
The University of North Carolina at Chapel Hill Health Sciences Library created an online tutorial to support PubMed instruction in an information management class for first and second year dental students. Tutorial content was intended to be understood by dental students with minimal exposure to the PubMed database and limited knowledge of dental terms. Usability testing was conducted using think-aloud procedures, PubMed application questions, and an interview. Data collected from this study revealed a number of usability and content areas that need improvement, such as the presentation of MeSH concepts, the presentation of MeSH and other content area that will stimulate knowledge retention, clarification of terms, structure of lessons, and organization of concepts. Sample scenarios, sample records, and interactivity with links to preformatted searches were found to support successful learning.

Headings:

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PubMed/Instruction
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Web sites/Evaluation
USABILITY STUDY OF AN ONLINE PUBMED TUTORIAL FOR DENTAL STUDENTS

by

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Approved by

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<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction</td>
<td>2</td>
</tr>
<tr>
<td>Literature Review</td>
<td>4</td>
</tr>
<tr>
<td>PubMed Tutorial Development and Preliminary Evaluation</td>
<td>6</td>
</tr>
<tr>
<td>Usability Testing Methods</td>
<td>7</td>
</tr>
<tr>
<td>Participants</td>
<td>7</td>
</tr>
<tr>
<td>Procedures</td>
<td>8</td>
</tr>
<tr>
<td>Data Analysis</td>
<td>10</td>
</tr>
<tr>
<td>Results</td>
<td>10</td>
</tr>
<tr>
<td>Usability Problems</td>
<td></td>
</tr>
<tr>
<td>Learning</td>
<td></td>
</tr>
<tr>
<td>Discussion</td>
<td>21</td>
</tr>
<tr>
<td>Recommendations</td>
<td>22</td>
</tr>
<tr>
<td>Conclusion</td>
<td>27</td>
</tr>
<tr>
<td>Sources Cited</td>
<td>29</td>
</tr>
<tr>
<td>Appendices</td>
<td>31</td>
</tr>
<tr>
<td>Appendix A: Tutorial Screenshots</td>
<td>32</td>
</tr>
<tr>
<td>Appendix B: PubMed Application Questions</td>
<td>43</td>
</tr>
<tr>
<td>Appendix C: Interview Questions</td>
<td>44</td>
</tr>
<tr>
<td>Appendix D: Recruitment Flyer</td>
<td>45</td>
</tr>
<tr>
<td>Appendix E: Consent Form</td>
<td>46</td>
</tr>
</tbody>
</table>
Introduction

With the escalating rate at which evidence-based medicine is being integrated into clinical practice, the teaching of basic search skills to find relevant literature is also gaining value. In 1999, the report of the Medical Informatics Panel of the Association of American Medical Colleges' (AAMC's) Medical School Objectives Project (MSOP) recommended that medical schools should incorporate a new discipline of teaching information retrieval and application skills into their medical education programs (Medical School Objectives Project, 1999). Unfortunately, few colleges have yet to implement such classes that teach literature searching, resulting in little evidence regarding the efficacy of various instructional methods (Berner et al., 2002). The curricula of dental schools face similar problems as those of medicine: incorporating literature searching into in an already full program.

Like most students in the health sciences, dental students have a full schedule, taking at least 7 to 8—sometimes up to 14—courses in a single semester. Dental schools are being pressured to reduce stress among their students by decreasing the number of hours of lectures and moving toward implementing methods of self-study and active learning strategies for instruction (Tomar, Silverman, & Carpenter, 1998; Institute of Medicine, 1995). It is crucial therefore to find further methods of instruction that increase self-study, moving learning outside of the classroom and into the scope of the individual’s own learning rate. One manner through which self-study can be pursued is
identifying and reading the literature pertinent to dentistry. This type of learning can be
undertaken whenever and wherever a student has access to the internet.

MEDLINE is one of the principle databases for finding evidence-based medicine support in dentistry: clinical trials, systematic reviews and meta-analyses. As a free service, the National Library of Medicine offers PubMed, a database that has indexed over 14 million citations including references not found in the core MEDLINE database (National Institute for Biotechnology Information). Like all databases, however, it has idiosyncratic search features and functions. To become an efficient or proficient user requires a certain amount of familiarity and experience. One aim of the University of North Carolina at Chapel Hill’s (UNC’s) Health Sciences Library (HSL) is to offer PubMed instruction to individuals and groups. Especially gratifying is when librarians are presented the opportunity by faculty members to teach PubMed search skills to their students.

A one-credit information management course is a requirement for first/second year students at the UNC Dental School. A single class session is designated to a health sciences librarian with the objective of giving students experience in PubMed and teaching them how to conduct simple literature searching. This class is typically the only opportunity UNC dental students have for receiving structured training on the PubMed database unless they make an individual effort to consult with a librarian. After the lecture, students are asked to answer various questions designed to apply their instruction to hands-on experience with the database within a lab setting. Given the size of the information management course, which can range anywhere from 70-85 students, library
resources are spread thin during this session as there are copious questions and problems that arise.

The Health Sciences Library decided to investigate whether or not PubMed training within the information management class setting could be enhanced via the use of a web tutorial, based on the content usually given in traditional lecture-style instruction. Such a tutorial was created from May to December 2004 by a team of one reference librarian, the liaison to the dental school, and a graduate assistant. The tutorial would then be used in a comparative study of instruction methodologies to investigate which is the preferred method for students and which method achieves a more positive outcome on testing. The goal of the current study was to evaluate the usability of the tutorial prior to its full-scale implementation and efficacy testing.

**Literature Review**

The Index to Dental Literature is a comprehensive dental index that covers articles published on dentistry from around the world and stretches back to 1839. MEDLINE contains bibliographic information on the articles—1966 to the present—taken from this index, making it the database of choice for most dental searches (Hook-Shelton, 1989; Ahluwalia & Long, 1996). Besides providing access to bibliographic information beyond the scope of MEDLINE (National Institute for Biotechnology Information), PubMed is also the cost effective choice (the National Library of Medicine’s PubMed access is completely free). PubMed is frequently recommended as the premier database for searching MEDLINE by evidence based dentistry centers.
The literature does not reveal much about the PubMed search skills and experience of dental students. Rather, a considerable number of studies look at the PubMed search performance of a population of medical students (Eldredge, 2004; Burrows & Tylman, 1999; Hersh et al., 2002; Berner et al., 1999). One study, however, implemented at the University of Texas Health Science Center at San Antonio, looked at the search experience and need for MEDLINE training among medical and dental students (Lawrence & Levy, 2004). The impetus behind this study was the estimation that MEDLINE training integrated into curricula was unnecessary. Results of this study reveal that 70% or more of the medical and dental students involved learned something about each MEDLINE concept that was taught during a workshop, convincing librarians, associated faculty and students that a MEDLINE class is important and should even be mandatory. It should be noted that both of these studies looked at teaching MEDLINE via the Ovid software, not via PubMed.

A review of the literature clearly shows evidence of a growth in usability studies performed on online library instruction tutorials (Bury & Oud, 2005; Jenks-Brown, 2004). What is less apparent are usability studies done on online modules used in search training. The literature does not disclose information on the effectiveness of online tutorials in searching.
PubMed Tutorial Development and Preliminary Evaluation

The tutorial is comprised of 4 lessons: 1—Introduction to PubMed; 2—Basic search skills; 3—Working with results; and 4—Getting to the full text of the article (Appendix A 1). All content covered in the tutorial lessons is analogous to the content that was taught in the lecture format with a single exception; the concept of MeSH (Medical Subject Headings) was not covered in previous lectures, but was incorporated into the tutorial. The tutorial was designed with freshman and sophomore dental students in mind. Terminology and scenarios used in the tutorial have a dentistry focus, but their inclusion is also based on the expectation that primary users of the tutorial—first and second year dental students—have limited knowledge of dental terminology. As a result, the use of advanced dental concepts and language were avoided as much as possible. Designers worked from scratch to build a template that was navigable and clear. Based on pilot tests conducted among HSL staff, the length of the tutorial was created so as to take a novice user approximately 50 minutes to complete and so matched the allotted time of the lecture in the information management class.

In January 2005, HSL staff conducted a comparative study to evaluate the relative effectiveness of the PubMed tutorial in comparison with a lecture style of teaching. Based on preliminary findings of this study, the Health Sciences Library wished to publish the tutorial on the web so that future classes would be asked to prepare by looking at the tutorial before class, and so that the online tutorial would serve as a permanent reference to which students can return.
Usability Testing Methods

In order to optimize the learning process a usability study was performed on the tutorial. The HSL staff had several concerns that were the focus of the usability study: clarity of terminology, especially words and phrasing associated with dentistry; organization of lessons; classification of content; navigability; relevance of examples and scenarios; and accuracy and understandability of concept descriptions. Of particular interest were usability issues relating to the presentation of concepts such as MeSH, and “mapping” (i.e., PubMed’s ability to translate a layman’s term into a medical subject heading).

Participants

The ideal participant for evaluating the tutorial would be a first or second year dental student with limited experience and knowledge of the PubMed database. However, since the entire UNC-CH population of first and second year dental students already had instruction using the tutorial, they were not recruited. Students in the Dental Hygiene and Dental Assisting programs were invited to participate through email flyers (Appendix D) and personal contacts. Since this recruitment strategy did not yield enough participants, they were also recruited from other environments. While not ideal, this strategy was not expected to create serious problems, since the tutorial avoided terminology of advanced dental concepts. The only inclusion criterion for participants was that they had minimal exposure to PubMed. Participants in the study were enlisted from undergraduate workers at the library, undergraduate students in an introductory biology class, and students in a
genetics class at UNC-CH. As compensation for their time, each participant was given $15.

The mean age of the nine participants was almost 20 and the median age, 19. There were five females and four males. All participants said that they spent an average of seven days a week using a computer. Five said that they had no previous experience using PubMed; three said that they had searched PubMed at least once before their session but had trouble finding what they needed; only one participant claimed to have searched PubMed more than once before the session and was able to find what was needed. Not a single participant said that they could successfully use PubMed in searching for articles. Seven of the participants were undergraduate students in the general College of Arts & Sciences at UNC-CH. The break down of year of study for those seven: four freshmen; one sophomore; one junior; and one senior. Two participants are employees of the Health Sciences Library: one is a recent graduate from UNC-CH, the other is a recent graduate from another University.

**Procedures**

Each usability study session was composed of three parts. First, each participant was to complete three lessons of the tutorial while thinking aloud (Barnum, 2002; Preece, Rogers, & Sharp, 2002). The participant was asked to voice any thoughts or opinions on the tutorial. Use of think-aloud protocols supports a greater depth of understanding of users’ frustrations and problems with a tutorial. Second, the participant responded to four PubMed Questions (Appendix B), applying the knowledge that they acquired through the tutorial. The third and last part of the session was an interview (Appendix C) composed
of questions intended to gauge users’ opinions on the tutorial as a whole and what they thought were problem areas. Participants were encouraged to offer as much discussion and feedback as they wanted, and had more freedom to express themselves than could be measured with a simple high/low rating scale.

Nine participant sessions were conducted individually—all took place at the Health Sciences Library, and all in one of two study rooms located on the first floor. The investigator was present for the entirety of each session. The equipment that was used for all the sessions was an HSL loaner laptop and an audio cassette player/recorder, also borrowed from the Health Sciences Library. Both the PubMed tutorial and database were opened on separate browsers prior to the beginning of each session. After entering the room, participants were first asked to read the consent form (Appendix E). The investigator answered any questions and explained the three parts of the session that would be asked of the participant: going through the tutorial, the four PubMed application questions, and the interview. The think-aloud procedure was described; participants were asked to narrate their negotiation of the tutorial and to mention any usability problems such as navigation and concept comprehension. Privacy issues were also explained; only the investigator would have access and listen to the tapes. During times of no-use, the tapes would be stored in a locked cabinet. The investigator let each participant know that he or she was welcome to ask the investigator any questions that might arise, as that would also help to determine issues of clarity. After the participant signed the consent form the record button was pressed and the session began.
Data Analysis

Audio tapes of the think-aloud protocols and the interviews were reviewed and those portions describing problem areas were transcribed. All of these comments were identified, categorized and tallied. These category descriptions are presented with the results.

Results

Usability Problems

Table 1 shows the results of the main usability problems identified. Each category will be defined and examples of each category usability problem will be presented here.

Table 1: Classification of Usability Problems

<table>
<thead>
<tr>
<th>Usability Category</th>
<th># Participants with stated Usability Problem</th>
</tr>
</thead>
<tbody>
<tr>
<td>Image Clutter</td>
<td>3</td>
</tr>
<tr>
<td>Lack of Interactivity</td>
<td>4</td>
</tr>
<tr>
<td>Language &amp; Terminology</td>
<td>5</td>
</tr>
<tr>
<td>Mapping</td>
<td>5</td>
</tr>
<tr>
<td>MeSH Definition</td>
<td>3</td>
</tr>
<tr>
<td>MeSH Concept</td>
<td>7</td>
</tr>
<tr>
<td>Navigation</td>
<td>1</td>
</tr>
<tr>
<td>Organization of Content</td>
<td>4</td>
</tr>
<tr>
<td>Sample Record</td>
<td>1</td>
</tr>
<tr>
<td>Scenario Clarity</td>
<td>1</td>
</tr>
<tr>
<td>Structure of Lessons</td>
<td>3</td>
</tr>
</tbody>
</table>
Image Clutter

The “Image Clutter” category is for participant comments that articulate an image being superfluous or unclear; that a certain page has too many images or suffers from “image overload,” which makes reading the text in between the images difficult. For instance, Participant 9 said, about the tutorial during the interview, “Sometimes it was a little busy with the graphics.” This was not a usability issue that was directly tested for—images or pictures were not specifically mentioned in the prescribed interview questions. However, as the images were intended to aid the comprehension of concepts, they were indirectly analyzed through the testing of clarity and understanding.

The problem area for image clutter takes place most often on the last two pages, Limiting Search Results and Selecting Results (Appendix A 2-3). Of the Selecting Results page and its first image, Participant 3 said, “This page is kind of, I mean it’s good, but at the same time showing all this. Especially right here [pointing to the image of “xylitol AND chewing gum AND dental caries” with two results selected and circled in red.] I don’t know what I’m supposed to be looking at exactly.” On the same page Participant 2 felt that perhaps there should be “some kind of space between them. Someone might think that [the text] is part of the picture, even though there is a border--but a dotted line maybe, or a bar or a different background color.” Participant 9: “That picture might be a little unnecessary. Most of them seem pretty good but that one’s a little ‘uh?’” The image in question is the last one on the page, showing the link to “Clipboard” circled in red (Appendix A 3, part 3).
There was a counterbalance to image clutter; many people explicitly stated that they liked the images, such as Participant 7: “I really like the pictures…they help me see what I’m supposed to do.”


Lack of Interactivity

Another unanticipated usability issue, “Lack of Interactivity” is the category for participants’ opinions that more places to interact with the tutorial and more ability to practice with presented concepts would have added to the success of the tutorial. Throughout the tutorial were links to preformatted PubMed search results or simply to PubMed, but there were no intra-tutorial ways of practicing, such as quizzes or practice fields. Participant 3 expressed a clear dissatisfaction on this issue:

The content was pretty good, I think that the only thing that would have been better if I could have actually had like a mini page up while I was looking at it, or use the drop down menu, so I’d kind of, you know, when I actually went to go to it I’d already kind of done it as I was doing the tutorial… It seems that it would have been easier to have something like that to look at while going through it and actually seeing the exact screen of what it was that the person needed to know and look at. More than two sentences and an image with a red circle.

Some participants expressed their feeling that a quiz or interactivity was expected in a learning module. Such was the case with Participant 4 who, when going through the page on using single citation matcher, said, “Do you have a practice search at the end of this, or does it just go through how to do it?” After the investigator said no, it would not have a practice search at the end of the page: “I was expecting it to do that later, afterwards. It’s usually helpful.”
Language & Terminology

Any mention of a word or phrase not making sense was tallied in this category. The two exceptions to this were the terms, “MeSH” and “Mapping”; each of these was placed in an individual category. Confusion arose from terms such as “Xylitol,” a substance name that one of the searches explains means sugar alcohol. Some people were unclear about this. Participant 7 wanted greater clarification of what Xylitol is, and Participant 3, when coming across the word, stated, “Is this based on the assumption that the dental students would know what, whatever that is?...I would never read that and think to use that word instead. I would have no idea what that is.” The “that” to which Participant 3 is referring is Xylitol and the word that it is replacing is “sugarless.” “Dental caries” was another term that garnered confusion (Participant 4: “Dental caries? Is that a specific dentistry term?”). In part, this confusion may be due to the original intended audience not being included in the sample; they might have a better idea of what a sugar alcohol is.

There was also confusion with terminology that is more related to the language used by PubMed. For instance, in PubMed, to view the full record of an article along with all of its MeSH terms, one needs to select “Citation” next to Display. Participant 3 explained: “When I think of citation I think of the short information about an article.” Another source of confusion was the phrase “publication type” which, in PubMed, refers to the study design that was employed in the article, such as meta-analysis or randomized controlled trial or review, etc. Participant 3: “When I first saw the word publication type, I was thinking oh, book or magazine or journal, not the actual, how they collected their research.”
**Mapping**

The formal definition of “Mapping” is somewhat vague as described in the tutorial, which does not explicitly say what “mapping” is. The term “mapping” or “maps” is given a contextual definition at the bottom of the *Entering Search Terms* page in lesson 2. Participants conveyed confusion upon first reading the term. Participant 3 asked simply, “So, mapping--?” In *Check the Details*, “map” is again used and a number of participants revealed that the earlier definition did not suffice. Said participant 3 later: “I’m not sure I understand why ‘sugarless’ is not mapping.” Participant 5, like others, had trouble understanding from the tutorial definition that mapping helps perform a search: “So is it good that it mapped to a MeSH?”

**MeSH Definition**

A distinction was made between the categories of MeSH Definition and MeSH concept. “MeSH is a concept that is mentioned in the tutorial prior to its formal identification and definition. A usability issue that is assigned to the “MeSH Definition” category is a problem where the participant expressed a lack of understanding or a curiosity of the concept prior to its definition. The category of “MeSH Concept” (below) is when a participant expresses confusion during or after the point of having been exposed to the definition in the tutorial. The two categories are not mutually exclusive, some participants expressed issues that were tallied in both the Definition and the Concept.

Because it is so integral to the PubMed database, the term, “MeSH,” could hardly be avoided in creating the tutorial. In fact, it warranted mention even in the first page of
the first lesson of the tutorial, long before it is formally identified. It is no wonder, then, that a number of participants had questions when seeing the strange acronym, MeSH. Participant 7 indicated that he wanted more clarification of MeSH when encountering it on the first page. (Participant 8: “What’s a MeSH”; Participant 5: “What’s this [MeSH]?”)

MeSH Concept

Almost all participants articulated some kind of confusion with the concept of MeSH as described in the tutorial. Participants’ comments were typically made both during the think-aloud protocols and during the interview. The following quotations are a sampling of the variation in the comments:

Participant 1: “I did feel like that the first time that I saw the part about mapping and MeSH, that made sense when I read it, but the way that it was used in the actual program was a little bit different.”

Participant 2: “MeSH terms.” –After being asked what was the most troublesome area in terms of understanding.

Participant 3: “Everything was clear except for the MeSH.”

Participant 4: “I’m a little confused on these MeSH words, MeSH terms, um, are they… Does just the computer recognize them as specific MeSH terms, or you have to put them into a certain--?”

Participant 5: “Maybe the MeSH could have been presented first.”—After being asked if the tutorial was well organized.

Participant 6: “Will you know what the MeSH terms are, that you’re looking for?”
Participant 7: “So MeSH will find synonyms?”

Participant 9: “Maybe a dental student would know what that meant.”

**Navigation**

Usability issues regarding problems moving between pages and lessons were categorized here. With a single exception, no one claimed to have any problems with navigation. Participant 4 did express frustration when trying to go back into the tutorial to answer the first PubMed question, having trouble getting to the page he was looking for. Rather than use the contents page, he used the “previous page” arrow found at the bottom of all pages. In fact, all users used the arrows at the bottom of the page for navigating. Participant 4 later explained that he was confused about the side-links, thinking that they were for getting between lessons, rather than a listing of the individual pages among the present lesson. “Sometimes there was navigation issues, with the side-links….at first I thought these were all the pages that I’d already viewed. I didn’t realize it was just for one lesson.” Since this issue also gets at an issue of structuring the lesson, this issue was tallied under “Structure of Lessons” as well.

**Organization of Content**

This category was intended for users’ descriptions of problems concerned with concepts’ relationships with one another. For instance, three people made comments regarding the last page of Lesson 3 (*Selecting Results*) being jumbled, and lacking a proper segue between the two related but separate topics: emailing results and saving results in Clipboard. Participant 1: “So this is after already talking about searching…Well
it’s sort of abrupt because it’s going, like this is the different ways you can search and
then talks about email.” Participant 3 had a number of things to say on this topic:

“Like on the big long page where it was talking about how to send it to yourself, and all that kind of stuff, you know, all of a sudden we’d be doing it a different way and I wouldn’t realize that we weren’t really sending it to ourselves any more, we were just storing it on clipboard instead, and so halfway through, ‘clipboard’, that’s not really a way to send it to yourself. And that was kind of confusing.”—After being asked if the content was clear.

“Some of it I don’t think was broken up very well, and there was just a lot of stuff that was crowded onto a few pages and then pages just had next to nothing on them and so those pages were really easy to look at and go through and grasp and then move on to the next page.”—After being asked if the tutorial was well organized.

Disorganization of concepts could be the reason behind some participants’ requests for clarification; Participant 8, on Clipboard: “So that’s where you want to store things after email, that clipboard option?” Participant 7: “Can you just view the article online or do you have to send it to yourself?”

Sample Record

Most people made positive comments about seeing a sample record. For example, “I like seeing this example;” Participant 1 said. One person, however, said the format of the record in the tutorial—being in a chart form (Appendix A 6)— was confusing.

Participant 8, when looking for MeSH terms in the Citation view: “I’m having trouble finding the MeSH terms. I must have been thrown off by that table earlier.”

Scenario Clarity

This category was defined as including the potential lack of clarity with scenarios that focused on dentistry (Appendix A 4-5). Said participant 8: “Um, I didn’t really
care…It is there for medical reasons, so the examples were fine. I just didn’t really pay
attention because I didn’t care. I wasn’t really researching anything.” Overall, however,
users said they thought the scenarios were effective and useful in providing a practical
example. Participant 4, for example: “I think the examples are good. They’re not
technical, so you can understand them.”

Structure of Lessons

Any uncertain distinction about the tutorial’s lessons and the pages found therein
were tallied in this category. Participants cited their confusion with what things are
called, and their difficulties remembering what concepts are called and where they can be
found in the tutorial. This was part of Participant 4’s dilemma when trying to go back
into the tutorial and find information about the best way to enter names. Participant 1 had
similar problems, when looking for journal abbreviation information. She found it, but
later described a usability problem: “I wasn’t sure what that section was called.” When
asked about the lessons, Participant 3 said that she had trouble knowing when one lesson
ended and another began.

Learning

The inclusion of the four application questions (Appendix B) in the study was
intended to measure whether or not participants were able to understand and retain
concepts presented in the tutorial. Each of the four questions was meant to assess learning
of one of four main concepts the tutorial was designed to teach.
Table 2 shows the results from the scoring of the application question responses. If the answer was incorrect, a score of ‘0’ was given. A ‘1’ was given if the user got the question right, but the answer was qualified in that he or she asked the investigator a question or, in the case of the last question, only half of the question was answered correctly. When the participant answered the question fully and did not need to inquire the investigator’s help, a ‘2’ was awarded.

Table 2: *PubMed Questions*

<table>
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<tr>
<th>PubMed Question</th>
<th>Number of Participants to Receive Each Score</th>
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<tbody>
<tr>
<td></td>
<td>0</td>
</tr>
<tr>
<td>Search by Author Name</td>
<td>2</td>
</tr>
<tr>
<td>Single Citation Matcher</td>
<td>1</td>
</tr>
<tr>
<td>Journals Database</td>
<td>3</td>
</tr>
<tr>
<td>MeSH</td>
<td>0</td>
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The first application question asked users’ knowledge of how to *best* enter an author’s name in PubMed. Although thought to have been clearly described in the tutorial, most users went to the database and tested each of the four possible choices before deciding. They usually, but not always, chose the correct answer.

The second question was meant to test the tutorial’s ability to teach Single Citation Matcher. Single Citation Matcher is a useful PubMed tool in which one can look up an existing article only having a few bibliographic pieces of information. It has search fields of author, date, volume, year, first page number, and title keywords. Almost everyone got this question right. Everyone was able to get to a results page but one
person did not scroll down far enough to see the right article. However, only two people actually used Single Citation Matcher to arrive at their answer. Most people entered terms into the main search box. Scores to these were not qualified because a) entering terms is an appropriate way to look for things, just not the best method, and b) the structure of the question does not necessarily rule out a lack of understanding of Single Citation Matcher if the question is arrived at in a different manner.

The third question is less ambiguous. It essentially requires that someone utilize the Journals Database in PubMed to arrive at a correct answer. Although three people got full points correctly using the Journals Database, many had difficulties. After floundering in PubMed for a while, three people eventually asked a question. Two people choose to go back into the tutorial to look for the information, saying that they remembered seeing a section discussing the Journals Database. Only one person successfully found it, though. Three people eventually put something incorrect and moved on. One person later explained that the question confused him; Participant 2 asked, “Is this the full title, Sleep Breath? So I type it in here?” Evidently, the abbreviated journal title that the question was asking about, Sleep Breath, appeared to be a full title, therefore confusing the participant.

The last question had two components. The first involved knowing how to display the MeSH indexed to an article, and the second involved understanding the concept of using specific MeSH when wanting to find related articles. Most people were able to correctly view the MeSH terms. But then they simply chose two terms, not necessarily two that would help them look for articles on that topic. Participant 9 asked: “Do I just pick two?” More often, participants would first select a MeSH that was correct, either
Orthodontic Appliances or Sleep Apnea, pause, and eventually ask whether they needed to select another. When it was explained that the MeSH should be something that would help find articles on the given scenario, many participants would put Humans, not realizing that both ideas in the question’s scenario were MeSH.

**Discussion**

There were several limitations to this study. First, the participants involved in the study were not dental students. While language and scenario terminology were confusing to some participants, it remains unclear whether a first year dental student would have similar attitudes or would be able to easily understand all language and scenarios in the tutorial. Second, two of the application questions had design faults. The second question did not adequately gauge the success or failure of the tutorial’s ability to teach on Single Citation Matcher. The third question used a poor example: “Sleep Breath” already appeared to be a full journal title and thus confused the participant as to what the question was asking. Lastly, many participants illustrated poor usability issues of the PubMed interface. Almost all participants had trouble when attempting to view the article in the “Citation” format. After selecting “Citation” from the drop down menu, a person needs to hit the “Display” button, it does not do it automatically. This particular issue has now been resolved in the PubMed database since the conclusion of the data collection period of this study (National Center for Biotechnology Information, 2005). Participants would also get stuck in the Journals Database or the MeSH Database, not realizing that they had to go back to PubMed in order to search for articles again. Usability shows that
instruction on the Journals Database and the MeSH Database as separate but related databases is necessary.

**Recommendations**

In spite of these weaknesses, the study was successful in identifying two types of usability problems. The first type of usability problem was those mentioned only rarely, but still of importance. Usually, these were problems of clarification of terminology (e.g., xylitol and MeSH) or a single area of content organization (e.g., layout of last page). This type of problem should require less time, effort and thought to redress. The second type of usability problem included chronic and extensive concerns, typically at the conceptual level. These problems suggest that some concepts are not being carefully or thoroughly illustrated, and may require a large revamping or extrication of certain areas of the tutorial.

**Image Clutter**

Images were added to the tutorial to aid understanding of the steps one should take when navigating the PubMed database to perform specific tasks. The usability study found that some of the images presented in the tutorial are either unclear or superfluous without complementing text (e.g., first and last images on the *Selecting Results* page). One participant though that the last image on the *Selecting Results* page was “unnecessary.” It is, however, important to show where a user can find the “Clipboard” link. Therefore, it is recommended that instructions be laid out more effectively of where to find Clipboard, as well as provide a specific example to practice with. Usability
guideline also recommends somehow highlighting each image as being an image, making a clearer distinction between it and the text. Only one participant observed this, but it would certainly help in pages where verbiage is constantly flanked by images. Usability guideline recommends putting more space between images and text on these pages.

*Lack of Interactivity*

Usability testing found that people wanted more places to practice in the tutorial, that this would make clearer the concepts and help retain knowledge. The tutorial has links to PubMed scattered throughout it, for practicing skills recently taught or to view results of searches described. However, only four participants used these links at least once. Three participants asked if they should follow them and do the practice. When told that doing so was completely up to them, one person did and two did not. The links that are available for practice typically take the participant into PubMed to perform the same search that the tutorial went through.

Usability results indicate that quizzes should be added at the ends of pages and lessons to reiterate concepts. Answering of the quizzes will pop up in new windows when a selection is made. Including quizzes was something that the designers grappled with when making the modules. Part of the reason for leaving the quizzes out was because of the original time constraints put on by the class setting. The tutorial designers also hoped that the practice links in PubMed might be more useful.

Other links took users to preformatted search results in PubMed. However, the purpose of the table with these varying searches and the number of results, which is found on the *Search for Similar Articles*, was not clear: “I’m not sure what this is for?”
Participant 5: “Are these MeSH?” No one really gave positive feedback on these so it is recommended that the list be shortened and more textual context be provided.

*Language & Terminology*

The usability testing revealed that some terminology –“xylitol” and “dental caries”— is perhaps too complex and dentistry-related to be used for a broad audience. These usability tests, however, were unable to ascertain whether first year dental students would have similar problems with comprehension, since study participants did not come from the target audience.

It is recommended that PubMed jargon, such as “citation” and “publication type,” be explained, as it was a source of confusion for some people. One method is to put the definition underneath the word. It might prove more useful, however, to have the terms, whenever mentioned in the tutorial, hyperlinked to a glossary of terms where they are then defined. Alternatively, the hyperlink could open a new pop up window with the related definition.

*Mapping*

Mapping was found to be a conceptual problem, perhaps due to its interrelatedness with MeSH (another chronic problem area). Since shorter pages are easier to read, “Mapping” should be giving its own page so as to define it and offer examples. A short quiz could be given at end: a question asking, “What does this term “map” to in PubMed?”
MeSH Definition

As stated earlier, it would be next to impossible to withdraw all mention of MeSH from a tutorial about PubMed. Thus, even if the concept is deemed too advanced for the goal of this tutorial and therefore removed, the word and its definition will still need to be addressed. Making an interactive glossary should greatly lessen the usability problems that were included in the “MeSH Definition” category. Users would be able to click on the term, “MeSH,” wherever they see it mentioned in the tutorial, and go either to a glossary entry or go straight to the definition of MeSH as it is presented in the tutorial. The approach to providing the MeSH definition hinges on how the MeSH Concept is presented, discussed below.

MeSH Concept

There are a number of avenues that will address the usability problems identified in this category. The MeSH concept is a chronic problem and may need to be extracted from the tutorial entirely, or, more likely, placed in an advanced section of the tutorial that would be created at a later time. If the tutorial is intended to teach only basic methods and skills of searching in PubMed, MeSH should not be kept. Unavoidable citing of MeSH should be linked to a concise definition. Moreover, a better solution is to create an advanced searching module. This was an idea that the original design team discussed. This portion of the tutorial would discuss ways to limit or narrow searches. If created, MeSH should be transferred to this section. It should have its own page, and should be described thoroughly yet succinctly, supplemented with a quiz at the bottom and hyperlinked definitions of the term mentioned elsewhere in the tutorial.
**Navigation**

Although navigation was not a significant problem, more indication should be made that the side-links are in fact side-links. The tutorial should have a page at the beginning to describe “Using This Tutorial.” Here, the purpose of the side-links (i.e., that they link to pages within the lesson and that there is one that links to the table of contents) should be explained. Other possibilities are to more prominently display the links or underline them.

**Organization of Content**

To improve the tutorial’s organization, it is recommended that the Selecting Results page be separated into two pages: one on Emailing Results and one on Storing Results on Clipboard. Having more pages with less content on each should make concepts easier to grasp.

**Sample Record**

The sample record was useful for users and should therefore be kept in the tutorial. However, it would be useful to clarify with some verbiage at the top of the page what exactly the record is; what the user is seeing is the disparate elements of a full record divided and in a table format.

**Scenario Clarity**

As with language and terminology, this usability test was unable to evaluate scenario clarity on its intended audience to gauge understandability. Only one participant,
however, stated having trouble with the scenarios; and it was not a situation of not understanding but, rather, one of not “caring.” Therefore, no changes are recommended for the scenarios. They are clear and should not be too clinically worded for the tutorial’s intended audience.

Structure of Lessons

The titles of lessons and pages should be made more distinctive. Many users were not aware that there were multiple lessons. There should be clear breaks between lessons, with a header page or introduction page separating each one.

The titles of sections should also be made clearer and simpler. Emailing Results should be used rather than Selecting Results. This change will help users know where to go when referring back to something specific in the tutorial. Also recommended is to have more pages with less content in general; the longer pages should be broken up like those in the third lesson.

Conclusion

The goal set out by the investigator of this study was to assess the usability of the HSL PubMed tutorial. Its aim was to look at potential problem areas, such as MeSH and the language and terminology used, as well as other problem areas that could possibly arise, and to gauge the tutorial’s clarity and understandability while determining recommendations for improvement. The usability study accomplished these goals. It revealed more superficial problem areas that can be remedied relatively quickly, while
simultaneously proposing more conceptual changes to be made or considered. Not all the recommendations made as a result of this usability study may be possible to make, but taken together, the results have indicated options open to designers at this point.

The usability study was a worthwhile endeavor. It succeeded in its goals and provided necessary recommendations for the future design of the tutorial. This usability study has implications for future usability studies. The data collected from the PubMed Application Questions helped appraise the tutorial in an effective manner, supplemented by the comments from the interview and the think aloud protocols.
Sources Cited


Medical School Objectives Project. (1999). The informatics panel and the population health perspective panel. contemporary issues in medicine—medical informatics and population health: report II of the medical school objectives project.” *Acad Med.* 74:130–41


Appendices
Appendix A: Tutorial Screenshots

Appendix A 1: PubMed Tutorial Table of Contents

Lesson 1
- What is MEDLINE / PubMed?
- Sample PubMed Record
- Connecting to PubMed

Lesson 2
- Scenario
- Entering Search Words
- Single Citation Matcher
- Browse Related Articles
- Search for Similar Articles

Lesson 3
- Scenario and Initial Search
- Check the Details
- Finding New Search Words
- Limiting Search Results
- Selecting Results

Lesson 4
- Getting the Complete Article
- Abbreviated Journal Title to Full Title
- Full Text from LIL Electronic Journals
- Full Text from the Library Catalog
- Full Text in the Library
Appendix A 2: PubMed Tutorial *Limiting Search Results*

Limiting options can help focus the search results.

<table>
<thead>
<tr>
<th>Option</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Publication</td>
<td>Limits results to records about pre-planned clinical studies of</td>
</tr>
<tr>
<td></td>
<td>the safety and efficacy of a therapeutic substance. See results.</td>
</tr>
<tr>
<td>Review</td>
<td>Limits results to records about articles that review a number of</td>
</tr>
<tr>
<td></td>
<td>studies on the topic. See results.</td>
</tr>
<tr>
<td>MeSH Database</td>
<td>Limits results to records about terms that define MeSH terms as well as the</td>
</tr>
<tr>
<td></td>
<td>meaning of all Publication Types.</td>
</tr>
</tbody>
</table>

Limits options are available for the following areas:

- **All Fields**: Only items with abstracts
- **Publication Types**: Languages, Subsets
- **Apps**: Humans or Animals, Gender
- **Publication Date**: From, To

For this search look at two options under Publication Type:

- **Clinical Trial**: Limits results to records about pre-planned clinical studies of the safety and efficacy of a therapeutic substance. See results.
- **Review**: Limits results to records about articles that review a number of studies on the topic. See results.
- **MeSH Database**: Limits results to records about terms that define MeSH terms as well as the meaning of all Publication Types.
Appendix A 3: PubMed Tutorial Selecting Results, part 1

Selecting Results

Mark selections

Click in the box next to the citations you want to select.

E-mail selections

Select "E-mail" from the drop-down list and then click the "Send to" button.
Appendix A 3: PubMed Tutorial Selecting Results, part 2

Selecting Results, part 2

Select “E-mail” from the drop-down list and then click the “Send to” button.

Enter the email address and click the “Mail” button.

Store selections on Clipboard
Appendix A 3: PubMed Tutorial *Selecting Results*, part 3

Enter the email address and click the "Mail" button.

- **Select 2 document(s)**
  - **Format**: Summary, HTML
  - **Sorting**: Sort
  - **Start with steps**: 1 and 20 of 2
  - **Additional text (optional)**
  - **E-mail**: [Field]

**Store selections on Clipboard**

Select "Clipboard" from the drop-down list and then click the "Send to" button to store selections while performing multiple searches.

Click on "Clipboard" under the search statement to work with selections when you are done searching.

*Send to* options are available on the Clipboard pane.
Scenario

A basic task in PubMed is to search for the record of an article when you have some information about it. Perhaps the article was mentioned in class, or maybe you saw it cited in something you were reading. Once you find the article's record in PubMed you can read the abstract to find out more about its content and use information in the record to search for similar articles.

We'll use the following citation as a search example:


There are two ways to search PubMed for known articles.

1. Enter a few search words connected by AND in the main search box
2. Use Single Citation Matcher
Appendix A 5: PubMed Tutorial Lesson 3 Scenario and Initial Search

Scenario and Initial Search

A more advanced task in PubMed is to look for article records that relate to a specific information need. The following situation is an example:

The initial examination of a new patient in your practice, a 14-year-old boy, reveals that he has a number of carious lesions. When you ask him about his typical snacks and drinks you learn that he chews gum "most of the time." He says he has heard that some kinds of gum may help prevent tooth decay and asks for your advice on what kind to chew.

You remember seeing some research indicating that certain kinds of sugarless chewing gum may help reduce tooth decay. You suggest that sugarless gum would be better than gum with sugar, and tell him that you will look for more specific information to give him at his next appointment.

Later, you try a "quick and dirty" search in PubMed, entering a few search words/phrases related to the topic.

Go to search results in PubMed.
## Sample PubMed Record

<table>
<thead>
<tr>
<th>Field</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abbreviated journal title</td>
<td>Am Dent Assoc.</td>
</tr>
<tr>
<td>Date, Vol #, Issue #, Page #</td>
<td>2001 Mar;152(3):368-76.</td>
</tr>
<tr>
<td>Link(s) to comments</td>
<td>J Am Dent Assoc. 2001 Jan; 132(6):723.</td>
</tr>
<tr>
<td>Link to full-text article</td>
<td>UNC Full-Text Online</td>
</tr>
<tr>
<td>Title of the article</td>
<td>Evaluation of a biadhesive device for the management of aphthous ulcers.</td>
</tr>
<tr>
<td>Author’s names</td>
<td>Katcher MJ, Ladhoe JB, Sammelson AD, Campbell T, Pazek SN.</td>
</tr>
<tr>
<td>First author’s institutional affiliation</td>
<td>Department of Diagnostic Sciences and General Dentistry, University of North Carolina School of Dentistry, CB 7450 Braxes Hall, Chapel Hill, NC 27599-7450, USA. <a href="mailto:MIEWVCJED@email.unc.edu">MIEWVCJED@email.unc.edu</a></td>
</tr>
<tr>
<td>Detailed abstract</td>
<td><strong>BACKGROUND:</strong> Aphthous ulcers are common and painful. Current treatments are palliative and focused on pain reduction. This article reports on the clinical trials of a novel, biadhesive treatment modality. <strong>METHODS:</strong> Formulations of 2-octyl cyanoacrylate, or 2-OCA, tissue adhesive were tested in two blinded, sham-controlled studies. A total of 200 patients with a single, partial aphthous ulcer were entered. In the first study, the investigators applied the tissue adhesive to the aphthous ulcer; in the second trial, the subjects...</td>
</tr>
</tbody>
</table>
## Sample PubMed Record, part 2

### Publication Types
- Clinical Trial
- Clinical Trial, Phase I
- Clinical Trial, Phase II
- Multicenter Study
- Randomized Controlled Trial

### MeSH Terms:
- Administration, Topical
- Adult
- Comparative Study
- Cynomolgus, Administration & dosage
- Cynomolgus, therapeutic use*
- Drug, Non-Prescription, administration & dosage
- Drug, Non-Prescription, therapeutic use
- Female
- Hemorrh
- Hydrogel, Administration & dosage
- Hydrogel, therapeutic use
- Linear Models
- Male
- Pain prevention & control
- Pain Measurement
- Ethanols
- Promotional Hazard Models

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Conclusions: The formulations of 3-OCA tissue adhesive tested were safe and demonstrated statistically significant pain reduction when applied by either the investigator or the subjects.

Clinical Implications: Our clinical trials indicate that these novel tissue adhesives could be used as nonprescription, over-the-counter devices to provide significant pain relief for patients suffering from superficial wounds.
Appendix B: PubMed Application Questions

Appendix B 1: PubMed Application Questions

PubMed Questions

1. Which of the following searches is the best way to look for all of the papers published by Dr. Daniel Caplan that have been indexed by PubMed?
   ______Daniel Caplan
   ______Caplan, Daniel
   ______Caplan D
   ______Caplan

2. Search PubMed for the PubMed record of an article published in 2002 by Labella about dental injuries in college basketball. Copy the PMID # (found at the bottom of the record).

3. What is the full title for the journal with the PubMed abbreviation: Sleep Breath?

4. Enter 15211392 in the PubMed search box. (This number is the PMID # for a specific PubMed record.) Change the Display so you can see the MeSH Terms for this record. Enter two of the MeSH terms that you could use to find more articles about the use of oral appliances in patients with sleep apnea.
Appendix B 2: PubMed Application Questions and Answers

PubMed Questions

1. Which of the following searches is the best way to look for all of the papers published by Dr. Daniel Caplan that have been indexed by PubMed?

______Daniel Caplan
______Caplan, Daniel
___X___Caplan D
______Caplan

2. Search PubMed for the PubMed record of an article published in 2002 by Labella about dental injuries in college basketball. Copy the PMID # (found at the bottom of the record).

11782645

3. What is the full title for the journal with the PubMed abbreviation: Sleep Breath?

Sleep and Breathing

4. Enter 15211392 in the PubMed search box. (This number is the PMID # for a specific PubMed record.) Change the Display so you can see the MeSH Terms for this record. Enter two of the MeSH terms that you could use to find more articles about the use of oral appliances in patients with sleep apnea.

Orthodontic Appliances, Removable*
Sleep Apnea, Obstructive/physiopathology*
Appendix C: Interview Questions

Interview Questions

Demographic Questions

1. Identification Number: __________________________

2. Age _____

3. Female____

   Male____

4. With which school are you affiliated?

5. What is your year of study with that school?

Usability Questions

1. On average, how many days in a week do you use a computer?

2. Which statement best describes your previous use of PubMed.

   _____ I have never searched PubMed before today.

   _____ I have searched PubMed at least once before today but had trouble finding what I needed.

   _____ I have searched PubMed more than once before today and was able to find what I needed.

   _____ I can successfully use PubMed in searching for articles.

3. How familiar are you with online materials/ databases/ tutorials/ etc. ?

4. Overall, how satisfied are you with the tutorial?

5. Did you have trouble moving between pages or lessons?
7. Do you feel that the tutorial was well organized?

8. How clear were language and terminology used in the tutorial?

9. How clear was the content being covered?

10. What were the most troublesome areas you had in terms of understanding?

11. How informative were the lessons in the tutorial?

12. How suitable and/or effective were the scenarios offered in lessons 2 and 3?

13. Did the tutorial enhance your ability to search and navigate PubMed?

14. If so, how and to what degree?

15. Did the four PubMed Questions effectively test your knowledge as reflected in what you learned from the tutorial?

16. Please describe or discuss any further issues you had while going through the tutorial or the PubMed questions.
Appendix D: Recruitment Flyer

Volunteers Wanted!

Learn PubMed for FREE!

The Health Sciences Library at UNC-Chapel Hill has created a PubMed training tutorial directed especially toward students in the School of Dentistry. We are looking for students enrolled in the dental assisting and the dental hygiene programs to help evaluate the tutorial. The session will take no longer than 90 minutes. All participants who complete the session will receive $15!

If you are interested or have questions please contact Anna Krampl (krampl@email.unc.edu).
Appendix E: Consent Form

University of North Carolina-Chapel Hill
Consent to Participate in a Research Study
Adult Participants
Social Behavioral Form

IRB Study #_____________________
LIBS 2005-026
Consent Form Version Date: __________

Title of Study: Usability Study of an Online PubMed Tutorial for Dental Students

Principal Investigator: Anna Krampl
UNC-Chapel Hill Department: SILS
UNC-Chapel Hill Phone number: (919) 966-8334
Email Address: krampl@email.unc.edu
Faculty Advisor: Barbara Wildemuth
Study Contact telephone number: (919) 966-8334
Study Contact email: krampl@email.unc.edu
Funding Source:

What are some general things you should know about research studies?
You are being asked to take part in a research study. To join the study is voluntary. You may refuse to join, or you may withdraw your consent to be in the study, for any reason, without penalty.

Research studies are designed to obtain new knowledge. This new information may help people in the future. You may not receive any direct benefit from being in the research study. There also may be risks to being in research studies.

Details about this study are discussed below. It is important that you understand this information so that you can make an informed choice about being in this research study. You will be given a copy of this consent form. You should ask the researchers named above, or staff members who may assist them, any questions you have about this study at any time.

What is the purpose of this study?
The purpose of this research study is to learn about the usability problems of a PubMed tutorial that was created by the Health Sciences Library to teach first and second year dental students how to search the PubMed database.

Are there any reasons you should not be in this study?
You should not be in this study if you are familiar with the PubMed database.

**How many people will take part in this study?**
If you decide to be in this study, you will be one of approximately 6-8 people in this research study.

**How long will your part in this study last?**
Your one-time session with last no more than 90 minutes.

**What will happen if you take part in the study?**

1. You will be asked to complete the first three lessons of the online tutorial.
2. While you are going through the tutorial, you will be asked to speak aloud your thoughts about the tutorial. These will be audiotaped, with your permission.
3. After completing the 3 lessons, you will be asked to go to PubMed and answer four questions dealing with material that was covered in the tutorial.
4. You will then be asked to respond to several interview quesions about your impressions of the tutorial’s usability.

**What are the possible benefits from being in this study?**

Research is designed to benefit society by gaining new knowledge. You may also expect to benefit by participating in this study by learning how to search for articles using PubMed.

**What are the possible risks or discomforts involved from being in this study?**

I do not know of or foresee any personal risks of discomfort you will have from being in this study. There may be uncommon or previously unknown risks. You should report any problems to the researcher.

**How will your privacy be protected?**

I will make every effort to protect your privacy.

No where on any form or on any information collected from this study or in any research reports will your name appear. Audiotapes of your session will be kept secure in a locked cabinet and will be seen only by me, Anna Krampl. Kathleen McGraw, a reference library at the health Science Library, may be shown the transcripts of clips of the audiotapes for the sole purpose of improving the tutorial’s design., All audiotapes will be destroyed after the study is over.

Participants will not be identified in any report or publication about this study. Although every effort will be made to keep research records private, there may be times when
federal or state law requires the disclosure of such records, including personal information. This is very unlikely, but if disclosure is ever required, UNC-Chapel Hill will take steps allowable by law to protect the privacy of personal information. In some cases, your information in this research study could be reviewed by representatives of the University, research sponsors, or government agencies for purposes such as quality control or safety.

**Will you receive anything for being in this study?**

You will be receiving $15 for taking part in this study. Even if you choose to withdraw from the study, you will still be able to keep the $15.

**Will it cost you anything to be in this study?**

There will be no costs for being in the study.

**What if you have questions about your rights as a research participant?**

All research on human volunteers is reviewed by a committee that works to protect your rights and welfare. If you have questions or concerns about your rights as a research participant you may contact, anonymously if you wish, the Behavioral Institutional Review Board at 919-962-7761 or aa-irb@unc.edu.

**Participant’s Agreement:**

I have read the information provided above. I have asked all the questions I have at this time. I voluntarily agree to participate in this research study.

______________________________   _____________________
Signature of Research Participant     Date

______________________________
Printed Name of Research Participant