How Students and Faculty Interact With a Searchable Online Database of the Medical Curriculum

Firas H. Wehbe, MD, MS[1] and Anderson Spickard-III, MD, MS[1,2]
Department of Biomedical Informatics[1] and Department of Internal Medicine[2], Vanderbilt University, Nashville, TN

ABSTRACT

Many medical schools currently provide electronic access to their medical curriculum. In order to better develop and evaluate online curricular databases, knowledge of the interaction of students and faculty with such systems is required. The KnowledeMap application provides a web interface for students, faculty and administrators to perform NLP-assisted searches for documents from the entire medical curriculum. The pilot implementation of KM in a first year anatomy course was evaluated. Data were collected from the web-server log files over two years, a paper survey at the end of the course, and structured interviews with students and faculty members. The data showed complete adoption of KM. Analysis of usage patterns showed that most of the students chose to browse for current course material rather than to search for related medical concepts in future courses. Analysis of the interviews identified key concepts relating to the students' utilization of KM for their learning tasks. The impact of KM on medical pedagogy is discussed in light of our results.

INTRODUCTION

For decades medical educators have created systems to centralize access to curricular documents [1]. Typically the information is stored in databases [2-5] and the content is annotated by keyword fields. Keywords were selected from standardized vocabularies [6]. Early attempts to automate this process produced suboptimal results [7].

Many medical schools currently display curricular documents on the web [8, 9]. The Tufts Health Sciences Database [10] is unique from other web-based systems in that teaching resources (text, images, multimedia) are taken apart and entered as individually labeled objects into the database. The labeled pieces can be shared and reused by multiple faculty, can be inter-linked, and can be searched against an index based on the Unified Medical Language System.

KnowledgeMap (KM) [11, 12] is a web-based knowledge management tool that displays all the curricular documents of the medical school and uses an UMLS-based concept identifier to automatically locate biomedical concepts in the medical texts. The concept identifier parses text within educational resources (e.g. course handouts and syllabi, PowePoint® slides) and maps that text, using novel methods, to unique concept identifiers from the UMLS. KM performed favorably, when compared to NLM's MetaMap, in extracting relevant medical concepts from curricular documents [11]. Faculty members at Vanderbilt Medical School initially volunteered hundreds of their course materials to the KM development team. KM allowed students and faculty members to browse the documents by course, and also provided an interface for text-based search [12]. In the fall of 2002, the first year anatomy course became the first completely available course online. The instructors of the anatomy course agreed to upload all the course material. During this pilot implementation, students had the ability to browse the anatomy course documents through a calendar-like display that reflected daily class topics. They also had the ability to perform searches on the hundreds of documents from the entire four-year curriculum that had been already uploaded to KM.

An evaluation study was designed to accompany the pilot implementation. The first research objective was to quantify the initial usage of KM. The second research objective was to identify ways in which KM affected teaching and learning.

With regards to the first objective, published evaluations of web-based learning systems have relied on data from technical log files, surveys, interviews, focus groups, or any combination of these sources. McNulty et al [13] evaluated a web-based system for delivery of anatomy course content. They found no correlation between individual satisfaction or computer literacy scores obtained from surveys, and the usage of the system obtained from log files. They also found that the content of accessed electronic resources coincided closely with course content throughout the duration of the course. Cook's [14] review of the literature showed that studies of learning and cognitive styles correlated with measures of satisfaction [15] and computer attitudes, but not with actual usage of computers in web-based learning environments.

To meet the first objective to quantify usage of KM, we collected usage statistics, and studied the correlation between measurable and immeasurable

characteristics of individual students and their usage statistics.

Our second research objective was to identify ways in which KM affected teaching and learning. According to Koschmann [16], learning *with* computers, i.e. integrating computers into day-to-day learning, is a powerful means of fostering "termless" learning that students will need to practice medicine in the future. De Bliek et al [17] found that for a basic science domain in which a database is well-integrated in course activities, long term retrieval of information which augmented personal knowledge was increased. However, a new medium of instruction may raise new concerns or face opposition [18]. For example, Lee et al [10] observed the reluctance of faculty to change their teaching habits when adopting the Tufts Health Sciences Database. They also learned that the ease and flexibility with which electronic content can be reproduced raised new concerns among faculty members regarding copyright and intellectual property.

To meet our second objective, we used qualitative methods.

METHODS

Vanderbilt University School of Medicine (VUMS) has a traditional curriculum that is lecture-based in the first two years and clerkship-based in the latter two years. At the time of the study, in the fall of 2002, over 600 documents spanning many curricular courses were available on KM. We studied KM during the Anatomy Course from 9/1/02 to 12/21/02. We invited all students and faculty members of the course to participate in the study. Students granted permission for viewing of their personal computer log file of use of KM, and they agreed to complete a survey at the conclusion of the course in December 2002. In addition, we invited twenty students, whose names were randomly generated from the class roster, and the six course instructors to participate in structured interviews at the conclusion of the course. We followed the use of KM for two years by all students who participated in the initial phase of the study by tracking their computer log files until 12/21/04. The institutional review board approved the study protocol.

Log Files: Analysis of log files for each student included the date of first login, number of log-ins, number of log-offs, and the number of documents that were viewed to find a course, a set of lecture notes, or a particular concept.

Survey Instrument: We hypothesized that student's access and ability to use computers, satisfaction with KM, and motivation to learn would correlate with particular usage patterns of KM. For example, a more computer savvy and satisfied user may record more logins on KM. A student motivated by grades and highly anxious about tests may use KM earlier and/or more frequently than a student less motivated by grades and with less test anxiety. The students indicated their institutional user-ID on the cover of the survey, this information was used to tie the survey results to that student's log file data. The student survey assessed students' satisfaction with KM, access to computers, and their personal computer skill level using a previously validated scale [19]. The survey also measured student's motivation to learn using the Motivated Strategies for Learning Questionnaire (MSLQ)[20]. The MSLQ includes five constructs of motivation to learn: 1) Extrinsic Motivation - participation in a learning task for reasons such as grades, rewards, performance, evaluation by others, and competition, 2) Intrinsic Motivation - participation in a task for reasons such as challenge, curiosity, and mastery, 3) Test Anxiety - negative thoughts and anxiety about an upcoming test such that performance is disrupted, and 4) Elaboration - strategies for storing information into long-term memory by building internal connections. 5) Metacognitive Self Regulation – planning, monitoring and regulating one's learning activity. Each score was calculated from multiple Likert scale questions from 1-7 with a higher score denoting more concordance with the construct.

Student and Faculty Interviews: The student interview protocol covered attitudes about the use of computers, personal information need for material across the four-year medical school curriculum or elsewhere, effects of KM on classroom instruction and attendance, and personal study habits. The interviewer was blinded to student's computer logs of KM use and survey responses. We transcribed the interviews into a QSR Nud*ist 6 text database. We created a hierarchy of topics based on the content of the transcripts, such as: "KM satisfaction," "information retrieval," "study habits." Text passages within the transcripts were highlighted and mapped to a specific topic and a report was generated that included all text passages that were coded under that topic. All course instructors agreed to be interviewed. The faculty interview protocol covered similar topics to the student interviews, such as "information retrieval" and "satisfaction." In addition, they were asked about their opinion of pedagogy being affected by KM, and about concerns that are specific to faculty members that stem from KM being used across the medical school. Transcript analysis was performed in a similar fashion to student interviews.

Power Calculation: For a sample size of 70 students, it was possible to detect a 15% difference (approximately 1 unit) in MSLQ scores between two

groups of students (two-sided test at alpha = 0.05) at 90% power.

RESULTS

Overall usage statistics: Of the 105 first year medical students enrolled in the anatomy course, 104 had logged on to the system at least once during the pilot study, and 81 students responded to the survey. On average, the students logged-on to the system on 18 separate days. Figure 1, shows server traffic throughout the anatomy course. Table 1, shows usage information over three years.

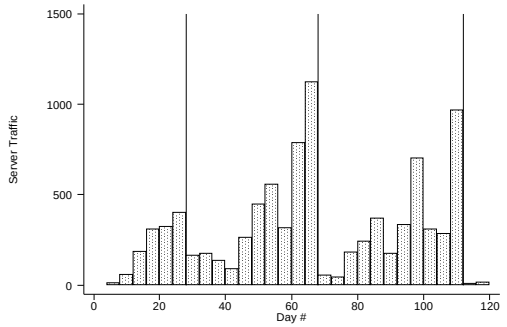

Fig 1: Server traffic throughout the anatomy course caused by first year medical students. The horizontal lines represent the days of the three course exams.

Correlation of usage with other statistics: There was no association between usage level and computer proficiency level. However, the more proficient group started using the system earlier during the pilot study. The first log-on to the system occurred on the 25th day for the proficient group and on the 42nd day for the less proficient group (p=0.03). Once the users started using the system, there was no difference in the subsequent frequency of log-on for both groups (1.30 days per week vs. 1.29 days per week, respectively, p=0.97). Ninety one percent of the students owned a computer at home, and 98% considered computers beneficial or very beneficial for their education.

As far as general satisfaction with KM, 80% of the students were satisfied or very satisfied and 4% were dissatisfied. There was no association between satisfaction and computer ownership nor between satisfaction level and computer proficiency. KM's server was overloaded on the eve of the second exam and 'crashed' repeatedly. Many students complained about this incident by email or through the free comments section of the survey. The high usage group was more likely to agree with the following two statements (using Likert scale questions) "I am frustrated by technical errors," and "technical errors prevented me from accessing important information when I needed it" ($p<0.02$, $p<0.05$), but no difference in agreement was observed for the following statement "technical errors made me use KM less frequently." These findings are compatible with the hypothesis that technical errors, though frustrating, did not lead to a lower adoption rate.

For both overall usage and "search" usage statistics, students in the high usage category did not score differently on any of the MSLQ scores. The usage categories were created using a 1:1 split (upper and lower 50 percentile), as well as 2:1 split (upper one third and lower two thirds, since most usage statistics were heavily skewed to higher usage). Satisfaction level also had no effect on MSLQ scores.

Structured Interviews: Interesting findings emerged from the structured interviews of students and faculty members. All students reported that their use of KM was primarily to browse course content covered in class; they rarely searched for concepts outside the anatomy course. Many professors however appreciated the search capability of KM. For them, KM helped position their work in context of what is being taught across the curriculum. Said one professor, "with KM, I am in sync. I am not a surgeon. I if am to cover the surgical relevance of my lecture, I may be out of date. I need to check my facts (by using KM to find the relevant material updated by a surgical colleague)."

Students explained that constraints on time and excess of information as barriers to searching for concepts in other courses. Students related elaboration strategies to store information into long-term memory by building internal connections between items to be learned. However, faced with limitations on time and the large amount of information to be learned, many students abandoned such long-term learning strategies in favor of more short-term "blatant memorization" tactics. One student said that the cost of searching through the

	Fall 2002 9/1/2002 – 12/21/2002	USMLE+ 5-6/04	Fall 2004 9/1/2004 – 12/21/2004
Documents viewed per Month	1329	1545	1271
Documents viewed outside of current course	7%	*	23%
Documents viewed through "search" mode	5%	38%	7.5%

+ United States Medical Licensing Exam Step 1
* No current course. The students were not enrolled in school

Table 1 – Global Usage Data for VUMS Class of 2006

"noise" of unknown concepts from advanced courses to determine how current knowledge "fits in the big picture" is not worth his time. Students relied on professors as valuable resources who can sift through upper year courses, available online through KM, and embed links to relevant advanced knowledge within their current course materials. The students anticipated an increased reliance on retrospective searches in future courses to revisit earlier material. They lauded KM's ability to replace searching through "piles of notes" in latter years to find a particular concept of interest.

Professors commented on how KM affected preparation for lectures. They applauded the ease of providing lecture material to students by way of the Internet, even from home. Yet they were wary of the increased workload required to prepare electronic course material. One instructor said, "in this day and age, professors are almost required to master skills in multimedia-type presentations to make themselves marketable as educators." Professors recognized the accountability to quality afforded by increased scrutiny of lectures posted on the Internet. Still, they favored the attention to one's contributions to the education enterprise.

Students and faculty members commented on the impact of KM on study habits and class attendance. Students reported using KM more heavily during the last few days leading to an exam. Many students convened in study groups to review lecture notes via online projections of the class notes. They hoped that the availability of computer games and online sources would not distract them from attending to their studies. Four out of ten students said that the arrival of KM "decreased their class attendance." These students felt that class attendance is a matter of individual learning style and is not important as long as the material is being learned adequately. Other students considered class attendance as necessary for their learning. Students also mentioned that a "boring" lecturing style coupled with complete notes, whether in printed or electronic form, usually leads to low class attendance. The faculty members agreed yet remained perplexed about how to stimulate learners in class without overwhelming them with new information. On the one hand, the instructors wish to provoke students to actively seek knowledge by challenging them in class and refraining from "spoon feeding" them through complete notes. On the other hand, medical students who are overwhelmed with the amount of information they need to learn demand complete notes covering information on the test and "vote out" other teaching styles on course evaluations. The instructors pointed out that KM highlights this existing tension.

Finally the professors discussed concerns about intellectual property. KM may provide an easy conduit for others to steal their intellectual material and pass it off as their own. They had questions about how to acknowledge and display material not personally owned. Determining ownership of local material may not be clear. A professor explained that from year to year, anatomy instructors swap specific lectures and hand over their PowerPoint™ presentations. The PowerPoint™ presentations in the common pool are constantly modified by different instructors. She said "because of KM, we had to sit down and have a course meeting and decide who owns it."

DISCUSSION

KM was adopted unanimously. Higher computer literacy was associated with an earlier onset of use but no detectable long-term differences. The data show that usage was independent of the MSLQ constructs that were measured, and that usage of the system closely mirrored the content of concurrent didactic activity as reported earlier [13]. Relying on server log files is limited by the inability to capture the number of students using KM in a given session, such as when students assembled in study groups.

It is interesting that even when no didactic structure was imposed during the USMLE preparation period, and when the percentage of "search" retrieval multiplied five to eight folds, the majority of curricular content retrieval was still done through the "browsing" mode that is structured according to course-calendar motifs.

It is also interesting that while some students related elaboration-type learning strategies and lauded the ability to 'integrate in the big picture', others were wary of getting lost in the 'noise' of upper year courses and preferred that professors sift through upper year courses for them. They all agreed, however, that time constraints forced 'blatant memorization' upon everyone.

The dilemma that the teachers described was present when teachers were handing out complete notes and was highlighted by KM making the notes and the slides easily accessible. Currently most of the educational content that the teachers upload to KM is in what Cook [14] labels as "web-page-based" configuration. Page-based learning according to him parallels the configuration of the lecture making the user "attend a web page." An alternative is a discussion-based configuration (i.e. the web as a communication medium). Another option is enhancing flat text by interactive hyperlinks or multimedia (Cook). This latter form of presentation was favored by some of the students we interviewed.

In summary, we did not detect correlation between the adoption of KM and our hypothesized constructs. The student activity on KM closely mirrored the didactic content of the classroom, and the use of KM to search for biomedical concepts was less than expected. Most documents that were uploaded were in flat text presentation and did not leverage the potential of hypermedia. Time pressures in the traditional medical curriculum and student's lack of knowledge may explain why students only concerned themselves with current courses. In addition, not all of our course material for upper courses was available during the initial phase of the study; this may have limited student's browsing and searching beyond their current year. The design motifs of the KM application mirror the course-based organization of the medical curriculum. This may partly explain why students mostly retrieved content through course-based browsing instead of searching, even during the summer out of school when they were studying for the USMLE Board Exam. It is possible that interactions between the cognitive styles of students with specific features of web-based learning are too subtle and our study insufficiently powered to have been detected by our methods. Finally, KM, as a new instructional medium, has raised new concerns among faculty about personal preparedness and additional work to maximize web learning and about intellectual property and copyright issues [10]. These concerns are being addressed at our institution.

AKNOWLEDGEMENT

We wish to thank the instructors of the Clinical Anatomy course at Vanderbilt who opened up their course for us. The first author would like to thank Drs. Claire Smrekar and Randolph Miller for their guidance throughout this work, and Dr. Josh Denny for his valuable contributions to this project.

REFERENCES

1. Curry, L., et al., *Computerization of undergraduate medical curriculum content.* Med Educ, 1984. **18**(2): p. 71-4.
2. Rosen, RL, HA Paul, and LJ Goodman *Using a database to analyze core basic science content in a problem-based curriculum* Acad Med 1992 **67**:535-8
3. Mattern, WD et al *Computer databases of medical school curricula*Acad Med 1992. **67**:12-6
4. Kanter, SL *Information management of a medical school educational program: a state-of-the-art application* JAmMedInformAssoc 1996 **3**:103-11.
5. Salas, A.A., et al., *CurrMIT: a tool for managing medical school curricula.* Acad Med, 2003. **78**(3): p. 275-9.
6. Piggine, J.L., et al. *A computer-based system for indexing curriculum content.* in *SCAMC*. 1990. Los Alamitos, CA.
7. Kanter, SL et al *Using POSTDOC to recognize biomedical concepts in medical school curricular documents* Bull Med Libr Assoc 1994 **82**: 283-7.
8. McGee, J.B. *Development and Successful Pilot of a Web-based Scaleable, Distributed Curriculum Development and Management System for Medical Education*. in *AMIA Fall Symposium*. 2003. Washington, DC.
9. Fleiszer, D.M., N.H. Posel, and S.P. Steacy, *New directions in medical e-curricula and the use of digital repositories.* Acad Med, 2004. **79**: 229-35.
10. Lee, M.Y., et al., *Tufts Health Sciences Database: lessons, issues, and opportunities.* Acad Med, 2003. **78**(3): p. 254-64.
11. Denny, J.C., et al., *"Understanding" medical school curriculum using KnowledgeMap.* J Am Med Inform Assoc, 2003. **10**(4): p. 351-62.
12. Denny, J., et al. *The KnowledgeMap Project: Development of a Concept-Based Medical School Curriculum Database*. in *AMIA Fall Symposium.* 2003. Washington, DC.
13. McNulty, J.A., et al., *Evaluation of Web-based computer-aided instruction in a basic science course.* Acad Med, 2000. **75**(1): p. 59-65.
14. Cook, D.A., *Learning and cognitive styles in web-based learning: theory, evidence, and application.* Acad Med, 2005. **80**(3): p. 266-78.
15. Steele, DJ et al *Learning preferences, computer attitudes, and student evaluation of computerised instruction* Med Educ, 2002 **36**:225-32.
16. Koschmann, T., *Medical education and computer literacy: learning about, through, and with computers.* Acad Med, 1995. **70**(9): p. 818-21.
17. de Bliek, R., et al., *Database access and problem solving in the basic sciences.* Proc Annu Symp Comput Appl Med Care, 1993: p. 678-82.
18. Levy, A.H., *Factors affecting computer-mediated instruction in medical education.* Methods Inf Med, 1989. **28**(4): p. 215-22.
19. Spickard, A., 3rd, et al., *Learning about screening using an online or live lecture: does it matter?* J Gen Intern Med, 2002. **17**: 540-5.
20. Pintrich, P.R., et al., *Reliability and Predictive-Validity of the Motivated Strategies for Learning Questionnaire (Mslq).* Educational and Psychological Measurement, 1993. **53**: 801-813.