# Using computer-based case studies for developing information searching skills and implementing evidence-based medicine in patient care plans.

**Anthony J. Frisby, PhD and Daniel Kipnis, MSI**

**Thomas Jefferson University**

## Abstract

Since 1987 over 1,300 first year medical students at Jefferson Medical College in Philadelphia, PA have completed a required Medical Informatics course. This course is the responsibility of the Library's Education Services division. Designed to develop information-searching skills and teach methods for evaluating evidence-based medicine, the course employs a combination of self-paced online tutorials and case studies. The case studies in particular have proven to be a very effective learning tool. Course evaluations are consistently positive, with comments citing the interesting case studies and the effectiveness and appropriateness of the teaching method. This chapter describes the case development process, presents learner support issues for library staff, reviews the evaluation process and results, and identifies Jefferson's future plans for teaching medical students successful information-searching skills.

## Setting

Founded in 1824, Jefferson Medical College, one of the largest private medical schools in the US, has more living graduates than any other medical school in the nation. Our academic medical center includes: Jefferson Medical College, Jefferson College of Health Professions, Jefferson College of Graduate Studies and Thomas Jefferson University Hospitals, a 900+ bed

teaching facility. Scott Memorial Library serves the three Colleges in the University and is the Hospitals' library. Medical Informatics (IDEPT 123) is a required course for all first year medical students, 230 students on average. Over the past 15 years Education Services has experimented with a number of different methods for delivering the course content and the most recent model best meets the current needs of Jefferson's students.

## Approach

The Medical Informatics course began in 1989 as a live lecture to the entire 230-student class and followed with about 25 small-group sessions that included direct demonstrations of the databases and short practice exercises. Each session included approximately 9 - 10 students, with some reshuffling as students missed sessions and needed to reschedule. This format was not very effective for the teaching staff or the students. This isolated exposure did allow students to become familiar with the library's information systems, and to perform the required exercises; but since it was separate from any real context students could relate to, any learned skills were probably quickly forgotten. This approach did not reinforce the students' desire to become, or provide the skills to be, a life-long learner, a goal the University has for its' students.

To make instruction more efficient and more relevant, Education Service's librarians and instructional designers partnered with clinical faculty to develop realistic case studies. The first case includes considerable in-context support, or instructional scaffolding, that provides guidance on how to structure search questions and where it is appropriate to search for answers. Students can compare their questions, search parameters, and results, with those developed by

librarians. In later cases this scaffolding is removed, thus encouraging students to recall and apply their new skills.

Below is the instructional design process followed in the development of the cases and screen captures of the final case studies as presented to the students. The lead instructional designer had been using Gagne's instructional design model[1,2] for several years in the development of computer-based learning materials, and that model was used for the tutorials and case studies in the Medical Informatics course.

Table 1. Gagne's Instructional Events

| **Instructional Event** | **Example** |
|---|---|
| 1. Gain attention | Identify start of module (opening screen, may include sound and animation) |
| 2. Inform learners of objectives | List learning goals and why these are important to the learner (source of goals and how the learner will apply these goals in clinical practice) |
| 3. Stimulate recall of prior learning | Provide an example learner is likely to already be familiar with (relate the new learning materials to something the learner is already familiar with, providing a foundation to build on) |
| 4. Present the content | Begin actual tutorial or case study (the main body of the instructional content) |
| 5. Provide learning guidance | Support instruction with examples and explanations (provide different examples that will appeal to the different learners and to different learning styles) |
| 6. Elicit performance | Allow learner to apply new knowledge or skills (allow the learner to use new knowledge and skills in solving new problems) |
| 7. Provide feedback | Give appropriate feedback to learner's performance (provide detailed, corrective feedback to the performance, relate back to objectives and real world application) |
| 8. Assess performance | Provide learner opportunity to perform again and evaluate that performance (usually the final, evaluated performance that counts towards the course grade) |

| | |
|---|---|
| 9. Enhance retention and transfer | Review what knowledge and skills were presented and provide additional discussion of how this knowledge or skill is applied in real-world applications |

Before beginning any instructional activity it is important to first determine the instructional goals and identify certain characteristics about the learner. Jefferson's specific goals for this course are in the table below. These are based on larger goals identified by the Association of American Medical Colleges (AAMC) *Learning Objectives for Medical Student Education: Guidelines for Medical Schools*[3], the American Library Association (ALA) *Nine Information Literacy Standards for Student Learning*[4], and Jefferson Medical College's *Learning Objectives for Medical Student Education*.

Table 2: Medical Informatics Course Objectives

| | |
|---|---|
| Goal | The student will demonstrate an understanding of the need to engage in lifelong learning to stay abreast of relevant scientific advances. |
| Behavioral Objectives | 1. Recognize his/her need for additional information.<br>2. Identify relevant information resources including:<br>▪ Colleagues and mentors<br>▪ Librarians<br>▪ Scott Memorial Library catalog (THOMCAT)<br>▪ Electronic databases<br>▪ Internet search engines<br>3. Request the services of an information professional when appropriate i.e. Reference Librarian.<br>4. Use EBM resources and pharmacological databases to assess therapeutic interventions. |
| Goal | The student will demonstrate the ability to retrieve (from electronic databases and other resources), manage, and utilize biomedical information for solving problems and making decisions that are relevant to the care of individuals and populations. |
| Behavioral Objectives | 1. Formulate a search strategy to resolve clinical problem/question.<br>2. Select the appropriate information resource based:<br>▪ Content<br>▪ Time frame<br>▪ Depth Authority<br>3. Define "Medical Subject Headings" (MeSH). |

| | |
|---|---|
| | 4. Briefly describe the indexing process of journal articles utilizing MeSH terms.<br>5. Describe the process of Mapping.<br>6. Conduct an efficient and effective search using available tools including:<br>▪ Keywords, authors, titles, controlled vocabularies<br>▪ Boolean operators: and, or, not<br>▪ Special commands: truncate, explode, focus, limits<br>▪ Contrast the two MEDLINE electronic journal databases interfaces, OVID and PUBMED.<br>7. Prescribe therapeutic intervention using Evidence Based Medical Resources and pharmacological databases. |
| Goal | The student will demonstrate the ability to critically evaluate the medical literature and to seek opportunities to expand understanding and appreciation of scientific discoveries and their applications. |
| Behavioral Objectives | 1. Evaluate the merit of retrieved information using the criteria of:<br>▪ Content<br>▪ Time frame<br>▪ Depth<br>▪ Authority<br>2. The ability to effectively teach patients and colleagues.<br>▪ Obtain patient education materials and resources that are age and language appropriate.<br>▪ Create educational sessions using presentation software to display text and graphics. |

**JMC New Student Computing Survey**

Each year a survey, designed to measure prior computer use and computer-based learning experience, is distributed to all first-year medical students. The results of this survey are beneficial in helping the library and Learning Resources Centers (campus computer labs) prepare for the new students. Interesting to note in this data is the often-inappropriate reliance on general search engines to locate information relevant to health care, rather than the use of MEDLINE and evidence-based medicine databases. Samples of some of the questions asked, and the responses received, are in Appendix A.

The first three instructional events (attention, objectives, prior recall) begin during the two-hour mandatory orientation session in the auditorium. This session:

- presents the course objectives, discusses where these originated, and explains why they are important to them as both students and as clinicians
- ask the students questions about their previous use of the medical information resources, specifically, how they accessed them and their purpose in using them
- demonstrate how to access the course materials and provide a short orientation to the resources they will need to complete the case studies

The remaining course requirements are entirely self-paced, computer-based instruction. These include: a pre-test to measure the students' entering knowledge and skill level, two case studies, a post-test to demonstrate their mastery of the objectives, and the course evaluation. Though there is only the one required lecture, optional hands-on assistance is provided at dedicated computer classroom support sessions offered several times during the three-week course. During these sessions, librarians from the Education Services and Information Services departments provide one-on-one coaching for students wanting the extra attention.

**Instructional Event: Gain The Learners Attention**

Students complete a number of different activities online: checking email, participating in online group discussions, working with other online course material, and general web surfing. It is important to provide some way to identify the start of a new activity, and get the learner in the right "frame of mind" for that structured learning activity. Once logged into the course homepage, students select the "Assignments" folder, and then select the pre-test or case studies.

The pre-test is required, but the results are not included in any evaluation of the course. It provides both the library and the students with information about their entering knowledge and skill levels. It will later provide the student with a starting-point score they can compare to their post-test score. Pre-test scores consistently average in the upper 60's to low 70's on a scale of 0-100. The pre-test and post-test questions come from a pool of questions that are presented in a randomized structure by the University's course management system (Blackboard).

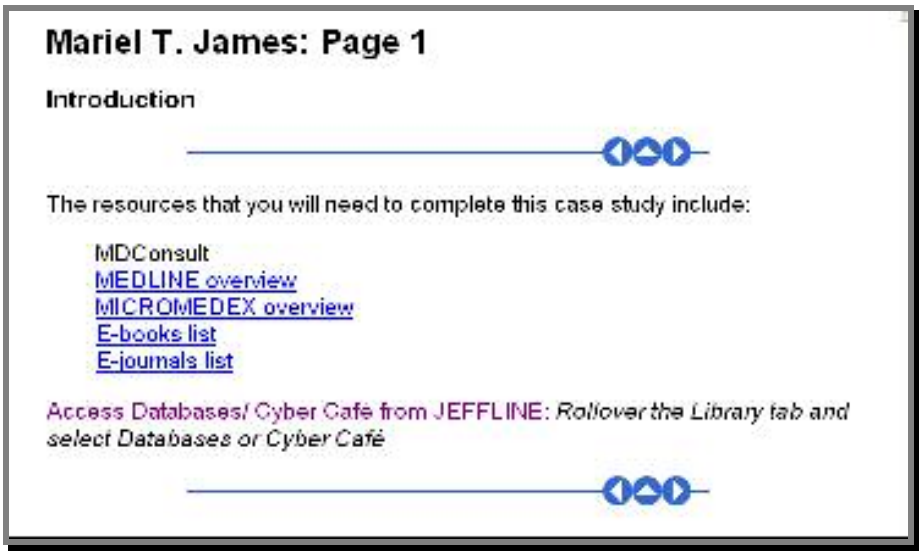


Figure 1. The first case study begins with a screen identifying the resources this case will use and then welcomes the student and introduces them to the activity they are about to begin.

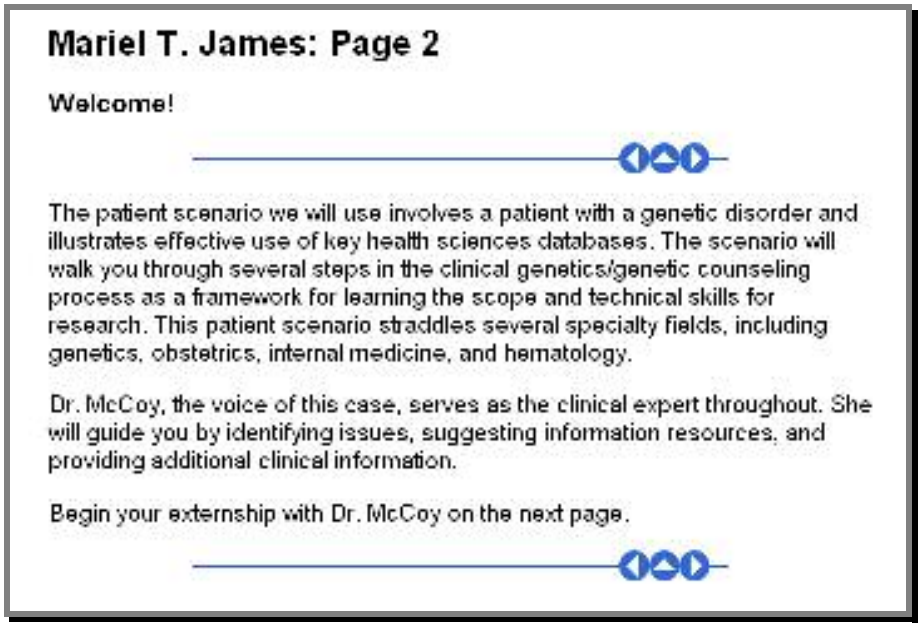


Figure 2. The second page welcomes the student and begins to describe the case setting.

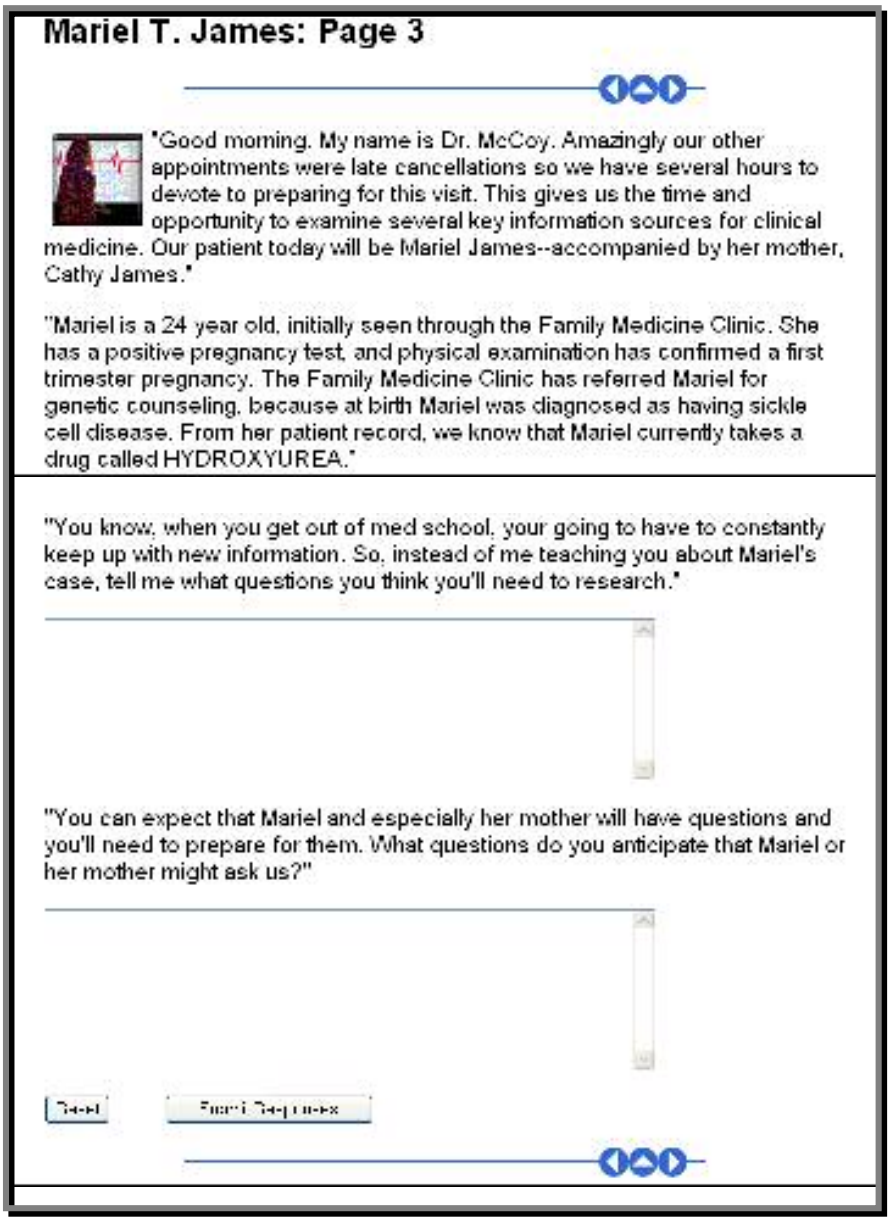


Figure 3. The student "meets" the virtual clinician and a Socratic dialog begins.

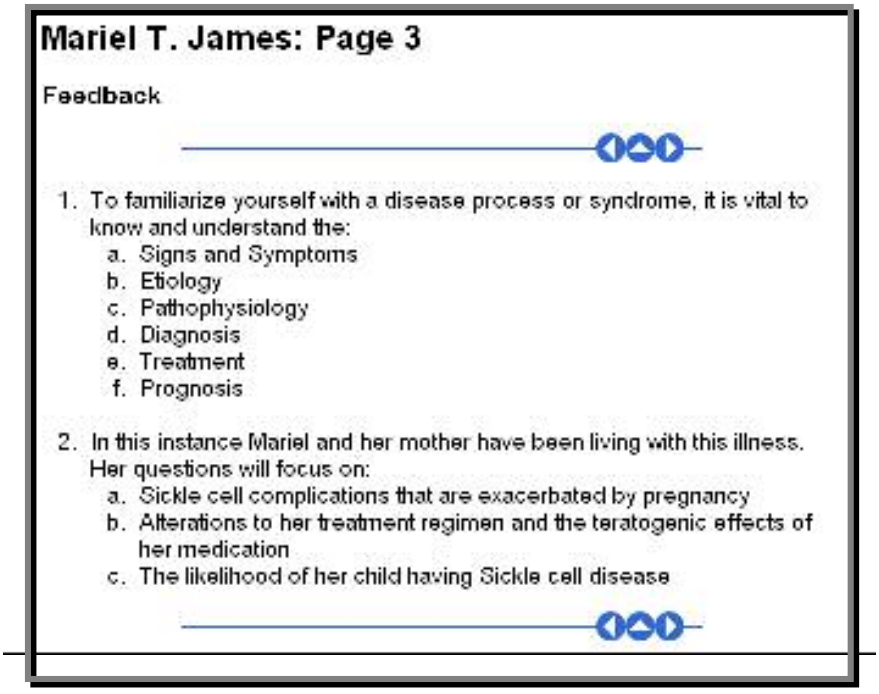


Figure 4. Standardized feedback is presented to the student when a response is submitted.

**Instructional Event: Inform The Learner Of The Objectives**

As noted earlier, the course objectives are presented at the single orientation lecture for the course. Additionally, upon entering the case studies the student is presented with the purpose of the clinical visit and their responsibility in caring for the patient is established. The knowledge and skill acquisition is embedded into the case study in order to provide a realistic context for learning the content. Adult learning theories emphasize the importance of context as situated cognition[5]. In essence, the theory of situated cognition states that knowledge and skills are best acquired in a setting as similar to their future application as possible. This transfer issue is reflected in the key problem of students doing well on multiple-choice exams, but being unable to actually apply the knowledge when out in the "real world". The situation the content is learned in should match the situation it will be necessary to recall it in, as much as possible.

Case studies were selected as the instructional conduit for presenting the information literacy skills in this course. To develop realistic case studies, Education Services partnered with physicians in Jefferson's Family Medicine Department. The clinical partners were asked to think of common patient scenarios that new students might encounter in the clinics and to walk us through this clinical encounter just as they would a student.

The cases were built using HTML and custom scripts to record the student's progress and responses in an Oracle database. The custom development permitted the cases to be presented as a natural story, allowing the content to fit in realistically with information and questions from the patient or virtual doctor. The frequent "dialog" between the student, patient, and doctor provides a very high level of interactivity to make the cases both interesting and engaging.

**Instructional Event: Recall Of Prior Learning**

A brief multiple-choice quiz is included within the case study, to stimulate recall of what students already understand about MEDLINE and MeSH. (A similar short quiz precedes each of the databases used in the course.) Students evaluate their score and are advised to take the tutorial if they score poorly. As adult learners, students are expected to ultimately make the decision whether or not to complete the tutorials or continue with the case studies. They are advised that the short time spent with each tutorial will reduce their time obtaining and evaluating relevant search results.

**Instructional Event: Presenting The Content**

A case study format allowed the authors to embed the knowledge and skill components in an investigative story-telling method. Educational research suggests that story telling is a particularly effective method of learning and may even be "hard wired" into people as a part of our human evolution[6]. Case studies may also provide an appropriate learning context for activities taking place later in a clinical setting.

**Instructional Event: Providing Learning Guidance**

Self-paced learning relies heavily on the learner's motivation to follow the learning exercise through to completion. Like older correspondence courses, early distance-learning courses had very high drop-out rates, perhaps because the learner was often presented with a large amount of instructional content, that wasn't organized well, and they received very little guidance on how to use it effectively. Self-directed learning readiness, as a component of life-long learning, is an objective most medical schools, and the AAMC, identify as important in the development of a physician. Earlier research by Frisby[7] indicates that medical students may not be acquiring these skills as part of their formal learning experience.

In these case studies, the doctor models self-directed learning readiness and demonstrates thatthe skills acquired in learning to search and evaluate the medical literature will be used throughout their career. The doctor in the first case coaches the student in what to expect during the clinical encounter, guides them to the different medical information resources available, and teaches them which resource is appropriate for each task. The virtual doctor models the learning

behavior Jefferson wants its' students to acquire. Later case studies remove this structured guidance, forcing students to reflect on what they did on the previous case, analyze what the problem calls for in the new case, and to apply those skills to reach a solution. The repetition of this process provides additional reinforcement and is designed to increase the students' self-confidence in their own readiness for self-directed learning. As demonstrated in the screens below, students are asked to apply their new skills in searching MEDLINE in general, to a specific search for evidence-based articles using the limit command.

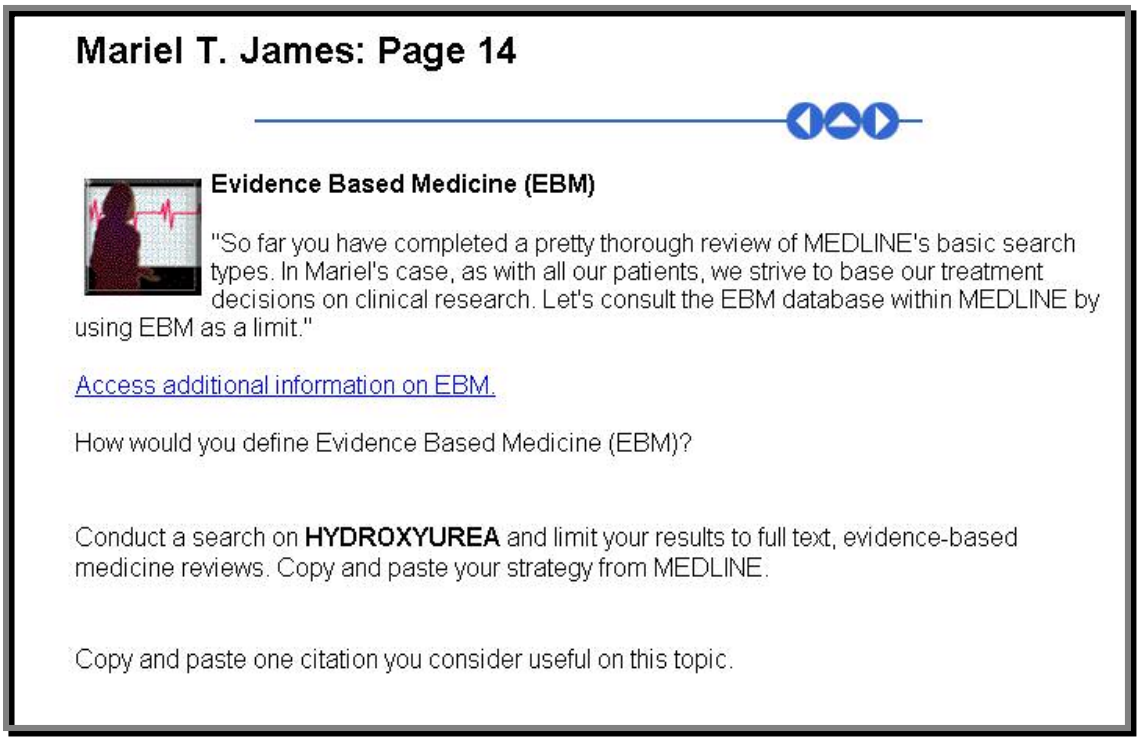


Figure 5. Limits and Evidence Based Medicine

The case study continues by asking the student to investigate any complications associated with the suggested treatment. This will begin with an assessment of the student's current knowledge

of, and skill in using, the MICROMEDEX database. After evaluating their performance, a student may choose to use the MICROMEDEX tutorial, and then continue with the case study.

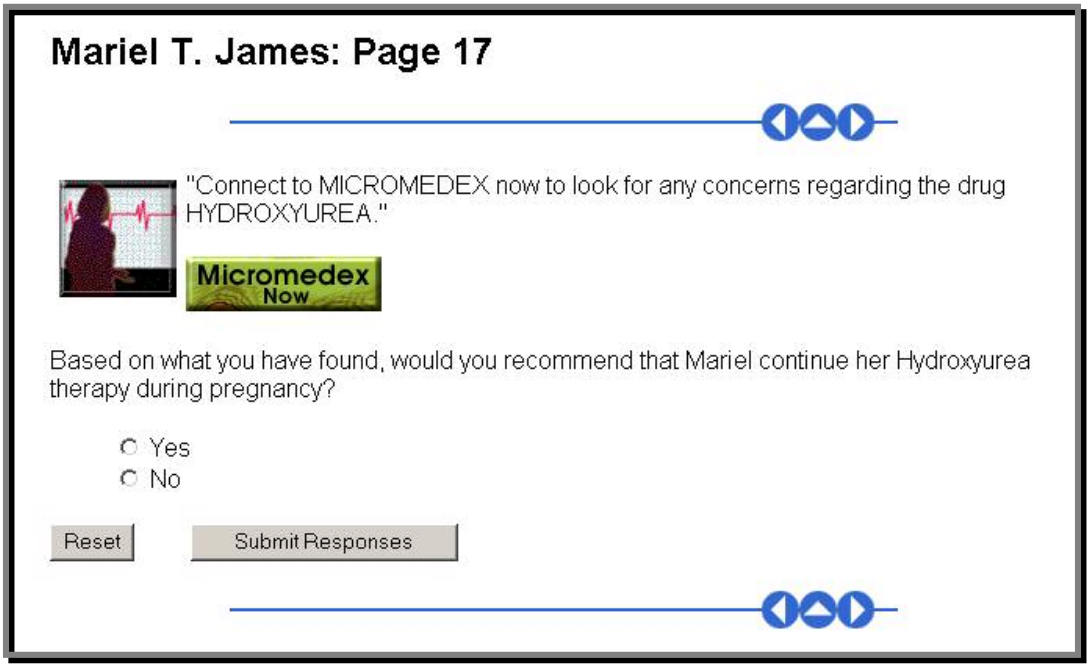


Figure 6. Decision based on information retrieved.

**Instructional Event: Elicit Performance**

Frequent interaction between the student and the doctor provides motivation and continued coaching throughout the case. Though the doctor's responses are predetermined, students are able to compare their answers and search results with those of the doctor. They may also repeat the search using the terms and limits the doctor describes to confirm that they're able to get the same results. All of the information students enter into the system is stored in a database and can be reviewed by the Library's teaching staff.

**Instructional Event: Provide Feedback**

Because of the large class size, students are divided into smaller groups with each staff member reading through the submissions of 40-50 students to check for any problems. Prior to the start of each class, the staff meets to select specific questions to pay particular attention to, and to establish guidelines for evaluating those answers. This ensures the same grading criteria are applied to all students. Some students will ask a question as part of their answer if they're unsure they've answered correctly. The immediate 'pre-determined' feedback from the doctor probably answers most of these types of questions, but a later feedback message from one of the staff provides additional information and reinforcement.

**Support Issues**

The move to case studies and self-directed learning as the primary instructional activities of the course shifted some of the support burden to other groups within the Library. The Learning Resources Centers (LRCs) are responsible for staffing the University's computer classrooms and the management of the public computers distributed throughout the library. The Education Services staff provided training for the LRC staff and created accounts that would allow them to go through the course in advance of the students. This helped the LRC staff to answer questions and respond to any problems the students might encounter in completing the exercises.

Other groups affected were the Library's Systems staff and the Information Services staff at the Reference Desk. It was anticipated that the Reference Desk, like the LRC, would get calls with questions about the cases and would see an increase in requests for help using the databases. The Information Services staff was already partly familiar with the course, as they assisted in writing

the pool of questions used in the pre- and post-tests. Course accounts were also created for the members of the Information Services staff, giving them the opportunity to complete the case studies and become familiar with the exercises within them.

With permission from the database vendors, the Systems staff mapped the students' individual accounts for database access to a special training account during the course period. This protects Jefferson's hospital and research users from getting denied access to resources that have a limited number of simultaneous users.

**Instructional Event: Assess Performance**

In addition to completing the two required case studies in the course, students take a post-test exam. This gives them something to compare to their entering score from the pre-test, to assess what they've learned in the course. The average post-test score was 90, an improvement of 21 points above the pre-test average of 68 (both out of a possible 100 points for 20 questions). Students are skeptical about the pre-test at the start of the course, since they are not commonly used in their other courses. Exemplifying the competitiveness of medical school students, students occasionally request to retake the pre-test because they think they did poorly.

**Instructional Event: Enhance Retention And Transfer**

The first case study ends with a short summary of the purpose of the case study in relation to the course objectives. The next case study adds two additional databases to the scenario, allowing the student to practice what they've learned so far and apply it to similar situations. During the course, the teaching team frequently checks the database for student answers to questions and

scans for anomalies or questions within the answers. Feedback is given as appropriate. One week following the course, a final message is sent to the class regarding their overall performance and addressing two or three areas that have similar patterns of misunderstanding. In one example from a previous year, regarding diabetes and scuba diving, many students submitted an incorrect answer based on the use of a site from a general Internet search engine, which listed that site near the top of the list. This indicates a continuing problem with reliance on general Internet search engines to locate appropriate clinical resources.

**Evaluation Methods**

This course provides frequent self-assessment. Students complete a pre-test so they can objectively measure how much they currently know about using databases to locate medical information. As part of the case studies, students encounter several small quizzes that evaluate their understanding of how to structure search questions, choose a database appropriate for the question, and execute a search in that database. Students score these quizzes for themselves and determine whether or not they should complete the associated tutorials. As with all self-directed learning, this puts the responsibility for learning on the student – where it will be when he or she is a practicing physician. The last formal assessment is the post-test. Students are once again presented with a set of questions from the same pool used in the pretest. The course management program allows for the items to be presented randomly (both question order and choice options) and the student's final score is immediately available to them.

The last course requirement is the completion of the course evaluation. This allows students to comment on the effectiveness of the orientation session, the use of case studies as a vehicle for

learning medical informatics, and on their level of satisfaction for the course as a whole. Scores for these measures range from 80-90% (good or excellent). Results from the 2003 course determined that only 25% of the students rated their current searching skills as good or excellent on the before the course, the number rose to 87% on the post-course evaluation. In addition, 99% of the post-course respondents considered these skills highly relevant to their career as a physician and 98% considered them relevant to success as a medical student.

Results indicate that this course format is effective and appropriate for teaching information literacy skills to medical students. The team hopes that the knowledge and skills acquired by the students during the course are retained and available for use when called for later in clinical practice. This retention is something Jefferson is just beginning to assess in its' graduates.

## Future Plans

The students' high level of satisfaction with this course has helped to promote the development of similar materials for additional courses in both Jefferson Medical College and the Jefferson College of Health Professions. The Education Services team is currently exploring the idea of building an OSCE (Objective Structured Clinical Exam) case study for the Medical College that will require students to consult the literature for evidence-based medicine solutions.

Researchers at Jefferson Medical College's Center for Research in Medical Education and Health Care and Dr. Frisby have been working on an instrument to measure life-long learning attitudes and skills in Jefferson graduates. A survey instrument was developed last year and tested on

several smaller populations[8]. The instrument will soon be sent to graduates and will, hopefully, indicate an upward trend in attitude and skills for self-directed life-long learning.

Developing realistic, interactive case studies is time consuming and requires a team approach. Accounting for the time of all team members we averaged 200 hours of work per one hour of finished, online activity. Pairing professional librarians, educators, and experts in the target field is necessary in order to construct cases that are convincing to students. In Jefferson's experience the results are worth the effort.

*The authors thank Elizabeth G. Mikita, MLS for her feedback and editing assistance in writing this chapter.*

**References**


1. Gagne, R.M. Briggs, L.J. Wagner, W.W. *Principles of Instructional Design* New York, NY: Holt, Rinehart and Winston, Inc., 1988.

2. Gagne, R.M. The *Conditions of Learning and Theory of Instruction* New York, NY: Holt, Rinehart and Winston, Inc., 1985.

3. *Learning Objectives for Medical Student Education: Guidelines for Medical Schools*. Washington, D.C.: Association of American Medical Colleges, January 1998 Available: <http://www.aamc.org/meded/msop/msop1.pdf>.

4. *The Nine Information Literacy Standards for Student Learning*. Chicago, IL: American Library Association 1998. Available: http://www.ala.org/aasl/ip_nine.html

5. Brown, J.S., Collins, A. & Duguid, S. "Situated Cognition and the Culture of Learning." *Educational Researcher*, 18(1988): 32-42.

6. Brown, J.S. & Duguid, P. *The Social Life of Information*. Boston, MA: Harvard Business School Press, 2000.

7. Frisby, A.J. "Self-Directed Learning Readiness in Medical Students at The Ohio State University" Ann Arbor, MI: *Dissertation Abstracts International* (1991) 2896A.

8. Hojat, M., et al "An Operational Measure of Physician LifeLong Learning: Its Development, Components and Preliminary Psychometric Data." *Medical Teacher,* 26(2003): in press.

Appendix A

Sample questions and responses from JMC Freshman Computing Survey.

| How many courses in your undergraduate program required you to use a computer? | Response |
|---|---|
| No courses | 6.5326633% |
| 1 course | 7.5376883% |
| 2 courses | 10.050251% |
| 3 or more courses | 74.874374% |
| Unanswered | 1.0050251% |

| Rate how confident you are that you could locate an authoritative discussion of a medical, pharmaceutical or therapeutic topic on the Internet. | Response |
|---|---|
| Extremely confident | 22.110554% |
| Confident | 45.22613% |
| Somewhat confident | 25.12563% |
| Not at all | 6.030151% |
| Unanswered | 1.5075377% |

| Rate how confident you are that you could locate an article using a bibliographic database such as MEDLINE or CINAHL. | Response |
|---|---|
| Extremely confident | 21.60804% |
| Confident | 43.21608% |
| Somewhat confident | 23.61809% |
| Not at all | 10.050251% |
| Unanswered | 1.5075377% |

| Do you know what MeSH means? | Response |
|---|---|
| Yes | 58.79397% |
| No | 39.698494% |
| Unanswered | 1.5075377% |

| Identify how important you think medical informatics skills will be to you as a physician. | Response |
|---|---|
| Very important | 69.34673% |
| Somewhat important | 28.643215% |
| Not very important | 1.0050251% |
| Not at all important | 0.0% |
| Unanswered | 1.0050251% |