the term 'attack', and clicks on the slide/video tab, all of the PowerPoint presentations and videos related to the term are displayed in order of relevance (Figure 1). The student is then able to click on each result item to see the specific PowerPoint or video slide. When the film icon is clicked, the student can also watch the video, beginning at that point where the sought material is discussed. In the 'textbook' tab students can choose a search result and that page of the textbook appears onscreen (Figure 2). In addition, the ontology tab shows all related terms in order of relevance. The student can then click on a related term, and view the search results in the slide/video tab and the textbook tab (Figure 3).

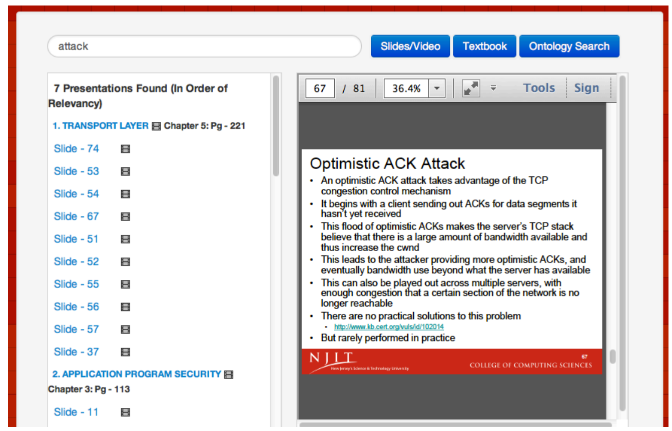


**Figure 1. UCS PowerPoint and Podcast search.**

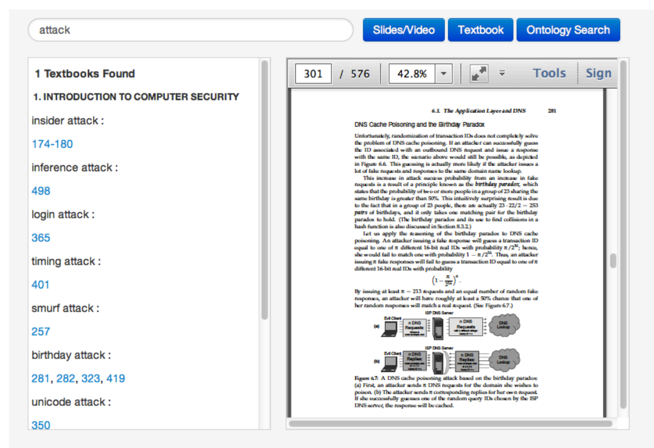


**Figure 2. UCS Textbook search.**

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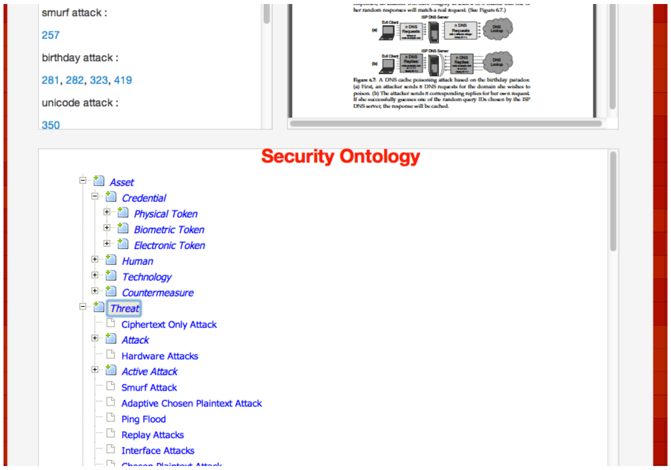


**Figure 3. UCS ontology search results.**

The ability to search for specific course material enables the student to individualize learning, as well as focus studying time. Rather than manually searching through video, students are able to access the video at the exact point the search term is introduced. Since textbook indexes are often lacking in detail, students are able to search the entire textbook for specific terms that might not be listed in the index.

## RESEARCH METHODS

### Research Questions

This pilot study was developed to determine educational outcomes, usability, and specific feedback for improvements of the beta version of UCS. The research was focused on student outcomes and the use of the Tool as a whole. UCS is a package, and therefore it was decided not to separate distinct parts (textbook, videos) or to provide information on each piece. There were four research questions developed for this study.

1. Is there a statistically significant difference in post-test and final exam outcomes between the control and experimental groups?
2. Is there a difference in attrition between the control and experimental classes?
3. How did the students utilize the tool?
4. How did the students utilize the learning preferences information?

### Method

In this pilot study, investigators utilized a quasi-experimental mixed method design to determine the initial effectiveness of the tool, and changes needed to increase usability of the beta version of UCS. IRB approval was secured from two institutions as the researchers are from a different university than the data collection site. The course chosen for the research was titled "Fundamentals of Network Security" an undergraduate introduction to security course for computer science students. This course was chosen due to its introductory nature and high attrition rate. Three sections of the course were utilized for research – two were control groups, and one was experimental. The sections of the course were taught by the same instructor, with the same lectures, PowerPoint presentations, textbook, exams, and assignments. The experimental section of the course was chosen at random. All students in the experimental class had use of the tool and their results of individual learning preferences after the first month of the semester. Students self-enrolled in the three courses, and were not aware of the research until the first day of class. Students were made aware that participation in the study was voluntary and would not affect their course grade in any way, and the instructor had no knowledge of research participation. The participating instructor was given a stipend to compensate for the amount of time he spent recording and editing in-class lectures. The lectures were only edited to remove student names or other identifying information and periods of silence during class time.

### Instruments

#### *Pre and post test*

A pre/post test of 20 multiple choice items from the course content was developed by an expert in security on the grant team who has taught this specific course, as well as the participating instructor teaching the course for this study. The pre/post test was administered to all classes at the beginning and end of the semester.

#### *The Index of Learning Styles.*

The Index of Learning Styles (ILS; Felder & Soloman, n.d.) is a 44-item dichotomous choice instrument that measures learning styles in four categories: active/reflective, sensing/intuitive, visual/verbal and sequential/global. The scores for each category are on a continuum. Please see Figure 4.

While there are other choices of learning style inventories [i.e. Kolb's Learning Style Inventory (Kolb, 1999); The VARK Questionnaire (Leite, Svinicki, & Shi, 2010)], the ILS was the only learning inventory developed for use with engineering and information technology students, thus it was a good fit for the intended research population. In addition, the ILS is

| ACT | | | | | | | | | | | REF |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 11a | 9a | 7a | **5a** | 3a | 1a | 1b | 3b | 5b | 7b | 9b | 11b |
| SEN | | | | | | | | | | | INT |
| 11a | 9a | 7a | 5a | 3a | 1a | 1b | 3b | 5b | **7b** | 9b | 11b |
| VIS | | | | | | | | | | | VRB |
| 11a | **9a** | 7a | 5a | 3a | 1a | 1b | 3b | 5b | 7b | 9b | 11b |
| SEQ | | | | | | | | | | | GLO |
| 11a | 9a | 7a | 5a | **3a** | 1a | 1b | 3b | 5b | 7b | 9b | 11b |

**Figure 4. ILS report of results.**

quick to administer, easy to score and the results are easy to understand. Results are on a continuum, thus showing preference rather than stating a specific learning modality. The ILS has been found to have test-retest reliability in multiple studies (Felder & Spurlin, 2005). For internal consistency reliability, cronbach alpha coefficients over .50 are acceptable scores for reliability for assessments that measure preferences (Tuckman, 1999). Cronbach alpha coefficients calculated for all of the subscales were above .50 in multiple research studies (Litzinger, Ha Lee, Wise & Felder, 2005; Felder & Spurlin, 2005). Pearson correlation coefficients were 0.2 or less (Felder & Spurlin, 2005).

## Procedure

Students were asked to participate in the research during the first class meeting. Participating students were offered raffle incentive to win a $50 university bookstore or Visa gift card. Participants in each class were placed into a raffle for each data collection. Researchers collected the first set of data during the first class session. After explaining the purpose of the research study and answering questions, the first research packet containing the consent form, demographics questionnaire, the ILS and the pre/post test was administered.

Due to technical issues with authentication, UCS was not available until one month into the semester. Thus, one month after the initial data collection the researchers returned the ILS results to the experimental section, explained the results, and provided a UCS tutorial. Students also received written information on the ILS results, and a letter with links to video podcasts explaining the results (http://bit.ly/1xEvlav).

At the midpoint of the semester, a midterm questionnaire was administered to the experimental group. The midterm questionnaire consisted of 10 open ended questions and was developed to determine how the students were using the tool, any problems they may be encountering that limit their use of the tool and suggested improvements. Self-report was utilized as the researchers needed instant, real time student impressions for the development team. Back-end user data was unable to be obtained. Questions included: On average, how many days a week do you use the course tool? What do you like about the tool? What might help improve the tool? The information from this questionnaire was presented to the development team, so improvements on the beta version of the tool could begin as soon as possible.

On the last day of class, both sections of the course were administered the pre/post test. The experimental section was also administered an end of Semester Questionnaire that asked similar questions as the Midterm Questionnaire. The control group students were provided with their ILS results and the ILS tutorial information.

## Results

### *Participants*

At the beginning of the semester there were 66 students enrolled in the control sections of the course with 28 choosing to complete the first research packet. Thirty-nine students completed the course with 21 students completing the post-test. There was a 41% student attrition rate in the control classes. The control participants had a mean age of 23.8 with a range of 19 to 41. Students were in their junior (3$^{rd}$ year) or senior (4$^{th}$ year) year of study. The mean year in school was 3.54. Four females and 24 males participated. Participants identified as African American (5), Asian (3), Caucasian (12), Latino (9), Pacific Islander/Native Hawaiian (1) and other (4). Several participants identified themselves in multiple ethnic identifiers. Three students chose not to identify.

In the experimental section of the class, 30 students were initially enrolled in the course and 21 students chose to participate in the research study. Twenty-six students completed the course and all 21 students completed the final research packet. The student attrition rate for the experimental class was 13%. The mean age of participants was 23.19 with a range of 19 to 32. The mean academic year in school was 3.52. In this class, one participant was female and 20 were male. The participants identified as: African American (2), American Indian or Alaskan Native (1), Asian (6), Caucasian (6), Latino (8), Pacific Islander/Native Hawaiian (1) and other (5). Several participants identified themselves in multiple ethnic identifiers. All participants chose to identify.

An independent t test was run on the demographics (age, gender, year in school, ethnic/racial identifiers) and no statistically significant difference was found between the two groups for age, year in school, and ethnic/racial identifiers. There was statistical significance for gender $t(47)= 1.081$, $p=.026$, with the control group having more female participants. Both control and experimental groups had less female than male participants.

### *Student Learning Preferences*

Below is a chart of the learning preferences for the control and experimental groups at the beginning of the semester. In the control group, one student did not complete the ILS, but chose to complete the pre/post tests. Two students in the experimental group chose not to complete the ILS. Of the 21 experimental group students that completed the end of semester questionnaire, 10 stated they had not known their learning preferences prior to this study. Seven out of 21 students replied 'yes' to the question "did you change the way you studied or interacted with new material as a result of the ILS information." Two students chose not to answer that question.

**Table 1. Number of students in each ILS category.**

| Learning Preference | Control Group | Experimental Group |
|---|---|---|
| Active | 6 | 10 |
| Reflective | 21 | 9 |
| Sensing | 20 | 15 |
| Intuitive | 7 | 4 |
| Visual | 21 | 17 |
| Verbal | 6 | 2 |
| Sequential | 14 | 12 |
| Global | 13 | 7 |

### *Reported UCS Usage*

During the end of semester questionnaire, 18 students answered questions regarding UCS usage. The semester usage was reported as not at all (3), once (1), twice (6), three times (1), four times (3), five times (1), twice a week (1), three times a week (1), and 20-30 times. In comparison, the students were asked how much time a week they spent studying for the course. The student answers ranged from 30 minutes a week to over 20 hours a week with the most frequent answer five hours a week.

When asked, "in what ways did you use the tool?" students had a variety of answers. Studying for exams (6), watching lecture videos (5), and searching for information (4) were the most frequent responses. Other students stated they used the tool to take notes, to complete homework assignments, and to 'test the tool.' Students wrote that the tool helped them in their learning, with one student stating, "I didn't feel overwhelmed cause I had all the information in tools." Another student wrote, "…it was like having the professor actually explaining & answering the questions I had." Several students wrote that having a search engine for course material was helpful for their learning, writing, "effectiveness of the search when looking for a topic to study about"; "it was excellent reference on slides where the prof. talked about how to do something like spinning tree"; and "fast search engine."

### *Student Learning Outcomes*

Independent samples t-tests were conducted to determine if there were statistically significant differences in pre/post tests, and final exam scores between the control and experimental group. Levene's Test for Equality of Variances, $p = .055$, suggests that the assumption of homogeneity of variance was met.

The control group had a pre-test score mean of 9.39 out of 20. The post-test mean was 12.18, showing an increase of 2.79 points. The experimental group had a pre test mean of 9.10, with a post-test mean of 11.70, showing an increase of 2.6 points. A T-test was run to determine within group differences. The pre/post test scores were statistically significantly different for both the control class, $t(27)= 9.39$, $p<.0005$, and the experimental class, $t(21)=12.182$, $p<.0005$. A one-way ANOVA was run to determine statistical significance of learning outcomes between the groups as measured by the pre/post test. There were no statistical differences, $F(1,47)=.567$, $p=.456$.

The final exam had a maximum point value of 200. The control group's mean final exam score (n= 28) was 144.57 with a standard deviation of 47.60. The experimental group's mean 150.86 points with a standard deviation of 17.59. An independent T-test showed no between statistical significance in the final exam scores: $t(47) = 6.286$, $p=.568$.

### *Limitations*

There are limitations to the generalizability of this study. Having the researchers from a different institution than the research site might have caused less students to participate, as the researchers were unfamiliar to the students. The high attrition rate for the courses caused the n to be low. The small sample size limited the degree of statistical analyses that could be performed, and limited the strength of those analyses. In addition, UCS was not available until a month into the semester, and this may have limited the students' use of the tool as students may have already developed other ways to study the course material. As this was a Beta version of UCS, student might have encountered issues related to functionality that may have limited their use of the tool Due to a coding issue, students were not able to access the pdf of the textbook until the last six weeks of the semester, although the searches did produce a queries' textbook page numbers. Students did mention in their comments that having to access the tool in addition to their course management system was problematic, and may have reduced the use of the tool.

## DISCUSSION

The research was conducted to determine the effectiveness of the Ultimate Course Search tool in learning outcomes, attrition rates, and usability. High attrition seems to be a natural tendency of this particular course, and of many computer science courses (Beaubouef & Mason, 2005; Chen & Soldner, 2013). The control group, however, had a much higher attrition rate (41%) than the experimental group (13%), showing that access to the tool could have mitigated the attrition rate in the experimental class. The ability to retain 87% of students is a significant find for courses and programs, like computer science, with high attrition rates. In addition, it is important to note that none of the students participating in the experimental research group dropped the class. The high attrition of the participants in the control group can be attributed to the high attrition of the class itself. Additionally, it can be deduced that, because the students in the experimental group had access to the tools, they were less likely to drop the course. Since the initial goal of the NSF funded grant that led to creating UCS was focused on reducing attrition rates in computer science security courses, the differences in attrition rates lends value to UCS and the project as a whole.

Suggesting that students in the experimental group had less variation in scores, and that the overall scores were higher. Students using UCS had more consistent scores and less low scores. There was more variation in scores in the control group, with students having very high and very low scores. Two students in the control group failed the final exam, while none of the students in the experimental group failed the exam. As Robb (2013) indicated that millennial students prefer using technology, and Roberts, Newman and Schwartzatein (2012) suggest using online tools when teaching to increase the ability of students to multitask, using a tool like UCS is supported by current research.

Low sample size might be why no statistical significance was found. Additionally, since UCS was not available until one month into the semester, students would have had to adjust their studying methods to incorporate UCS. Students indicated that having UCS and their learning management system separately was a concern, this might have limited how often students used UCS. If the tool were incorporated into their learning management system, or specific assignments using the tool were integrated into the assignments, students usage might have increased.

Similar to previous findings regarding millennial students (Elam, Stratton & Gibson, 2007; Howe & Strauss, 2000; Johnson & Lopes, 2008; Shih & Allen, 2007) a majority of the students were visual learners and expressed an appreciation for the visual materials such as the textbook, PowerPoint slides, and podcasts as these enhanced student learning. Students reported that the tool helped them study, that it was easy to use, and produced appropriate search results. These comments are supported by fact that millennial students "value access to information anytime and anywhere" (Mirriahi, & Alonzo, 2015, p. 22), and prefer flexible learning environments.

The integration of the ILS information was found by some students to be helpful. Ten students did not know their preferences prior to this study, and seven students changed the way they studied because of the ILS information. Since millennial students tend to have low self-insight, this information could have increased their understanding of how they learn (Elam, Stratton & Gibson, 2007). Overall, the students found UCS and the learning preferences information helpful to their learning.

## IMPLICATIONS FOR FUTURE RESEARCH

Due to technical and server issues with one of the participating universities, UCS was not available until a month into the semester. For future research we suggest having the ILS information and the tool available and ready to be used on the first day of the class so that students can immediately integrate the tool into their study strategy. As was noted in the research findings, a large number of the students did not know their learning style beforehand, therefore, having this information available to them at the very beginning of class may influence the way they choose to use the material. Also, having the material on the pre/post test come directly from previous courses in the sequence of this program may be a better gauge of student's prerequisite knowledge of the course, and may help the professor see better where to spend more or less time in teaching the material so that students don't feel too far beyond their depth. Integrating students learning preferences within UCS so that it is available at all times for the students may help keep the focus on studying. Finally, it would be helpful to ask those students who dropped the course their reasons for doing so, what part did the learning environment play in this decision, and what might have helped them stay in the course.

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